https://doi.org/10.48047/AFJBS.7.1.2025.78-90

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

COMPARISON OF CIRCADIAN DISRUPTION AND CHRONONUTRITION BETWEEN DAY AND NIGHT SHIFT WORKERS

Inaba Shujaat Qureshi[1], Hareem Jalal Sahi[2], Momina Ayub[3], Tayyaba Abid[4], Hafsa Amir[5], Maham Asif[6], Tanveer Aslam[7]

[1]Lecturer (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus, Pakistan

[2]Mphil Human Nutrition and Dietetics (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus Pakistan

[3]MPhil Human Nutrition and Dietetics (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus Pakistan

[4]MPhil Human Nutrition and Dietetics (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus Pakistan

[5]MPhil Human Nutrition and Dietetics (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus Pakistan

[6]MPhil Human Nutrition and Dietetics (Department of Human Nutrition and Dietetics), Riphah International University, Islamabad, Lahore Campus Pakistan

[7]Lecturer, Iqra University Chak Shahzad Campus, Islamabad, Pakistan

Corresponding Author: Inaba Shujaat Qureshi,
Lecturer, Riphah International University, Islamabad, Lahore Campus, Pakistan
Email: inaba.shujaat@riphah.edu.pk

Volume 7, Issue 1, Jan 2025

Received: 15 Nov 2024

Accepted: 18 Dec 2024

Published: 04 Jan 2025

doi:10.48047/AFJBS.7.1.2025.78-90

ABSTRACT

Background: The connection between circadian rhythms and nutrition is known as chrononutrition. Our bodies have a natural 24-hour cycle that influences everything from sleep-wake cycle to metabolism and digestion.

Objective: The study examines chrononutrition and circadian rhythms in Day and Night shift workers to understand their routines and dietary habits, aiming to provide insights on how work schedules impact health and well-being for better occupational practices.

Methods: In this cross-sectional study with 124 participants, SPSS 28 assessed chrononutrition in Day and Night Shift workers**.** MEQ assessed morning/evening activity preferences, IPAQ measured physical activity, PSQI evaluated sleep quality, MNA conducted nutritional assessments, and FFQ analyzed dietary habits, quantitatively investigating chrononutrition across work shifts.

Result: In the study, 20.8% of Day Shift workers (n=120) had normal chrononutrition practices, compared to just 3.3% of Night Shift workers. This indicates a significant impact of work schedules on dietary habits and underscores the need for targeted interventions for Night Shift workers.

Conclusion: The study compared Circadian Disruption and Chrononutrition in Day and Night Shift Workers. It found variations in BMI, Chronotype, and physical activity. Both groups had similar sleep quality, but Night Shift Workers consumed more unhealthy foods, while Day Shift Workers preferred healthier options like cereals and fruits.

Key words: Chorononutrition, Circadian Disruption, BMI, MNA, MEQ, PSQI, IPAQ, FFQ

INTRODUCTION

Exploring the correlation between circadian rhythms and nutrition is known as chrononutrition. It is founded on the idea that our bodies have a natural 24-hour cycle that influences everything from our sleep-wake cycle to our metabolism and digestion. Our health and well-being can be maximized by consuming the correct meals at the proper times (1). Also, our internal body clock affects many things like when we sleep, blood pressure, hormones, body temperature, and physical activity, all in about 24-hour cycles (2). A natural body clock that runs on its own and creates 24 hour patterns in the body is called a circadian rhythm (3). The body's internal clock controls how our metabolism works, getting ready for the usual changes in our surroundings. This clock is all over the body, including important metabolic parts like the liver, fat tissues, and intestines. The clock's timing is mostly influenced by the signals it gets from the food we eat (4).

Even though problems with our body clock (circadian rhythm) can be connected to various health issues like shift workers having a higher chance of heart and metabolic problems or cancer, we usually think of circadian rhythm issues as just having trouble with sleep timing. This idea is changing, and now there's a new area of study called circadian medicine that looks at the bigger picture. It's found that changes in the body clock can happen before we see signs of diseases like

problems with memory and thinking. This shows that our overall health is connected to how our body clock works (5)

This study aims for a comparison between day shift and night shift workers to see which one of the two demonstrates positive impact and which one has high risk towards diseases.

People who work during the day are more likely to eat three meals a day, with the majority of their food being consumed during this time. Working shifts often means eating at various times, including during the night. For people who work different hours, like night shifts, it's common for their eating and fasting times to be not in line with their body's natural clock. This is called circadian misalignment. In connection with this, it is known that variations in food consumption, particularly among shift workers, have an impact on a number of aspects of cognitive function, emotional state, and wakefulness (6).

The International Labor Organization and the European Foundation for the Improvement of Living and Working Conditions conducted a study across 187 countries involving about 1.2 billion workers. It revealed that roughly 10% to 30% workers engage at least once a month at night shift, with 12% to 13% following a rotating or regular night-shift pattern in North America. (7)

People who ate during atypical timings due to shift work or long-term jet lag are prone to develop CVDs, diabetes type 2 and obesity. Weak energy expenditure, irregular sleep hormones, stress, and appetite circadian rhythms, as well as weight gain, have all been linked to late and delayed meals.

An assortment of long-term conditions affecting the heart, blood vessels, and metabolism is referred to as cardio metabolic illnesses, or CMDs. Chronic nutrition can have a range of positive benefits on cardio metabolic health, including the treatment of diabetes, chronic kidney disease, and cardiovascular disease (CVD). Chrononutrition is the practice of consuming food with correspond to circadian rhythms of body. This can help to enhance blood sugar balance, inflammation, metabolism, hunger regulation, and sleep quality (8).

Blood glucose levels are influenced by the circadian clock, which modifies insulin sensitivity and secretion patterns to produce highly cyclic fluctuations. Compared to eating the same meal in the morning, eating a carbohydrate-rich meal at night causes an increase in postprandial glycaemia (9).

Day workers and night workers have similar characteristics that may upset the circadian physiological cycle and lead to desynchronization. Frequent snacks, inactivity, inactive eating habits, and nocturnal physical activity are all potential nighttime causes. Systemic arterial hypertension, dyslipidemias, and diabetes mellitus may develop as a result of shift workers it is recognized that the primary causes of the rise in obesity are factors associated with a particular routine, like eating too many calories and leading sedentary lives. A higher body mass index (BMI) is positively correlated with night workers and this correlation is noticeably higher than for day shift workers (10). Night shift workers smoked more frequently, consumed fewer fruits and vegetables, engaged in less physical activity, and experienced lower-quality sleep (11). Meal timings can induce glucose intolerance by altering the phase relationship in liver and pancreatic

cells between the central circadian pacemaker and peripheral oscillator's. Dietary influences on circadian rhythmicity surely involve a connection between elements like meal timing and nutrition (chrononutrition) The glucose and lipid tolerance of shift workers was found to be reduced after switching from day shift to night shift (9).

Shift work is defined as a 24-hour work schedule with irregular hours, often including nighttime work, leading to circadian misalignment and inadequate sleep. Research indicates a higher likelihood of overweight or obesity among shift workers, along with an increased risk of nutritional and metabolic disorders such as dyslipidemias, metabolic syndrome, and type (12).

Circadian misalignment, marked by disparities between eating and sleeping times and the light-dark cycle, results in a mismatch between central and peripheral clocks. This misalignment has been associated with adverse physiological markers, including elevated blood pressure and inflammation (13).

MATERIALS AND METHODS

This cross-sectional study was assessed day and night shift workers using a structured questionnaire. The sample size consists of 124 participants (62 in each group), accounting for a 10% dropout rate. Data was to be collected through convenience sampling, targeting male and female workers aged 22-40 years. The study was placed between September and December 2023. Inclusion criteria include day and night shift workers within the specified age range who were willing to participate. Exclusion criteria include non-shift workers, individuals under 20 or over 40 years old, frequent travelers across time zones, those not willing to participate, and workers with chronic diseases.

The demographic data was collected through questions on age, gender, occupation, education, and employment status. Participants were also asked about their family structure (joint or nuclear), housing (owned or rented), and residential area. Finally, they were inquired about their socioeconomic status (upper, middle, or lower class).Respondents provided their anthropometric information, including height, weight, and BMI.

The MNA tool was used to assess malnutrition risk, nutritional status, and the possibility of malnourishment. Participants were categorized as having normal nutritional status, being at risk of malnutrition, or malnourished based on their scores. A total of 0-7 points indicated malnutrition, 8-11 points indicated a risk of malnutrition, and 12-14 points indicated normal nutritional status (14).The Mornings-Evenings Questionnaire (MEQ) assessed participants' sleep schedules, both on workdays and off-days. Based on 19 questions with scores from 1-4, respondents were categorized into different groups: definite evening, moderate evening, intermediate, moderate morning, or definite morning (15).The PSQI tool was used to evaluate sleep quality by asking about bedtime, time to fall asleep, total sleep duration, sleep disturbances, and the use of sleep aids. The global score, derived from seven components, indicated whether a participant was a good or bad sleeper based on their score (16).The IPAQ tool assessed physical activity levels, including time spent on moderate and vigorous activities, as well as walking and sedentary behavior. The frequency and duration of physical activities were recorded and used to calculate physical activity levels (17).The Food Frequency Questionnaire (FFQ) assessed participants' eating habits, including the frequency

of consumption of various food categories like meat, cereals, dairy, fruits, vegetables, fats, sweets, and drinks (18). Data was analyzed using Microsoft Excel and SPSS version 28.0. The Chi-square test was used to examine correlations between categorical variables, with a P-value of 0.05 considered statistically significant.

RESULTS

SHIFT WORKERS	**Day**	**Night**
CATEGORY	**FREQUENCY(PERCENTAGE)**	
GENDER OF RESPONDENTS		
Male	25(20.8%)	28 (23.3%)
Female	35 (29.5%)	32 (26.7%)
EDUCATION OF RESPONDENTS		
Uneducated	1 (0.8%)	2(1,7%)
Matriculation	3(2.5%)	9(7.5%)
Graduated	30(25%)	42 (35%)
Post Graduation	26(21.7%)	7(5.8%)
SALARY OF RESPONDENTS		
<25000	9 (7.5%)	15(12.5%)
26000-50000	21(17.5%)	20(16.8%)
51000-75000	10(8.3%)	17(14.2%)
76000-100000	8(6.7%)	5 (4.2%)
>100000	12 (10%)	3 (2.5%)
FAMILY TYPE OF RESPONDENTS		
Joint	29(24.2%)	31(25.8%)
Nuclear	31(25.6%)	29 (24.2%)
RESIDENCY OF RESPONDENTS		
Own House	50 (41.7%)	38(31.7%)
Rent House	10 (8.3%)	22(18.3%)
RESIDENTIAL AREA OF RESPONDENTS		
Urban	49(40.8%)	51(42.5%)
Peri Urban	10(8.3%)	8(6.7%)
Rural	1(0.8)	1(0.8%)

Table: Association of Frequency Distribution of BMI among Day and Night Shift Workers

BMI	**Day shift**	**Night Shift**	**Total**	**P-Value**
Underweight (<18.0)	3(2.5%)	12(10%)	15(12.5%)	.000*
Normal (18.1-24.9)	37(30.8%)	4(3.3%)	41(34.2%)	

Overweight (25-29.9)	16(13.3%)	26(21.7%)	42(35%)	
Obese G1 (30-34.9)	2(1.7%)	15(12.5%)	17(14.2%)	
Obese G2 (35-39.9)	2(1.7%)	3(2.5%)	5(4.2%)	
total	60(50%)	60(50%)	120(100%)	

The BMI distribution among workers revealed that 37 (30.8%) in the Day Shift and 4 (3.3%) in the Night Shift fell within the normal range (18.1-24.9). Conversely, 3 (2.5%) in the Day Shift were categorized as underweight (<18.0), while 12 (10.0%) in the Night Shift were underweight. For overweight individuals (25-29.9), 16 (13.3%) were observed in the Day Shift, and 26 (21.7%) in the Night Shift. Those classified as obese Grade 1 (30-34.9) included 2 (1.7%) Day Shift workers and 15 (12.5%) Night Shift workers. In the Obese Grade 2 category (35–39.9), 2 (1.7%) in the Day Shift and 3 (2.5%) in the Night Shift fell into this classification.Statistical analysis using the Chi-Square test indicated a significant difference in BMI distribution between Day and Night Shift workers at a significance level of <0.05.

Table: Association of Frequency Distribution of MEQ among Day and Night Shift Workers

MEQ	Day Shift	Night Shift	Total	P - Value
Definite Evening (16 -30)	2 (1.7%)	14(11.7%)	16(13.3%)	.000*
Moderate Evening (31-41)	6(5%)	31(25.8%)	37(30.8%)	
Intermediate (42-58)	38(31.7%)	15(12.5%)	53(44.2%)	
Moderate Morning (59-69)	12(10%)	0(0%)	12(10%)	
Definite Morning (70-86)	2(1.7%)	0(0%)	2(1.7%)	
Total	60(50%)	60(50%)	120(100%)	

Among the respondents, 2 (1.7%) in the Day Shift were categorized as Definite Evening types (16-30), whereas 14 (11.7%) in the Night Shift fell into the same category. In the Moderate Evening category (31-41), 6 (5.0%) of Day Shift workers and 31 (25.8%) of Night Shift workers were classified. For the Intermediate category (42–58), 38 (31.7%) in the Day Shift and 15 (12.5%) in the Night Shift fell within this range. In the Moderate Morning category (59-69), 12 (10.0%) Day Shift workers were classified, while none (0.0%) from the Night Shift fell into this category.
Regarding early risers, 2 (1.7%) of Day Shift workers were adaptable early risers, and none (0.0%) were definite early risers. The Pearson Chi-Square test revealed a significant difference in Morningness-Eveningness Questionnaire (MEQ) distribution between Day and Night Shift workers at a significance level of <0.05.

Table: Association of Frequency Distribution of MNA among Day and Night Shift Workers

MNA	Day Shift	Night Shift	Total	P - Value
Normal Nutritional status (12-14)	24(20%)	4(3.3%)	28(23.3%)	.000*
At risk of malnutrition (8-11)	30(25%)	44(36.7%)	74(61.7%)	
Malnourished (0-7)	6(5%)	12(10%)	18(15%)	
Total	60(50%)	60(50%)	120(100%)	

In terms of nutritional status 24 (20%) from the Day Shift and 4 (3.3%) from the Night Shift, fell within the Normal Nutritional status range (scores 12-14). A significant proportion of 30 (25%) from the Day Shift and 44 (36.7%) from the Night Shift, were found to be at risk of malnutrition (scores 8-11). Additionally,6 (5%) from the Day Shift and 12 (10%) from the Night Shift, were classified as malnourished (scores 0-7).P value was significant <0.05.

Table: Association of Frequency Distribution of PSQI among Day and Night Shift Workers

Global Score PSQI	Day Shift	Night Shift	Total	P- Value
Good Sleeper (1-5)	33(27.5%)	30(25%)	63(52%)	.357
Poor Sleeper (6-12)	27(22.5%)	30(25%)	57(47.5%)	
Total	60(50%)	60(50%)	120(100%)	

In assessing the overall sleep quality using the PSQI, the results revealed that 33 (27.5%) respondents in the Day Shift and 30 (25%) in the Night Shift were categorized as Good Sleepers (scores 1-5). On the other hand, 27 (22.5%) Day Shift workers and 30 (25%) Night Shift workers were identified as Poor Sleepers (scores 6-12). The pearson Chi- Square test between Day and Night Shift workers of global score showed non significance with P value > 0.05.

Table: Association of Frequency Distribution of IPAQ among Day and Night Shift Workers

IPAQ	Day Shift	Night Shift	Total	P- Value
Low <600 MET	23(19.29%)	38(31.7%)	61(50.8%)	.004*
Moderate 600-3000 MET	28(23.3%)	22(18.3%)	50(41.7%)	
>3000 MET	4(3.3%)	0(0%)	4(3.3%)	
Total	60(50%)	60(50%)	60(50%	

In the assessment of physical activity levels using the IPAQ, it was found that 23 (19.29%) Day Shift workers and 38 (31.7%) Night Shift workers fell into the Low category (<600 MET). In the Moderate category (600-3000 MET), 28 (23.3%) Day Shift workers and 22 (18.3%) Night Shift workers were classified. Notably, 4 (3.3%) Day Shift workers engaged in high physical activity levels (>3000 MET), while none (0%) of the Night Shift workers reached this level.P value was significant <0.05.

Table: Association of Frequency Distribution of FFQ among Day and Night Shift Workers

FOOD FREQUENCEY QUESTIONAIRE												
Food Products	**Never /Once a month**		**1-3 /month**		**Once a week**		**2-4/week**		**5-6/week**		**1/Day**	
	D.S	**N.S**	**D.S**	**N.S**	**D.S**	**N.S**	**D.S**	**N.S**	**D.S**	**N.S**	**D.S**	**N.S**
Meat Group	10	11	17	12	18	28	12	06	01	02	02	01
Cereals	0	01	0	02	03	12	14	29	16	10	15	04
Dairy	0	03	03	12	10	29	13	12	18	03	16	01
Fruits	0	0	1	0	06	12	07	16	26	23	19	09
Vegetable	0	0	01	05	02	15	22	18	26	18	09	04
Fried And Processed	11	09	17	15	25	33	07	03	0	0	0	0
Fats(nuts)	09	11	11	26	16	13	20	09	1	1	03	0

Food consumption patterns between day (D.S) and night shift (N.S) workers. Day shift workers generally consume healthier foods more frequently. For instance, 28% of D.S workers eat meat 2-4 times per week compared to 12% of N.S workers. Similarly, 29% of D.S workers have cereals 5-6 times weekly, while only 16% of N.S workers do the same. Dairy and fruit intake is also higher among D.S workers, with 16% having dairy daily compared to 1% of N.S, and 19% consuming fruits daily versus 9% of N.S. Fried foods are more commonly eaten by night shift workers (33% once weekly), while day shift workers show higher nut consumption. Overall, day shift workers have a more consistent intake of healthier foods.

DISCUSSION

In this study, notable differences were observed between the two groups, shedding light on the interplay of demographic, socioeconomic, and lifestyle factors with circadian rhythms and nutritional behaviors. Night shift workers were predominantly female, while postgraduates were more common in the day shift. Salaries mostly ranged from 26,000 to 50,000, but day shift workers more often earned above 1 lakh. Both groups predominantly resided in urban areas, with middle-class workers comprising half of the workforce. These findings provide a critical foundation for analyzing how work schedules impact circadian alignment and dietary habits, offering valuable insights for targeted interventions.

The examination from present study reveals significant differences in BMI distributions between day and night shift workers. Day shift workers had a higher percentage in the normal BMI range (37%) compared to night shift workers (4%). Night shift workers showed higher rates of underweight (12% vs. 3%), overweight (26% vs. 16%), and Obese G1 (15% vs. 2%). In the Obese G2 category, night shift workers slightly outnumbered day shift workers (3 vs. 2). These findings highlight potential health imbalances associated with shift work.

In addition to these studies there were several more studies that proved the same result just like this one which was conducted at a hospital this cross-sectional study was done to assess the association between Lebanese nurses' eating habits with body mass index (BMI) in night shift workers. However, the results proved that the eating habits of night shift workers were irregular and the number of snacks they ate at night were unreasonable as compared to meals they had which correlates with abnormal BMI (19).

Hence the overall results of the studies proved that the night shift workers exhibit a higher percentage of underweight, overweight, and obese individuals compared to day shift workers. Day shift workers, on the other hand, show a higher prevalence of individuals with a normal BMI.

In our study we used MEQ questionnaire in order to determine the chronotype of individuals whether they were morning persons or evening persons. After employing this tool we came to know that Day shift workers were in morning chronotype category, they preferred to work during early or day time. In contrast to Night shift workers they were in evening chronotype category. They were feeling more energetic during night timings. They were working with their full potential during night time.

A similar study was conducted in order to evaluate the effect of chronotype on academic performance of students in Milan. According to chronotype the students were divided into three groups Morning-Type (MT), Evening-Type (ET), and Neither-Type (NT). After assessing its was seen that the students in Morning chronotype group were good in their studies. They scored higher in both practical and theoretical papers as compared to both other groups. Evening chronotype group performed worst in practical exam. As for as NT concerned there mean average in theoretical exam was very poor. So overall morning chronotype students showed great academic results this because of coordination of circadian rhythms during exam performance (20).

In our investigation of sleep quality, the Pittsburgh Sleep Quality Index (PSQI) was employed, yielding non-significant results. Among the day shift workers, 33 individuals were identified as having good sleep quality as compared to night shift workers who had 30 good sleepers and 30 individuals with poor sleep quality. Whereas the day shift workers had only 27 individuals with poor sleep quality which suggests that sleep quality of day shift workers are better than the night shift workers.

Furthermore, a similar study was conducted in Korea, researchers studied how the timing and types of meals before bedtime relate to the sleep quality of nurses who work night shifts. They wanted to see if there's a connection between when nurses eat and what they eat before bedtime and how well they sleep after finishing their night shifts. The results uncovered a fascinating connection between the content of meals and sleep quality, especially for those working the night shift. What we found was that consuming meals with higher calorie content positively impacted sleep. Night shift workers who had their meals closer to bedtime reported longer sleep durations, and this can be attributed to disruptions in their circadian rhythms. Interestingly, those night shift workers who opted for meals rich in calories experienced better sleep quality compared to their counterparts who opted for lower-calorie options. Hence, the conclusion drawn from these observations was that there seems to be a link between higher-calorie meals and improved sleep quality, potentially

owing to their ability to alleviate hunger and reduce anxiety. These findings show the importance of considering meal content, particularly calorie intake, as a potential factor influencing the sleep patterns of night shift workers (21).

Another examination from our study was conducted in which we studied the activity levels of Day and Night shift workers and for a better understanding of this comparison IPAQ was used. Our study showed results as for lower than 600 MET Night shift workers ranges were higher as compared to Day shift workers. Whereas, higher ranges of Day shift workers scored in moderate MET (600- 3000) when compared with Night shift workers. Lastly, only 4 Day shift workers scored greater than 3000 MET. This showed significant results as of Day shift workers were seen to have a more active lifestyle as compared to Night shift workers.

Another study was found which showed different results from our study. As this study was conducted among nurses from the University Malaya Medical Centre, Kuala Lumpur to understand the physical activity levels of hospital nurses with different work schedules and explore how their demographic backgrounds, body mass index (BMI), and work schedules relate to their physical activity. When comparing shift-work and day-work, statistically significant differences emerged in the 'work, domestic chores, and intensity-specific walking and vigorous activity domains.

However, overall physical activity engagement remained high in both groups. Therefore, the study suggests that working shifts does not compromise the overall measured physical activity levels of individual nurses (22).

In our research dietary assessment was done which revealed the dietary patterns of day and night shift worker. The consumption of fried items like fries, pakoray, samosay was high in night shift workers as compared to day shift workers. Moreover, night shift workers showed high intake of pizza, burger and chocolates showing a trend of less nutritious and unhealthy eating patterns.

Similar study was conducted to examine the energy and food intake of night shift workers. Night shift workers dietary habits were recognized as particularly unhealthy, putting them at higher risk of diseases. Their calcium,fiber and sodium intake was lowered ,leading towards nutritional deficiencies associated health risks. In contrast to day shift workers showed commendable meal timing practices and they were maintaining healthy eating habits (23).

A study comparing the nutritional habits of night shift nurses and midwives found significant differences in eating patterns. Night shift workers had higher intakes of energy, cholesterol, and carbohydrates, leading to higher rates of overweight and obesity. In contrast, midwives, as non-shift workers, exhibited more balanced diets, highlighting the health risks of shift work on nutritional choices. (24).

CONCLUSION

In our study we did comparison of Circadian Disruption and Chrononutrition between Day and Night Shift Workers. The comparison showed more females in Night Shifts as of males. The results of BMI, MNA, MEQ and IPAQ were significant whereas PSQI showed non significant result. The consumption of fried food items, chocolates, carbonated beverages was high among Night Shift

Workers whereas the consumption of cereals, fruits and vegetables was high among Day Shift Workers.

Limitation of study

- Data of the Day and Night shift workers was not inquired by the Pakistan Bureau of Statistics which should be an addition for the upcoming surveys for Pakistan.
- Difficulties were encountered during the data collection process from Night Shift Workers
- Participants were not willing to cooperate in our study.
- Participants were not willing to share their Dietary information.

Recommendations

After the completion of the study, the following suggestions and recommendations are made:

- Awareness campaign, health education program/sessions /seminar should be organized to educate the people about the chorononutrition.
- Electronic and print media should also be used as strong communication for awareness programs among the people.
- Regular dietary habits should be assessed.
- Further research should be suggested to evaluate effect of chorononutrition on health.

REFERENCES

1. Tahara Y, Qian J, Oike H, Escobar C. The present and future of chrono-nutrition studies. Frontiers in Nutrition. 2023 Apr 3;10:1183320.
2. Aoyama S, Shibata S. Time-of-day-dependent physiological responses to meal and exercise. Frontiers in Nutrition. 2020 Feb 28;7:18.
3. Fatima N, Rana S. Metabolic implications of circadian disruption. Pflügers Archiv-European Journal of Physiology. 2020 May;472:513-26.
4. Pickel L, Lee JH, Maughan H, Shi IQ, Verma N, Yeung C, Guttman D, Sung HK. Circadian rhythms in metabolic organs and the microbiota during acute fasting in mice. Physiological Reports. 2022 Jul;10(14):e15393.
5. Abbott SM, Malkani RG, Zee PC. Circadian disruption and human health: A bidirectional relationship. European Journal of Neuroscience. 2020 Jan;51(1):567-83.
6. Mohd Azmi NA, Juliana N, Mohd Fahmi Teng NI, Azmani S, Das S, Effendy N. Consequences of circadian disruption in shift workers on chrononutrition and their psychosocial well-being. International journal of environmental research and public health. 2020 Mar;17(6):2043.
7. Boivin DB, Boudreau P, Kosmadopoulos A. Disturbance of the circadian system in shift work and its health impact. Journal of biological rhythms. 2022 Feb;37(1):3-28.
8. Katsi V, Papakonstantinou IP, Soulaidopoulos S, Katsiki N, Tsioufis K. Chrononutrition in cardiometabolic health. Journal of Clinical Medicine. 2022 Jan 7;11(2):296.

9. Henry CJ, Kaur B, Quek RY. Chrononutrition in the management of diabetes. Nutrition & diabetes. 2020 Feb 19;10(1):6.
10. Brum MC, Dantas Filho FF, Schnorr CC, Bertoletti OA, Bottega GB, da Costa Rodrigues T. Night shift work, short sleep and obesity. Diabetology & metabolic syndrome. 2020 Dec;12:1-9.
11. Hulsegge G, Proper KI, Loef B, Paagman H, Anema JR, van Mechelen W. The mediating role of lifestyle in the relationship between shift work, obesity and diabetes. International Archives of Occupational and Environmental Health. 2021 Aug;94:1287-95.
12. Silva, C. M., Teixeira, B. S., Wright Jr, K. P., Maia, Y. C. D. P., & Crispim, C. A. (2022). Time-related eating patterns are associated with the total daily intake of calories and macronutrients in day and night shift workers. Nutrients, 14(11), 2202.
13. Phoi, Y. Y., Bonham, M. P., Rogers, M., Dorrian, J., & Coates, A. M. (2021). Content validation of a chrononutrition questionnaire for the general and shift work populations: a delphi study. Nutrients, 13(11), 4087.
14. Sonneborn-Papakostopoulos M, Dubois C, Mathies V, Heß M, Erickson N, Ernst T, Huebner J. Quality of life, symptoms and dietary habits in oncology outpatients with malnutrition: A cross-sectional study. Medical Oncology. 2021 Feb;38:1-0.
15. Özata Uyar G, Yildiran H, Korkmaz G, Kiliç G, Kesgin BN. The effect of chronotype on chrononutrition and circadian parameters in adults: a cross-sectional study. Biological Rhythm Research. 2023 Dec 2;54(12):782-802.
16. Magalhães AC, Marques CG, Lucin GA, Nakamoto FP, Tufik S, Thomatieli-Santos RV, Dos Santos Quaresma MV. The relationship between sleep-and circadian rhythm-related parameters with dietary practices and food intake of sedentary adults: a cross-sectional study. Sleep and Biological Rhythms. 2023 Sep 26:1-2.
17. Ács P, Betlehem J, Oláh A, Bergier J, Melczer C, Prémusz V, Makai A. Measurement of public health benefits of physical activity: validity and reliability study of the international physical activity questionnaire in Hungary. BMC Public Health. 2020 Aug 17;20(Suppl 1):1198. (D)5
18. de Rijk MG. Time to eat: The diet of night shift workers from different dietary perspectives and its association with health and safety (Doctoral dissertation, Wageningen University).
19. Samhat Z, Attieh R, Sacre Y. Relationship between night shift work, eating habits and BMI among nurses in Lebanon. BMC nursing. 2020 Dec;19(1):1-6.
20. Montaruli A, Castelli L, Galasso L, Mulè A, Bruno E, Esposito F, Caumo A, Roveda E. Effect of chronotype on academic achievement in a sample of Italian University students. Chronobiology international. 2019 Nov 2;36(11):1482-95.
21. Upadhyay D, Agrawal S, Verma A, Mahajan N, Shah N. Evaluation of prevalence of daytime sleepiness and its association with chronotype in undergraduate medical and paramedical students. Natl. J. Integr. Res. Med. 2019 Jul 1;10:10-7.

22. Li LZ, Danaee M, Jaafar Z. The association between physical activity and work schedule among hospital nurses: A cross-sectional study. Malaysian Journal of Movement, Health & Exercise. 2019 Jan 1;8(1):15-32.
23. Bucher Della Torre S, Wild P, Dorribo V, Danuser B, Amati F. Energy, nutrient and food intakes of male shift workers vary according to the schedule type but not the number of nights worked. Nutrients. 2020 Mar 27;12(4):919.
24. Peplonska B, Kaluzny P, Trafalska E. Rotating night shift work and nutrition of nurses and midwives. Chronobiology international. 2019 Jul 3;36(7):945-54.