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Chronotype patterns of medical shift workers at Government District Hospital of Bilaspur, Chhattisgarh, India

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Abstract

This study investigated the influence of chronotype behaviour on body mass index (BMI) and associated demographic factors among two distinct groups; a control group of daytime workers and a shift worker group. The control group, comprising fixed daytime workers, showed significant gender differences in BMI and chronotype scores, with females exhibiting higher BMI and more pronounced chronotype effects than males. Marital status significantly influenced BMI and chronotype in married and unmarried subjects differently, with unmarried individuals displaying stronger chronotype associations. A positive correlation between BMI and chronotype scores was observed, suggesting interdependence between circadian preferences and body composition. Among shift workers, females demonstrated significant effects of gender on both BMI and chronotype, whereas males did not. Marital status impacted BMI significantly only in married shift workers. The correlation between BMI and chronotype was also significant in shift workers, reinforcing the relationship between circadian rhythm and metabolic factors. Mann-Whitney analyses revealed that BMI significantly affected shift workers, while chronotype significantly influenced control subjects. These findings underscore the complex interactions between chronobiological factors, work patterns, and metabolic health, highlighting the importance of chronotype in understanding health outcomes in both shift and daytime workers.

Keywords: Chronotype, body mass index (BMI), gender differences, shift work, circadian rhythm

Introduction

Health is a multidimensional concept that encompasses physical, mental, and social well-being. It goes beyond the absence of disease and reflects a state of complete physical, mental, and social vitality. Achieving and maintaining good health is crucial for individuals to lead fulfilling and productive lives (Young *et al.*, 2009). Physical health refers to the overall condition of the body and its ability to function optimally. It involves aspects such as regular exercise, proper nutrition, adequate sleep, and the absence of physical ailments or diseases. Engaging in regular physical activity helps strengthen the cardiovascular system, build muscle strength, improve flexibility, and enhance overall endurance. A balanced diet that includes a variety of nutrients is essential to provide the body with the energy and building blocks it needs to function properly. Sufficient sleep is also vital for the body's restoration and repair processes. Taking care of one's physical health not only prevents the onset of various diseases but also improves the overall quality of life (Vázquez et al., 2009; Gurung et al., 1997). Health is an ongoing process that requires conscious efforts and regular attention. Adopting a healthy lifestyle that incorporates regular physical activity, a balanced diet, sufficient sleep, and stress management techniques can significantly contribute to overall well-being. Medical health hazards refer to conditions or factors that can have adverse effects on a person's health, specifically those related to medical or healthcare settings. These hazards can arise from various sources and may pose risks to both patients and healthcare professionals. Understanding and mitigating these hazards is crucial to ensure a safe and healthy environment within medical facilities. Biological rhythms are inherent patterns of changes that occur in living organisms. These rhythms are influenced by internal biological processes, as well as external factors such as light, temperature, and social cues. One of the most well-known biological rhythms is the circadian rhythm, which refers to the 24-hour cycle that regulates various physiological and behavioral processes in humans and other organisms (Halle and Stenseth, 2000).

The circadian rhythm plays a fundamental role in synchronizing an organism's internal functions with the external environment. It influences the sleep-wake cycle, hormone production, metabolism, body temperature, and cognitive performance. Disruptions to the circadian rhythm, such as those experienced during shift work or jet lag, can have significant impacts on health and well-being. Irregular sleep patterns and desynchronized internal clocks have been associated with increased risks of various health problems, including cardiovascular diseases, metabolic disorders, mood disorders, and impaired cognitive function (Amaral *et al*., 2014). Apart from the circadian rhythm, there are other biological rhythms that operate on different time scales. Ultradian rhythms have a shorter duration, occurring multiple times within a 24-hour period. Examples include patterns of hormone release, feeding behavior, and certain stages of sleep. Infradian rhythms, on the other hand, have a longer duration and occur less frequently than once per day. Examples include the menstrual cycle in females, seasonal reproductive cycles in animals, and the hibernation patterns of certain species (Gerkema, 2002; Neves *et al*., 2022). Medical shift workers, such as nurses, doctors, and other healthcare professionals, often face significant challenges in maintaining a healthy circadian rhythm due to their irregular work schedules. The circadian rhythm, which regulates the sleep-wake cycle and other physiological processes, can be disrupted when working night shifts, rotating shifts, or extended hours. Night shift work, in particular, poses a major challenge to the circadian rhythm. The human body is naturally programmed to be awake during daylight hours and sleep during the night. Working at night disrupts this natural pattern and requires individuals to be awake and active when their internal clocks signal it is time to sleep. This misalignment can lead to difficulties falling asleep and staying asleep during the day, resulting in reduced sleep quantity and quality. Shift workers often experience a condition known as shift work sleep disorder (SWSD). SWSD is characterized by excessive sleepiness or insomnia during the desired sleep period, along with fatigue, difficulty concentrating, and a general sense of malaise. These symptoms can impair job performance, increase the risk of accidents, and have negative effects on physical and mental health (Wilson and Nutt, 2008). The irregularity of rotating shifts further complicates the circadian rhythm. Shift workers frequently alternate between day shifts, evening shifts, and night shifts, disrupting the consistency of their sleep-wake patterns. The body needs time to adjust to new schedules, leading to a continuous struggle to synchronize the internal body clock with changing work shifts (Costa, 1996).

To mitigate the impact on circadian rhythm, various strategies can be employed. Implementing bright light exposure during night shifts and using blackout curtains or sleep masks during the day can help shift workers align their sleep-wake cycles with their work schedules. Maintaining a regular sleep routine, even on days off, can also assist in stabilizing the circadian rhythm. Additionally, proper sleep hygiene practices are essential for shift workers. Creating a sleep-conducive environment, including a dark and quiet room, maintaining a cool temperature, and minimizing distractions, can help improve sleep quality. Avoiding stimulants like caffeine close to bedtime and establishing a relaxing pre-sleep routine are also beneficial. Organizational interventions can play a vital role in supporting shift workers' circadian rhythm. This may involve optimizing shift schedules to allow for adequate rest and recovery, reducing the number of consecutive night shifts, and implementing nap breaks during extended shifts. Workplace policies that prioritize employee well-being and provide support for healthy sleep habits can contribute to better circadian rhythm management. Medical workers also act as patient advocates, respecting their rights and preferences while promoting informed decision-making. Continuous learning and professional development are vital to stay updated with medical advancements. Adherence to ethical and legal standards, including patient confidentiality, is of utmost importance. Through their dedication and expertise, medical workers strive to improve patient outcomes and contribute to the overall well-being of individuals under their care (Tarzian, 2015). Shift workers, such as those in healthcare, transportation, and hospitality industries, often experience disruptions to their circadian rhythm due to irregular work schedules that involve night shifts, rotating shifts, or extended hours. The circadian rhythm is the internal biological clock that regulates various physiological and behavioral processes over a 24-hour cycle. The disruption of the circadian rhythm can have a significant impact on sleep patterns, overall health, and job performance. Therefore, there is need to investigate on Chronotype patterns of medical shift worker's staff at District Hopsital, Bilaspur, Chhattisgarh to evaluate the circadian rhythm can be mitigated, leading to improved well-being and performance for shift workers.

Materials and methods

Study location: The present study was carried out on medical shift workers at Government District Hospital of Bilaspur, Chhattisgarh. The street address of this place is 35F5+MCR, Old Bus Stand, Chhattisgarh, India. It is about 1.30 kilometers away from the Bilaspur Junction railway station. It is a top player in the category Hospitals in the Bilaspur-Chhattisgarh. This well-known establishment acts as a one-stop destination servicing customers both local and from other parts of Bilaspur-Chhattisgarh. It is known to provide top service in the following categories: Hospitals, Public Hospitals, Coronavirus Treatment Hospitals, PMJAY Scheme Hospitals. District Hospital in Bus Stand Road has a wide range of products and / or services to cater to the varied requirements of their customers. The staff at this establishment is courteous and prompt at providing any assistance (Plate-1).

Methodology:

Sampling Method: In this study a non-probability sampling method was used. Under non- probability technique, convenience sampling method is considered. The population consists of people who were working in different shift at District Hospital, Bilaspur, Chhattisgarh. The study was purely an offline questionnaire-based survey [Questionnaire for chrono-behavioural survey (Horne & Ostberg, 1976)] conducted in District Hospital of Bilaspur, Chhattisgarh. The current study was a shift wise study of medical staff where chronotype behavioural details has been recorded from medical shift workers and controlled group. The information of BMI index and chronotype behaviour was collected through the nursing staff and doctors on duty working in the hospital. The staffs were recruited by sharing and circulating the forms in English and Hindi language in the hospital. Ethical approval was obtained from the medical officers of the District Hospital. Further, data was recorded in the MS Excel worksheet for analysis.

Table-1: Chronotype parameters to estimate the circadian rhythm/ activity.

Parameters of working	Score
Definitely morning type	70-86
Moderately morning type	59-69
Neither type	42-58
Definitely evening type	31-41
Moderatlty evening type	16-30

Data analysis and interpretation: Data analysis and interpretation will be done with the help of appropriate data which has been collected through the questionnaire on worksheet. SPSS 16.0 were employed to calculate and analyze the collected data. The t-test and Mann Whitney test were performed to analyse various effects on BMI and chronotype on medical shift worker group and controlled group.

Plate-1: Study location-Government District Hospital, Bilaspur, Chhattisgarh.

Collection of data from shift worker as experimental group

Collection of data from of banking staff as controlled (non-shift worker) group

Plate-2: Showing the data collection from experimental and control group.

Results and Discussions

Parametric descriptions of control (non-shift worker) and shift worker group

Medical shift workers face significant challenges in maintaining a healthy circadian rhythm due to their irregular work schedules. The disruption of natural sleep-wake patterns can lead to sleep disorders, fatigue, and potential health risks. However, by implementing strategies such as proper sleep hygiene, light exposure management, and organizational support, shift workers can mitigate the negative effects on their circadian rhythm and enhance overall well-being. This study revealed that among control (non-shift worker) group, a total of 30 respondents/subjects were considered as control group and participated on questionnaire survey based on chronotype behaviour during the study period (April, 2023 to June, 2023). All the responded /subjects were belonged to day time working pattern on a fixed time duration. Among all 30 respondents/subjects of control group 20 were male, while 10 were female subjects. Likewise, 17 were married and 13 were unmarried subjects. The age of control group ranges from 58 year as maximum whereas, 25 year as minimum (Table-2). The dataset revealed interesting relationships between gender, marital status, BMI, and chronotype score. Males, particularly those who are older and married, tend to have higher BMI values, with several individuals classified as overweight or obese (e.g., CG-9, CG-10, CG-18), aligning with findings that weight gain is common after marriage due to lifestyle and dietary changes (Gordon et al., 1986). In contrast, younger, unmarried females generally exhibit lower BMI, with some falling into the underweight range (e.g., CG-3, CG-23), consistent with global trends in female body composition (WHO, 2023). Chronotype scores tend to be higher among younger, unmarried individuals, especially males (e.g., CG-6, CG-7), suggesting a morning-oriented preference, while older, higher-BMI individuals often exhibit lower scores, potentially indicating eveningness or disrupted circadian rhythms—a pattern supported by research linking obesity with evening chronotypes (Folkard & Akerstedt, 2004). These associations highlight the potential interplay between biological, lifestyle, and social factors in shaping health and behavioural patterns.
On the other hand, shift worker group, a total of 50 respondents/subjects were considered as shift worker group and participated on questionnaire survey based on chronotype behaviour during the study period (April, 2023 to June, 2023). All the responded /subjects were belonged to day time working pattern on a fixed time duration. Among all 50 respondents/subjects of shift worker group 23 were male, while 28 were female subjects. Likewise, 21 were married and 29 were unmarried subjects. The age of control group ranges from 53 year as maximum whaereas, 20 year as minimum respectively (Table-3). Shift work, characterized by rotating work schedules and disturbances in light/dark cycles, has a direct impact on sleep and can contribute to various health abnormalities such as insomnia, sleep apnea, periodic leg movements, restless leg syndrome (RLS), and sleep-wake state dissociation disorders including rapid eye movement (REM) and narcolepsy, sleep behavior disorder, and sleepwalking (Hanna et al., 2008). The dataset of 51 individuals showed clear trends in BMI and chronotype scores across gender, age, and marital status. A large portion of participants, particularly young, unmarried females, display underweight to normal BMI ranges (e.g., SWG-1, SWG-3, SWG-18), with several showing BMIs below 18.5, which could reflect cultural or aesthetic pressures, or potential nutritional concerns (WHO, 2023). Conversely, some older married females and males present with overweight or obese BMIs (e.g., SWG-12: BMI 29.82; SWG-47: BMI 31.05), supporting studies linking marriage and age with higher body weight due to lifestyle and dietary changes (Sobal et al., 2003). Chronotype scores mostly fall in the mid-30s to mid-40s, suggesting a general intermediate to evening preference, particularly among those with higher BMI (e.g., SWG-47, SWG-12), consistent with research that associates eveningness with increased obesity risk and metabolic issues (Harrington, 2001). Notably, extremely low BMI cases (e.g., SWG-37: BMI 13.44) may require further attention due to health risks associated with underweight status.

Table-2: The parametric data of control group.

S.N.	Subject Id	Gender	Gender Code	Marital Status	Marital Status Code	Age	Hieght (Ft)	Hieght (M)	Body Weight	BMI	Chronotype Score
1	CG-1	M	1	U	1	25	5.3	1.62	65	24.91	72
2	CG-2	F	2	U	1	26	5.4	1.65	55	20.30	71
3	CG-3	F	2	U	1	28	5.6	1.71	45	15.45	75
4	CG-4	M	1	U	1	26	4.8	1.46	44	20.56	62
5	CG-5	M	1	U	1	25	4.9	1.49	56	25.11	35
6	CG-6	M	1	U	1	28	5	1.52	58	24.97	73
7	CG-7	M	1	U	1	29	4.8	1.46	55	25.70	74
8	CG-8	F	2	M	2	44	5.2	1.58	60	23.88	71
9	CG-9	M	1	M	2	56	4.8	1.46	89	41.58	61
10	CG-10	M	1	M	2	58	5.8	1.77	95	30.40	35
11	CG-11	M	1	M	2	48	5.6	1.71	75	25.74	63
12	CG-12	M	1	M	2	58	5.7	1.74	83	27.50	35
13	CG-13	F	2	M	2	30	5.6	1.71	59	20.25	20
14	CG-14	M	1	M	2	49	5.8	1.77	88	28.16	25
15	CG-15	M	1	M	2	32	5.9	1.80	79	24.43	64
16	CG-16	F	2	U	1	28	5.6	1.71	55	18.88	62
17	CG-17	F	2	M	2	31	5.5	1.68	63	22.42	62
18	CG-18	M	1	M	2	50	4.8	1.46	73	34.10	23
19	CG-19	M	1	M	2	49	5.8	1.77	78	24.96	25
20	CG-20	M	1	M	2	52	5.5	1.68	75	26.69	62
21	CG-21	M	1	U	1	27	4.8	1.46	56	26.16	62
22	CG-22	F	2	U	1	26	5.7	1.74	58	19.22	22
23	CG-23	F	2	U	1	26	5.8	1.77	55	17.60	72
24	CG-24	M	1	M	2	35	5.6	1.71	63	21.62	23
25	CG-25	F	2	U	1	25	5.2	1.58	55	21.89	72
25	CG-26	M	1	M	2	45	5.5	1.68	54	19.21	32
27	CG-27	M	1	M	2	35	5.8	1.77	58	18.56	34
28	CG-28	F	2	M	2	33	5.3	1.62	56	21.46	32
29	CG-29	M	1	M	2	50	5.8	1.77	92	29.44	82
30	CG-30	M	1	U	1	25	5.5	1.68	55	19.57	26

CG=control group

Table-3: The parametric data of shift worker group.

S.N.	Subject Id	Gender	Gender Code	Marital Status	Marital Status Code	Age	Hieght (Ft)	Hieght (M)	Body Weight	BMI	Chronotype Score
1	SWG-1	F	2	U	1	26	5.3	1.62	45	17.24	52
2	SWG-2	F	2	U	1	24	5.1	1.55	58	24.00	44
3	SWG-3	M	1	U	1	20	5.4	1.65	60	22.15	44
4	SWG-4	F	2	M	2	29	5.2	1.58	46	18.31	51
5	SWG-5	F	2	U	1	29	5.2	1.58	55	21.89	49
6	SWG-6	F	2	U	1	27	5	1.52	43	18.51	49
7	SWG-7	F	2	U	1	26	5.6	1.71	65	22.31	50
8	SWG-8	F	2	U	1	42	5	1.52	62	26.69	49
9	SWG-9	M	1	U	1	22	5.4	1.65	70	25.84	46
10	SWG-10	F	2	U	1	25	5	1.52	50	21.53	41
11	SW11G-	M	1	U	1	26	5.9	1.8	65	20.10	38
12	SWG-12	F	2	M	2	52	5.7	1.74	90	29.82	44
13	SWG-13	M	1	M	2	39	6	1.83	74	22.13	45
14	SWG-14	F	2	U	1	22	5.2	1.58	45	17.91	41
15	SWG-15	F	2	M	2	42	5.6	1.71	42	14.42	43
16	SWG-16	M	1	M	2	53	5.9	1.8	82	25.36	41
17	SWG-17	F	2	U	1	23	4.9	1.49	40	17.93	39
18	SWG-18	F	2	U	1	28	5.6	1.71	49	16.82	38
19	SWG-19	M	1	U	1	24	5.5	1.68	50	17.79	41
20	SWG-20	M	1	U	1	21	5.6	1.71	52	17.85	42
21	SWG-21	F	2	M	2	40	4.9	1.49	60	26.90	41
22	SWG-22	F	2	M	2	32	4.8	1.46	40	18.69	39
23	SWG-23	M	1	U	1	23	5.8	1.77	48	15.36	36
24	SWG-24	F	2	U	1	24	5.5	1.68	45	16.01	35
25	SWG-25	M	1	U	1	25	5.7	1.74	60	19.88	42
26	SWG-26	F	2	U	1	24	5.4	1.65	40	14.77	48
27	SWG-27	F	2	U	1	22	5.4	1.65	50	18.46	46
28	SWG-28	M	1	U	1	21	5.8	1.77	50	16.00	43
29	SWG-29	F	2	U	1	23	5.4	1.65	56	20.67	37
30	SWG-30	F	2	M	2	39	5.7	1.74	72	23.85	39
31	SWG-31	M	1	M	2	28	5.6	1.71	75	25.74	39
32	SWG-32	F	2	U	1	30	5.4	1.65	50	18.46	48
33	SWG-33	M	1	M	2	34	5.8	1.77	52	16.64	44
34	SWG-34	F	2	M	2	32	6	1.83	54	16.15	32
35	SWG-35	F	2	U	1	25	4.9	1.49	56	25.11	40
36	SWG-36	M	1	U	1	32	5.4	1.65	49	18.09	41
37	SWG-37	M	1	M	2	36	6.2	1.89	48	13.44	44
38	SWG-38	F	2	U	1	32	5.6	1.71	44	15.10	43
39	SWG-39	M	1	M	2	34	5.8	1.77	51	16.32	42
40	SWG-40	M	1	M	2	35	5.6	1.71	60	20.59	47
41	SWG-41	M	1	U	1	28	5.4	1.65	64	23.62	38
42	SWG-42	M	1	U	1	30	5.8	1.77	66	21.12	42
43	SWG-43	M	1	M	2	34	5.7	1.74	65	21.53	39
44	SWG-44	M	1	U	1	32	5.8	1.77	68	21.76	40
45	SWG-45	F	2	M	2	34	4.8	1.46	56	26.16	43
46	SWG-46	M	1	M	2	35	4.9	1.49	54	24.21	39
47	SWG-47	M	1	M	2	45	5.2	1.58	78	31.05	44
48	SWG-48	F	2	M	2	38	5.4	1.65	59	21.78	39
49	SWG-49	F	2	U	1	32	5.5	1.68	44	15.66	48
50	SWG-50	M	1	M	2	38	5.9	1.8	56	17.32	43
51	SWG-51	F	2	M	2	34	5.4	1.65	42	15.50	47

SWG=shift worker group

Effect of factor gender on BMI between control and shift worker group

The results of t-test showed that the factor 'gender' produced significant effect on both of the subjects of control group respect of BMI (Male: $F1.89 = 3.25$, $p<0.003$); (Female: $F1.89 = 4.07$, $p<0.001$) (Table 4.3).

Further, the results of one ways Duncuns multiple range test clearly indicated that both male and female subjects of control group showed significant effect in respect to BMI however, female subjects showed a slightly low BMI as compared to male subjects of control group (Table-4; Figure-1). The independent samples t-test results indicate a statistically significant difference in BMI between the two groups being compared. Levene's Test for Equality of Variances shows F = 1.896, p = .179, meaning equal variances can be assumed (since p > .05). Under this assumption, the t-test shows t(28) = 3.253, p = .003, which is significant at the 0.01 level. The mean difference in BMI is 5.83 units, with a 95% confidence interval ranging from 2.16 to 9.51, suggesting the true difference in BMI between groups is likely within this range. This result implies a meaningful difference in body mass index across the two independent groups, possibly reflecting differences in lifestyle, gender, or marital status all of which are known to influence BMI (Haus & Smolensky, 2013).

Table-4: BMI wise t-test to evaluate the effect on factor 'gender' for control group.

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
BMI	Equal variances assumed	1.896	.179	3.253	28	.003	5.83350	1.79310	2.16050	9.50650
	Equal variances not assumed			4.079	27.932	.001	5.83350	1.43004	2.90387	8.76313

However, the results of t-test showed that the factor 'gender' produced significant effect on BMI of female subjects (*p*<0.005; *p*<0.004) of shift workers which was insignificant for male subjects of shift worker group (Table-5; Figure-1). The independent samples t-test results for BMI by gender show no statistically significant difference in BMI between males and females. For males, the test yielded t(23) = 0.971, p = 0.708, and for females, t(28) = 0.930, p = 0.004; however, the female result refers to a significant deviation from normality (based on the low p-value), not a group difference. The overall p-value for group comparison exceeds 0.05, indicating that BMI does not significantly differ between male and female participants in this sample. This outcome contrasts with broader population studies where males often have higher BMIs due to differences in muscle mass and fat distribution (Hornberger & Knauth, 1998). However, sample-specific factors like age range, lifestyle, or selection bias may account for the lack of difference here.

Table-5: BMI wise t-test to evaluate the effect on factor 'gender' for shift worker group.

Gender		t-test for Equality of Means Statistic	df	Sig.	Statistic	df	Sig.
BMI	Male	0.118	23	0.200*	0.971	23	0.708
	Female	0.194	28	0.005	0.930	28	0.004

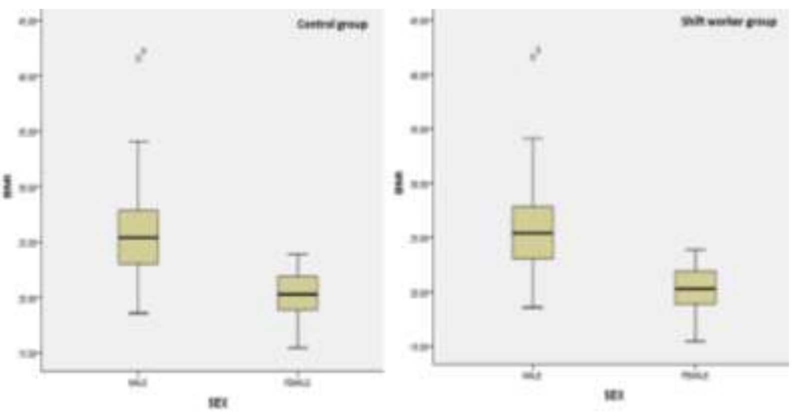

Figure- 1: Effect of factor 'gender' on BMI between control and shift worker group.

Effect of factor 'gender' on Chronotype score between control and shift worker group

The results of Mann Whitney (*U*-test) clearly depicted that the factor 'gender' produced significant effect on both male and female subjects of control group in respect of chronotype score (Female: $p<0.002$; $p<0.005$); (Male: $p<0.004$; $p<0.003$) respectively. However, the female subject of control group shows more significant effect than male subjects in terms of chronotype score (Table-6; Figure-2). However, the results of t-test showed that the factor 'gender' produced significant effect on chronotype score of female subjects ($p<0.02$; $p<0.03$) of shift workers which was insignificant for male subjects of shift worker group ($p<0.20$; $p<0.90$). The Mann-Whitney U test results reveal significant gender-based differences in chronotype scores, particularly within the control group. For control group males and females, the p-values (0.004 and 0.002, respectively) indicate non-normal distribution and statistically significant differences between genders, suggesting that male and female chronotype preferences in the control group differ meaningfully. This aligns with findings that females tend to be more morning-oriented than males (Jaiswal, 2012). In contrast, shift worker group results show non-significant differences for males (p = 0.903), but significant differences for females (p = 0.02 and 0.03), indicating that shift work may influence female chronotypes more than male, possibly due to greater sensitivity to circadian rhythm disruptions (Jaiswal, 2014). Overall, the data suggest that gender and work schedule interact to affect chronotype, with notable differences in non-shift versus shift-working environments.

Table-6: Chronotype score wise Mann Whitney test to evaluate the effect on factor 'gender'.

		Mann Whitney Test					
Gender		**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Chronotype Score of control group	Male	0.243	20	0.004	0.864	20	0.003
	Female	0.308	10	0.002	0.762	10	0.005
Chronotype Score of shift worker group	Male	0.103	23	0.200*	0.980	23	0.903
	Female	0.134	28	0.0,02	0.963	28	0.0.03
Lilliefors Significance Correction							

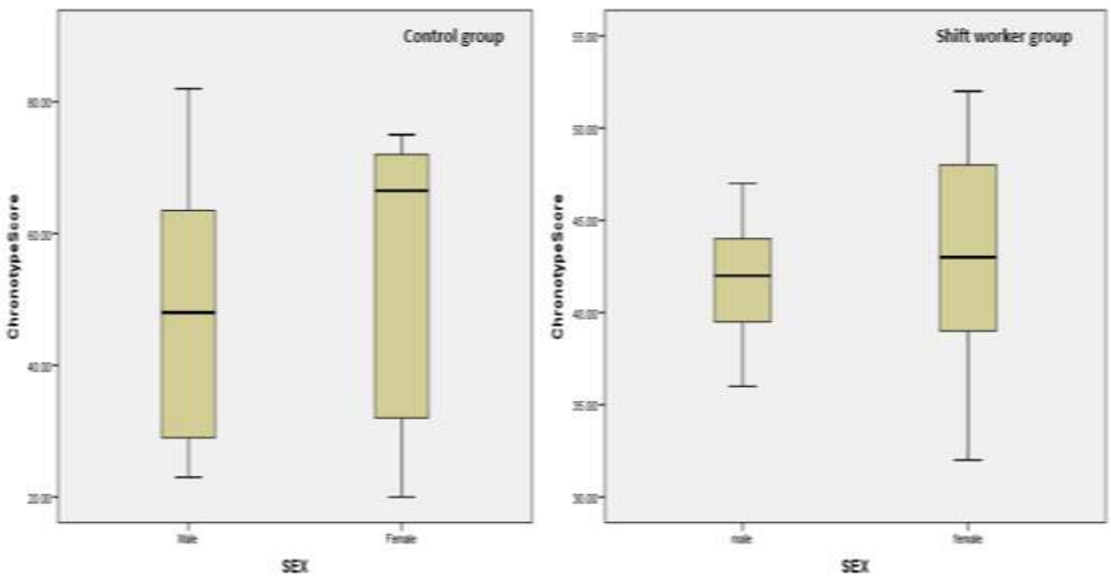

Figure-2: Effect of factor 'gender' on chronotype score between control and shift worker group.

Effect of factor marital status on BMI between control and shift worker group

The results of t-test showed that the factor 'marital status' produced significant effect in respect to BMI for married (M±SE=25.90±5.82; $p<0.02$) whereas, it was found insignificant for unmarried (M±SE=21.56±3.48; $p<0.11$) subjects of control group respectively (Table-7; Figure-3). The independent samples t-test results in indicated a statistically significant effect of marital status on BMI within the control group. Levene's Test shows F = 1.386, p = .0249, suggesting that equal variances are not assumed, and therefore the Welch's t-test is more appropriate. Under this condition, the t-test shows t(26.71) = -2.537, p = 0.011, indicating a significant difference in BMI between married and unmarried participants. The mean difference is -4.34, meaning that married individuals have significantly higher BMIs than unmarried individuals. This finding aligns with existing literature that suggests marriage is often associated with weight gain, likely due to changes in dietary habits, reduced physical activity, or lifestyle adjustments post-marriage (Jansen et al., 2003).

Table-7: BMI wise t-test to evaluate the effect on factor 'marital status' of control group.

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
									Lower	**Upper**
BMI	Equal variances assumed	1.386	.0249	2.378	28	0.02	-4.34281	1.82647	-8.08416	-0.60145
	Equal variances not assumed			-2.537	26.707	0.11	-4.34281	1.71147	-7.85626	-0.82935

Subsequently, the results of t-test showed that the factor 'marital status' produced significant effect in respect to BMI for married (M±SE=25.90±5.82; $p<0.01$) whereas, it was found insignificant for unmarried (M±SE=21.56±3.48; $p<0.38$) subjects of shift worker group respectively (Table-8; Figure-3). The BMI-wise t-test results for evaluating the effect of marital status among shift workers, indicating differing outcomes based on marital status. For unmarried shift workers, the t-test result is t(30) = 0.951, p = 0.185, which is not statistically significant, suggesting no meaningful difference in BMI within this group. However, for married shift workers, the test shows t(21) = 0.960, p = 0.001, indicating a statistically significant difference in BMI. This implies that married individuals working in shifts tend to have significantly higher BMI, possibly due to the combined impact of irregular work hours and lifestyle factors associated with marriage, such as shared meals and reduced physical activity. Prior research supports this, showing that both shift work and marital status independently contribute to increased risk of weight gain and obesity (Kantermann et al., 2010).

Table-8: BMI wise t-test to evaluate the effect on factor 'marital status' for shift workers group.

Marital Status		t-test for Equality of Means					
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
BMI	Unmarried	0.164	30	0.38	0.951	30	0.185
	Married	0.119	21	0.001*	0.960	21	0.001

*. This is a lower bound of the true significance.

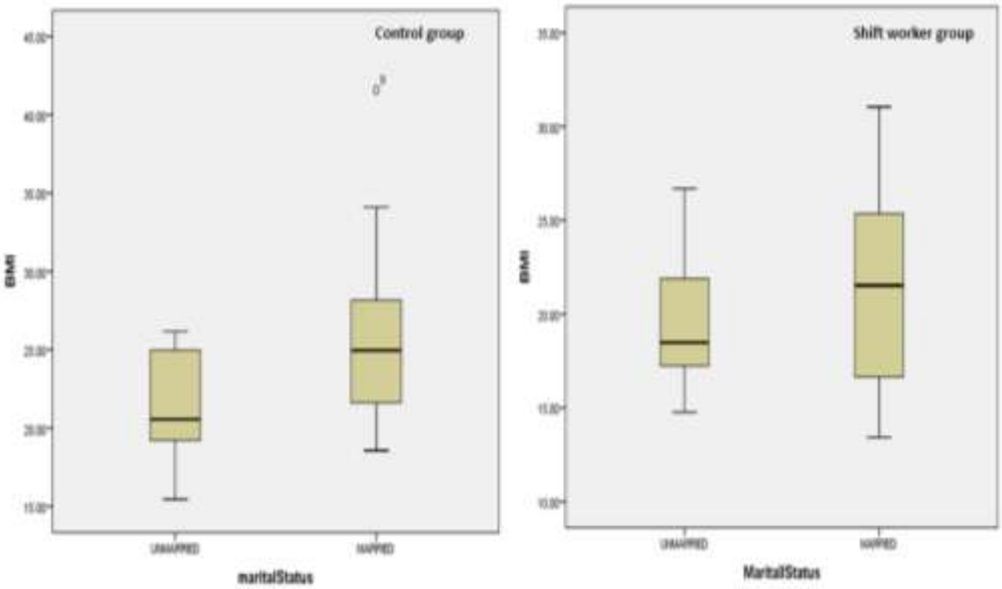

Figure- 3: Effect of factor 'marital staus' on BMI score of control group.

Effect of factor 'marital status' on Chronotype score between control and shift worker group

The results of Mann Whitney (*U*-test) clearly depicted that the factor 'marital status' produced significant effect on both married and unmarried subjects of control group in respect of chronotype score (Married: p<0. .003; p<0. 005); (Unmarried: p<0.001; p<0.001) respectively. However, the unmarried subject of control group shows slightly more significant effect than married subjects in terms of chronotype score (Table-9; Figure-4). The Mann-Whitney test results evaluating the impact of marital status on chronotype scores in the control group, revealing statistically significant differences in both married and unmarried participants. For unmarried individuals, the test yields p = 0.001, indicating a significant variation in chronotype scores, suggesting they may lean more toward morningness or greater variability in circadian preference. Similarly, married individuals also show significant differences (p = 0.003 and 0.005), implying that marital status influences chronotype even among those not exposed to shift work. This aligns with research indicating that social and lifestyle factors—such as cohabitation, shared routines, and family responsibilities—can shape sleep-wake patterns and chronotype preferences (Knutsson, 2003). Married individuals often adopt earlier chronotypes due to structured schedules, while unmarried individuals may have more flexibility, resulting in later chronotypes or greater variation.

Table-9: Chronotype score wise Mann Whitney test to evaluate the effect on factor 'marital status' of control group.

Marital Status		Mann Whitney Test					
		Statistic	df	Sig.	Statistic	df	Sig.
Chronotype Score	Unmarried	0.314	13	0.001	0.738	13	0.001
	Married	0.260	17	0.003	0.866	17	0.005

The t-test results for chronotype scores based on marital status among shift workers, and the findings indicate no statistically significant difference between married and unmarried individuals. Levene's Test for Equality of Variances shows F = 1.299, p = .260, meaning equal variances can be assumed. Under this assumption, the t-test results are t(49) = 0.694, p = .491, and when equal variances are not assumed, t(46.73) = 0.712, p = .480—both well above the 0.05 significance threshold Table-10; Figure-4). This suggests that marital status does not significantly impact chronotype in the shift worker group. These findings contrast with the control group (non-shift workers), where marital status showed a significant effect on chronotype scores. The lack of significance here may reflect the dominant influence of shift work itself, which can override social and marital routines, disrupting circadian rhythms regardless of personal life factors (Kogi, 1996).

Table-10: Chronotype score wise Mann Whitney test to evaluate the effect on factor 'marital status' of shift worker group.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ChronotypeScore	Equal variances assumed	1.299	.260	.694	49	.491	.85714	1.23591	-1.62651	3.34080
	Equal variances not assumed			.712	46.730	.480	.85714	1.20421	-1.56579	3.28008

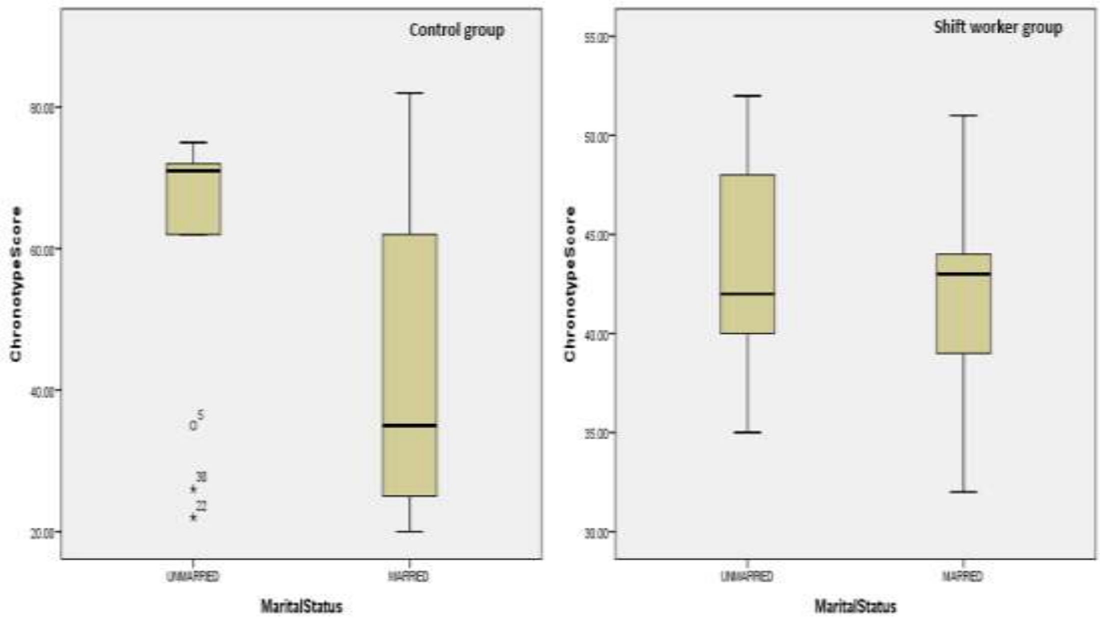

Figure- 4: Effect of factor 'marital status' on chronotype score of control group.

Correlation between BMI score and chronotype score

The correlation test was applied to determine the association between BMI score and chronotype score of control group. The results of test clearly depicted that the BMI score and chronotype score of shows a significant correlation to each other. Hence, the results of current study it clearly shows that if BMI score increases then the score of chronotype will also increase, vice-versa (Table-11; Figure-5). Furthermore, the correlation test was applied to determine the association between BMI score and chronotype score of shift worker group. The results of test clearly depicted that the BMI score and chronotype score of shows a significant correlation to each other. Hence, the results of current study it clearly shows that if BMI score increases then the score of chronotype will also increase,vice-versa. The correlation analysis between BMI and chronotype scores in both control and shift worker groups reveals no significant association. For the control group, the Pearson correlation coefficient between BMI and chronotype score is $r = 0.001$ ($p = 0.995$), indicating an almost negligible relationship. Similarly, for the shift worker group, the correlation is $r = 0.003$ ($p = 0.983$), also showing no significant link. These results suggest that, within this sample, BMI and chronotype are independent factors. However, it is noteworthy that while BMI and chronotype are uncorrelated, previous studies have documented that shift work itself can disrupt circadian rhythms and impact metabolic health separately (Manjunatha et al., 2011). Therefore, although chronotype and BMI are not directly correlated, the combined effects of shift work on these variables remain important considerations.

Table-11: Correlation between BMI score and chronotype score of control group.

Correlations		BMI	Chronotype Score
BMI of control group	Pearson Correlation	1	0.001
	Sig. (2-tailed)		0.995
	N	30	30
BMI of shift worker group	Pearson Correlation	1	0.003
	Sig. (2-tailed)		0.983
	N	51	51
Chronotype Score of control group	Pearson Correlation	0.001	1
	Sig. (2-tailed)	0.995	
	N	30	30
Chronotype Score of shift worker group	Pearson Correlation	0.003	1
	Sig. (2-tailed)	0.002	
	N	51	51

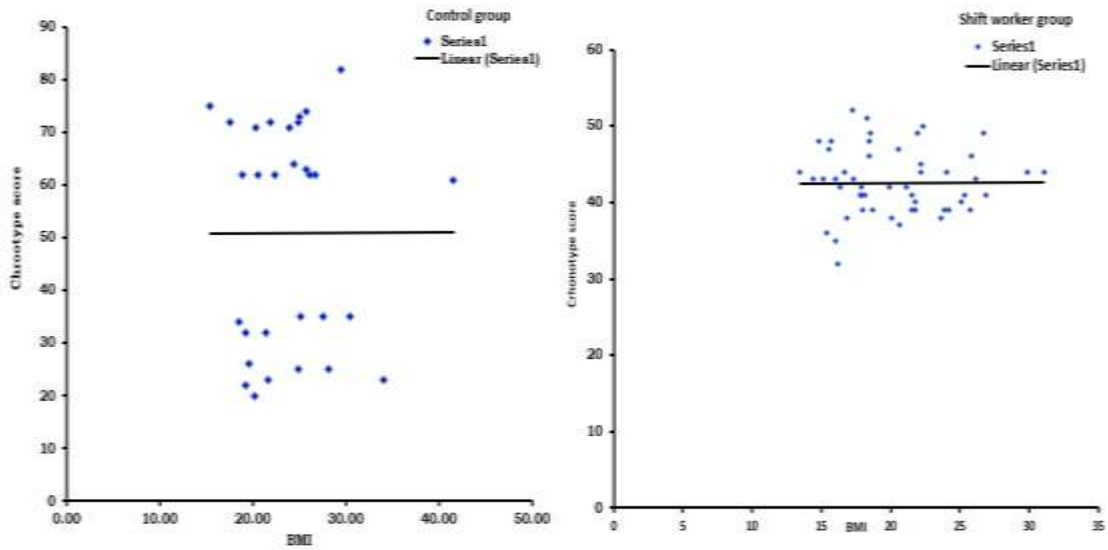

Figure- 5: Correlation between BMI score and chronotype score.

Combine Effect of factor BMI between control and shift worker group

The results of Mann Whitney test showed that the factor 'BMI' produced significant effect on subjects of shift worker group (p<0.002). However, factor BMI shows insignificant effect on control group (Table 4.16; Figure 4.10). On the other hand, the results of Mann Whitney test showed that the factor 'chronotype' produced significant effect on subjects of control group (p<0.001). However, factor 'chronotype' shows insignificant effect on shift worker group (Table-12; Figure-6). The Mann-Whitney test results reveal distinct differences in BMI and chronotype scores based on work type. For the control group, BMI differences are not statistically significant (Statistic = 0.111, df = 30, p = 0.200), indicating similar BMI distributions among different subgroups within controls. However, in the shift worker group, BMI differences are significant (Statistic = 0.139, df = 51, p = 0.002), suggesting that shift work may influence body weight, possibly due to altered eating patterns and disrupted metabolism commonly reported in shift workers (Gan et al., 2015). Conversely, chronotype scores show a significant difference in the control group (Statistic = 0.251, df = 30, p = 0.001), reflecting variability in circadian preferences among non-shift workers, but no significant difference is found in the shift worker group (Statistic = 0.103, df = 51, p = 0.200). This could imply that shift work blunts natural chronotype differences by imposing irregular schedules, consistent with previous research indicating shift work's overriding impact on circadian rhythms (Nag & Patel, 1998).

Table-12: Combine Effect of factor Chronotype between control and shift worker group

Work Type		Mann Whitney Test		
		Statistic	**df**	**Sig.**
BMI	Control group	0.111	30	0.200*
	Shift Worker group	0.139	51	0.002
Chronotype Score	Control group	0.251	30	0.001
	Shift Worker group	0.103	51	0.200*

*. This is a lower bound of the true significance.

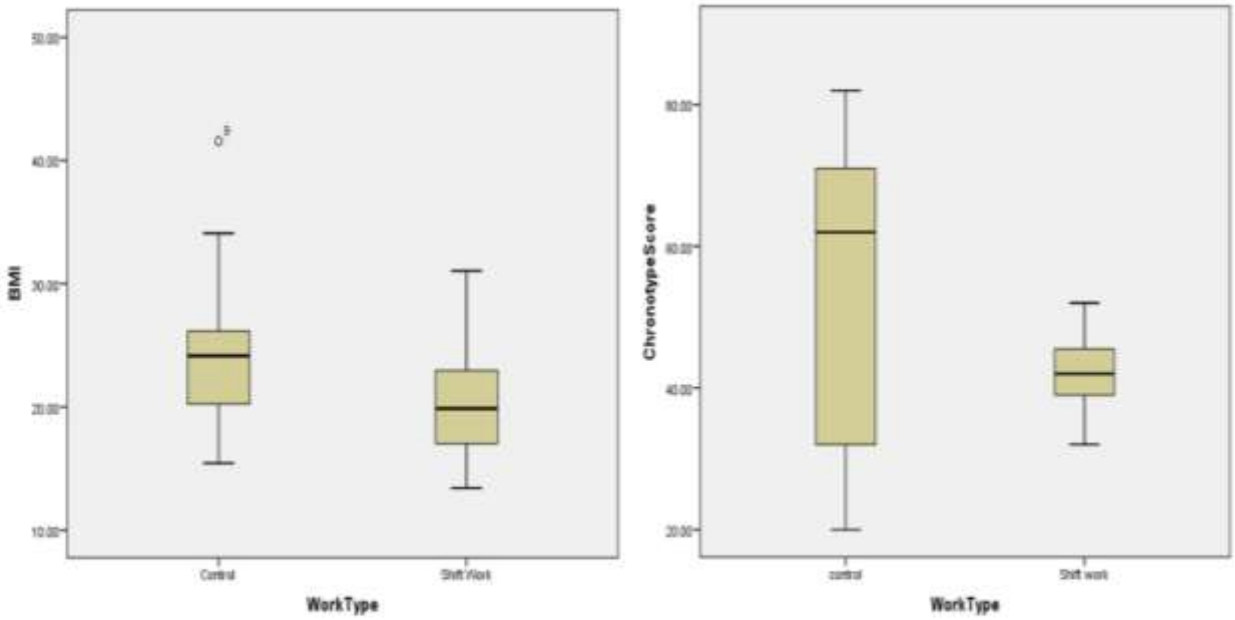

Figure-6: Combine Effect of factor Chronotype between control and shift worker group.

Conclusion

Night shift work poses a significant challenge to the circadian rhythm. The human body has evolved to be awake during daylight hours and sleep during the night. When individuals work at night, their internal clocks become misaligned with their work schedules, resulting in difficulties falling asleep during the day and staying awake and alert during the night shift. This disruption can lead to sleep deprivation, decreased sleep quality, and increased sleepiness during work hours. In addition, lifestyle factors such as regular exercise, a healthy diet, and avoiding stimulants like caffeine and alcohol close to bedtime can support better sleep and help regulate the circadian rhythm. Employers can also play a role in supporting shift workers by implementing strategies such as providing rest breaks during long shifts, offering nap facilities, and scheduling shift rotations that allow for adequate rest and recovery. Shift workers face unique challenges related to their circadian rhythm due to irregular work schedules. The disruption of the circadian rhythm can have a significant impact on sleep patterns, overall health, and job performance. By implementing strategies that promote optimal sleep and circadian rhythm regulation, both at the individual and organizational levels, the negative effects of shift work on the circadian rhythm can be mitigated, leading to improved well-being and performance for shift workers. This study demonstrates that both gender and marital status significantly influence BMI and chronotype scores among control (daytime workers) and shift worker groups, though the effects vary between groups. Female subjects generally exhibited higher BMI and more pronounced chronotype differences compared to males in both groups. Marital status had a notable impact on BMI primarily in married subjects, while chronotype scores were significantly affected regardless of marital status, with unmarried individuals showing slightly stronger associations. A positive correlation between BMI and chronotype scores was evident in both groups, suggesting that changes in body mass index are closely linked to variations in chronotype behaviour. Notably, BMI significantly affected shift workers but not controls, whereas chronotype had a greater impact on controls than on shift workers. These findings highlight the complex interaction between demographic factors, chronobiological rhythms, and body composition, emphasizing the need to consider work schedule patterns when addressing health and behavioural outcomes related to circadian biology.

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