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Association of social jetlag with sleep, breakfast jetlag, and other daily behaviors in Indian population

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ABSTRACT

This study aims to investigate the association of social jetlag with breakfast jetlag, circadian behaviors such as sleep pattern, breakfast time, sleep quality, eating frequency, gadget usage, and physical activities during social restriction within both social jetlag present and absent group (before and during social restrictions). This study includes 251 individuals out of 500 in which (n=112) were having no social jetlag (<1h) and (n=139) were having a prevalence of social jetlag (>1h) during social restriction. Participants having social jetlag reported a significant delay in the sleep-wake cycle, increased sleep duration during social restriction as well as on weekends before SR ($p<0.05$). There was a significant association of social jetlag with the increase in usage of gadgets and reduction in physical activities in the social jetlag prevalence group during social restriction. Regarding breakfast jetlag, there was a significant delay in breakfast timings during SR as well as delay on weekends in comparison to weekdays before social restrictions. Overall, we found a significant association between social jetlag with sleep characteristics and breakfast jetlag with eating timings. Thus, delay in sleep and breakfast time can lead to adverse health issues. To maintain a good healthy lifestyle, one should alleviate the social and breakfast jetlag by having their breakfast and sleep on time regularly.

Keywords: *Social jetlag, Breakfast jetlag, Sleep, daily behavior, social restriction*

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1. Introduction

In the present scenario, due to modernization and advancement in technology people are forced to work late at night, working in shifts, late-night use of electronic gadgets, eating late at night, and mismatch timings of various other activities. This misalignment of various daily activity timings with the natural day/night environmental cycle tends to misalign the circadian rhythm. As a result, people suffer from several circadian disruptions such as social jetlag, eating jetlag, obesity, depression, etc. If we focus on pre-lockdown, the previous studies have shown that continuous misalignment of daily circadian rhythms can lead to obesity, type ii diabetes, and various cardiovascular disorders (Buijs et al., 2016, Challet, 2019).

Nowadays, the desynchronization of eating and sleep timings throughout the weekdays are very common. The mild misalignment of eating time and sleep time on weekends versus weekdays is referred to as eating jetlag (Zerón-Rugerio et al., 2020) and social jetlag (Wittmann et al., 2006). The studies have demonstrated that eating behavior and calorie intake were affected by sleep timings (Baron et al., 2011) and consumption of food near bedtime is related to an increase in higher body mass index (Xiao et al., 2019). The shift workers are a primary example of misalignment of circadian rhythm because they experience changes in their sleep-wake cycle, eating-fasting cycles (Pickel & Sung, 2020). In non-shift workers, people also experience the changes in their eating and sleep behavior by extending their eating time more towards the night as a result of irregular eating behavior (Gill & Panda, 2015, St-Onge et al., 2017, Eicher-Miller et al., 2016).

The COVID-19 has caused severe crises with various aspects of life such as health, safety, financial. It has enforced the government to impose "Lockdown/social restriction" as a preventive measure to control the spread of COVID-19. During the pandemic, people faced various psychological stress regarding the spread of this virus. This resulted changes in their daily lifestyle including sleep, eating, and other circadian behaviors. Studies performed during the pandemic have shown changes in the sleep-wake cycle, increase in sleep duration, and participants also reported poor sleep quality (Cellini et al., 2020, Wright et al., 2020). One of the studies performed on university students reported that there was a reduction in social jetlag during lockdown (Wright et al., 2020).

According to (Korman et al., 2020) there was a significant delay in the mid-sleep which resulted in the reduction of social jetlag by 29 min among the large sample size (N=7517). During the COVID-19 about 43% and 52% reported more eating and snacking behavior which was more likely to be common in overweight and obese individuals. It was also mentioned that higher BMI was associated with less consumption of vegetables, along with an increase in eating fast food (Sidor & Rzymski, 2020). Studies have also reported that lockdown has induced potential health issues among the population as a result decrease in physical activities (Füzéki et al., 2020) which has a strong negative impact on the psychological health of the population (Maugeri et al., 2020). With an increase in usage of social media (Gao et al., 2020), about 0.9% were severely depressed, 2.7% were moderately depressed and 21.3% were having mild depression (Cao et al., 2020). The chronic stress caused because of pandemics has resulted in various physiological problems with some symptoms of headache, hormonal imbalance, fatigue, and insomnia (Majumdar 2020a). Studies performed on Indian school students showed that due to COVID-19 children had irregular sleep-wake cycles along with an increase in screen time and low physical activities (Dutta et al., 2020).

We are currently unaware of any work done on how social jetlag and breakfast jetlag are associated with sleep and daily other behaviors in the Indian population before versus during "social restrictions". Therefore, the study was designed to determine. (a) How social jetlag is associated with sleep and other daily behaviors. (b) How breakfast jetlag is associated with sleep within the social jetlag groups (present/absent).

2. Methods

2.1 Participants

This cross-sectional study was designed in google form and was distributed online through the WhatsApp contact of the author AD. It involved volunteers from different regions all over India. This study was approved by the Institutional ethical committee of the University of Lucknow (LU/IEC/ZOOL/2020/11/06). All the participants were provided a consent form to participate in the study. Initially, the volunteers were asked questions that assessed demographic aspects related to sleep pattern, breakfast time before the lockdown. The next section consisted of questions related to sleep pattern, breakfast time, daily behaviors (such as work hours, physical activities, use of electronic gadgets, maximum time spent in activities) during the lockdown, depression, and perception of the participants regarding the lockdown. The details of the methods used in the study have been described below: -

2.2 Sleep behavior and social jetlag

To examine the sleep pattern volunteers were asked to report their usual sleep time, wake-up time, time to breakfast on weekdays and weekends before social restrictions. Similar questions were asked during the social restriction conditions. Social jetlag was calculated as per the protocol established by Wittman et al., 2006. It was calculated by the absolute difference between mid-sleep on weekends and weekdays. Similarly, the absolute difference was calculated between the mid-sleep during social restriction (considering lockdown days similar to that of freedays) and weekdays (before lockdown). The further categorization was done as participants having 'no social jetlag' represented as (≥ 1 h) and 'socially jetlag' was considered as individuals having value (≤ 1 h).

2.3 Eating behavior and breakfast jetlag

For characterization of eating behavior, the participants were asked to report their breakfast timings on weekdays and weekends before and during social restrictions. We introduced this delay in breakfast timings as a 'Breakfast jetlag' because like social jetlag the internal misalignment with the external breakfast timings is considered as 'Breakfast jetlag'. It was calculated by the absolute difference between weekends and weekdays breakfast timing. Likewise, it was assessed for the absolute difference between the weekdays and during social restriction days. Further, it was categorized into the delay, advance, or maintenance concerning weekends and during the lockdown. The individuals having values (≥ -1 h) was considered as "delay", values with (≤ +1 h) were categorized into "advance" and values ranging between (-1 h and +1 h) were under the "maintenance" category.

2.4 Other daily behaviors and mental behavior during social restriction

To evaluate the frequency and category of other daily behaviors, we calculated the response of the participants by the questions related to the frequency of physical activities, daytime naps, use of electronic gadgets during the lockdown. We divided it into three subcategories; - 'decreased', 'increased' or 'no change'. Similarly, Sleep quality was assessed by asking whether their sleep quality was 'bad', 'good', or 'no change'. The volunteers were asked to rate their depression on the Likert scale of ‘0’ to ‘10’ to assess their mental health. Where ‘0’ represents ‘no depression’ and ‘10’ is ‘severely depressed’.

2.5 Statistical analysis

The statistical analyses were performed in SPSS version 20.0 (SPSS Inc., Chicago, IL, USA), and $p<0.05$ was considered to be statistically significant. Firstly, the participants were divided into two groups: the presence of social jetlag (≤ 1 h) and absence of social jetlag (≥ 1 h) in the participants respectively. The normality was checked by using Kolmogorov-Smirnov and Shapriowilk test. The continuous variables i.e. age, time to sleep (TOS), time to wake up (TOW), sleep duration, and time of breakfast (TOB) were summarized by using mean or median and standard deviations. To study the significant difference between the two groups of social jetlag the continuous variables i.e. time to sleep, time to wake up, sleep duration, and time of breakfast were analyzed by using the Mann-Whitney test as shown in figure 1. Further, within the two groups of social jetlag participants were divided into three categories based on eating jetlag namely: values (≥ -1 h) means “delay”, above or (≤ +1 h) is “advance” and value ranging between (-1 h and +1 h) is “maintenance”. In order, to assess the significant difference between the meantime of eating breakfast, the Kruskal-Wallis test was applied.

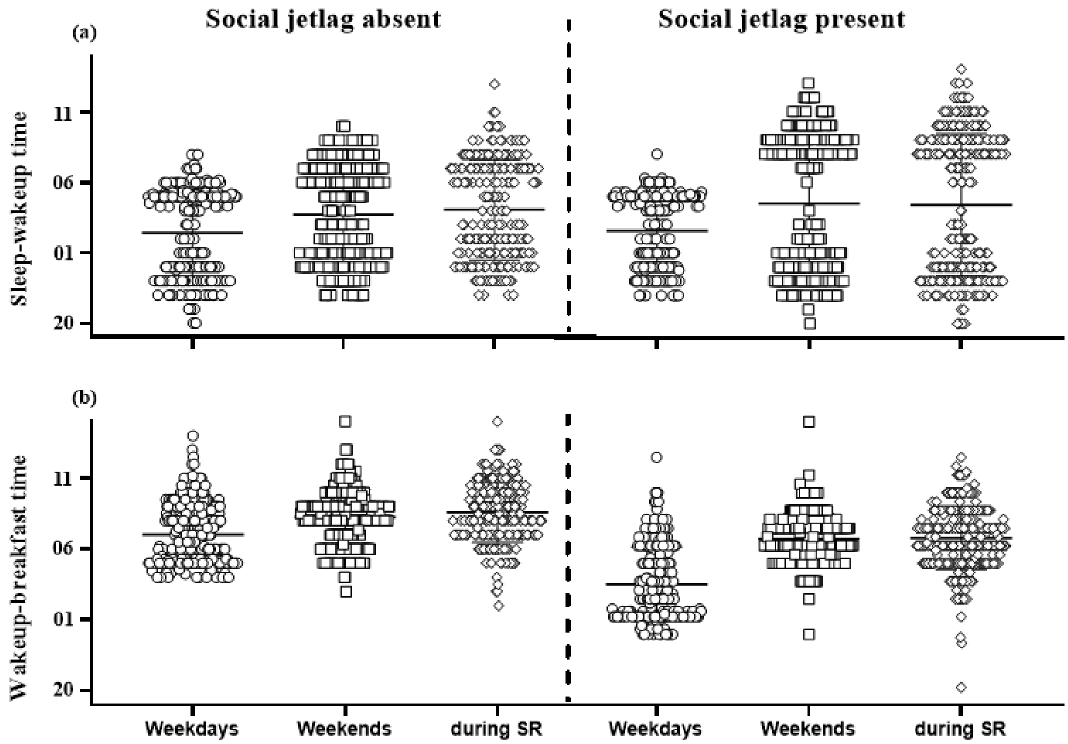

FIGURE 1 Change in sleep and breakfast time in social jetlag absent group before and during social restriction. The graph (a) represents sleep and wakeup time in all the three conditions (weekdays, weekends and during SR) in both social jetlag absent and present group. The graph (b) represents wakeup-breakfast timings in all the three conditions in both social jetlag absent and present group. The x-axis represents the conditions (weekdays, weekends and during SR). The y-axis indicates the clock hours.

The categorical variables (gender, region, physical activities, eating frequency, sleep quality, and use of electronic gadgets) were summarized using frequency and percentages. Firstly, to study the association between categorical variables and social jetlag the Pearson correlation was used. Further, they were divided into three categories of breakfast jetlag (Delay, advance, and maintenance) and their association with eating jetlag within the social jetlag groups was examined by using the Kruskal-Wallis test. The association between social jetlag and breakfast jetlag before and during lockdown was identified by using Pearson’s correlation respectively. The graphs were prepared by GraphPad Prism Software version 8.0, San Diego, USA.

3. Results

The study included 251 individuals (47% Male, 52% Female). The mean age of the total population was (26.18±0.56). The total participants were further analyzed based on the following categories: -

3.1 Association in SJL and BJL before and during social restrictions

According to the results shown in table 1, it can be concluded that there was a statistically significant association in SJL before and during SR (<0.001) as shown in figure 2 (b). Similarly, a significant association was seen in BJL as shown in figure 2 (c) before and during SR within all their three categories (<0.001). Further, we analyzed the data concerning social jetlag absent and present groups within the social jetlag and breakfast jetlag.

Table 1 Association between social jetlag before and during social restrictions (SR) according to delay, advance, and maintenance of breakfast jetlag.

		Breakfast jetlag during SR			
		Delay	**Advance**	**Maintenance**	**P***
Breakfast jetlag before SR	**Delay**	17 (44.7)	14 (36.8)	7 (18.4)	**<0.001**
	Advance	13 (14.0)	43 (46.2)	37 (39.8)	
	Maintenance	7 (5.8)	25 (20.8)	88 (73.3)	
		Social jetlag during SR			
		Present	**Absent**		
Social jetlag before SR	**Present**	72 (64.9)	39 (35.1)		**<0.001**
	Absent	67 (47.9)	73 (52.1)		

The values are represented as the total number (%).
Pearson chi-square test was done to compare categorical variables.
The bold value is statistically significant at p<0.001.

3.2 Changes in sleep and eating pattern along with other daily behaviors concerning social jetlag (SJL)

3.2.1 *Before social restrictions (SR)* – In this category, the participants showed a significant difference in their sleep time when compared within the social jetlag absent and present groups. On weekdays the TOS in SJL present group was 24.08±0.12 which was significantly delayed with the SJL absent group having 23.53±0.11 mean sleep time (<0.05). Similarly, the sleep duration in the social jetlag present group was 5.00±0.13 and in SJL absent group it was 05.76±1.12 (<0.05). Apart from time to sleep and duration, as shown in (Table 1) the TOW (Time to wake-up) was significantly earlier 05.07±0.06 in the SJL sufferers before SR (<0.05). If we focus on weekends before SR, the time of sleep was significantly delayed 23.96±0.14 in SJL sufferers (<0.001). While, during SR the time to sleep was 23.67±0.13 in SJL sufferers, and were having a longer sleep duration of 9.35±0.15 along with a late wake-up time of 09.02±0.14 compared with non SJL sufferers (<0.001).

3.2.2 During social restrictions (SR) – According to the results shown in Table 2, the time to sleep was 23.67±0.13 compared with non SJL groups (<0.001). While, both, sleep offset (Time to wake-up) and sleep duration were significantly delayed with an average time of 09.02±0.14 and 9.35±0.15 respectively (<0.001) in SJL present groups compared with before SR.

3.2.3 Other Daily activities – According to figure 2 (a) the daily other behaviors like physical activities during SR have significantly decreased in both SJL absent and present groups (<0.05). As shown in table 3, there was a remarkable increase in usage of electronic gadgets during SR in both SJL groups (<0.05).

Table 2 Descriptive and association of sleep and eating patterns according to the absence of social jetlag (≤1h) or presence of social jetlag (≥1h) with the total number of participants (N=251).

Variables	Before SR			During SR		
	≤ 1h	**≥ 1h**	**p***	**≤ 1h**	**≥ 1h**	**p***
Sleep pattern on weekdays						
TOS	23.53±0.11	24.08±0.12	**<0.002**	-	-	-
TOW	05.30±0.07	05.07±0.06	**<0.026**	-	-	-
SD	05.76±1.12	5.00±0.13	**<0.001**	-	-	-
Sleep pattern on weekends						
TOS	24.62±0.12	23.96±0.14	**<0.001**	-	-	-

TOW	06.76±0.12	08.95±0.13	**<0.001**	-	-	-
SD	6.14±0.14	9.00±0.16	**<0.001**	-	-	-
Sleep pattern during Social restriction (SR)						
TOS	-	-	-	24.88±0.14	23.67±0.13	**<0.001**
TOW	-	-	-	07.17±0.16	09.02±0.14	**<0.001**
SD	-	-	-	6.29±0.17	9.35±0.15	**<0.001**
Eating pattern						
TOB on weekdays	08.75±0.12	08.58±0.15	0.36	-	-	-
TOB on weekends	09.68±0.11	09.73±0.13	0.67	-	-	-
TOB during SR	-	-	-	09.91±0.15	09.76±0.16	0.71
Others						
Sleep bouts weekends (SR)	-	-	-	1.63±1.73	1.71±1.66	0.40
Depression weekends (SR)	-	-	-	2.33±2.82	2.04±2.65	0.57

The values are represented as mean and standard deviation.
Mann –Whitney test was done to compare continuous variables.
The bold value is statistically significant at $p<0.05$.
TOS = time to sleep, TOW = time to wake up, SD = Sleep duration, and SR indicates 'social restrictions' in the above table.

Table 3 Descriptive and association of demographic, daily lifestyle according to the absence of social jetlag (<1h) or presence of social jetlag (≥1h).

Variables	**During SR**		
	Social jetlag absent	**Social jetlag present**	**p***
Gender			
Male	54 (48.2)	65 (6.8)	0.81
Female	58 (51.8)	74 (53.2)	
Region			
Urban	90 (80.4)	106 (76.3)	0.57
Rural	8 (7.1)	9 (6.5)	
Physical activities			
Increased	27 (24.1)	26 (18.7)	**<0.04**
Decreased	69 (61.6)	75 (54.0)	
Eating frequency			
Increased	58 (51.8)	75 (54.0)	0.65
Decreased	20 (17.9)	19 (13.7)	
Sleep quality			
Good	68 (60.7)	82 (59.0)	
Bad	20 (17.9)	17 (12.2)	0.26
Use of electronic gadgets			
Increased	93 (83.0)	105 (75.5)	**<0.04**
Decreased	5 (4.5)	2 (1.4)	

The values are represented as the total number (%).
Pearson chi-square test was done to compare categorical variables.
The bold value is statistically significant at $p<0.05$

3.3 Changes in sleep and eating pattern along within SJL groups concerning breakfast jetlag (BJL) - During social restrictions

3.3.1 Delay – In both SJL groups there was no significant difference in the sleeping pattern of the participants but the statistical difference was found in time to breakfast within the three categories of BJL (<0.05). The mean TOB was a delay in the social jetlag present group with 09.54±1.20.

Table 4 Sleep behaviors according to the absence of social jetlag (≤1h) or presence of social jetlag (≥1h) and eating jetlag with delay (>1h), advanced (<-1h), and maintenance (between -1 and +1h) during SR.

	Social jetlag (During SR)							
Variables	**Social jetlag absent**				**Social jetlag present**			
	Breakfast jetlag				**Breakfast jetlag**			
	Delay	**Advance**	**Maintenance**	**P***	**Delay**	**Advance**	**Maintenance**	**P***
Sleep pattern								
TOS	24.78±1.34	24.67±1.82	24.98±1.49	0.35	23.60±1.49	24.00±1.97	23.61±1.54	0.46
TOW	07.35±2.00	06.81±1.06	07.18±1.58	0.27	09.11±1.44	08.81±1.63	09.02±1.71	0.75
SD	6.55±1.59	6.14±2.01	6.19±1.80	0.88	9.50±1.66	8.80±1.51	9.39±1.85	0.17
Eating pattern								
TOB	09.26±0.82	08.00±1.77	10.81±1.22	**<0.01**	09.54±1.20	07.20±2.47	10.60±1.26	**<0.01**

The values of breakfast jetlag are represented as mean and standard deviation.
Kruskal-Wallis test was done to compare continuous variables.
The bold value is statistically significant at p<0.05.

3.3.2 Advanced – The participants belonging to this category were having no significant changes in their sleep pattern. They were further examined on the basis of time to breakfast, where the individuals were having a significant difference in their mean breakfast time on both SJL absent and present groups (<0.05). The mean TOB was earlier with 07.20±2.47 in comparison with SJL absent group.

3.3.3 Maintenance – According to the results shown in table 5, the responders were having no significant difference in their sleep pattern but were having a statistical difference in their breakfast timings (<0.05). The mean TOB under this category was also earlier with 10.60±1.26 in SJL present group.

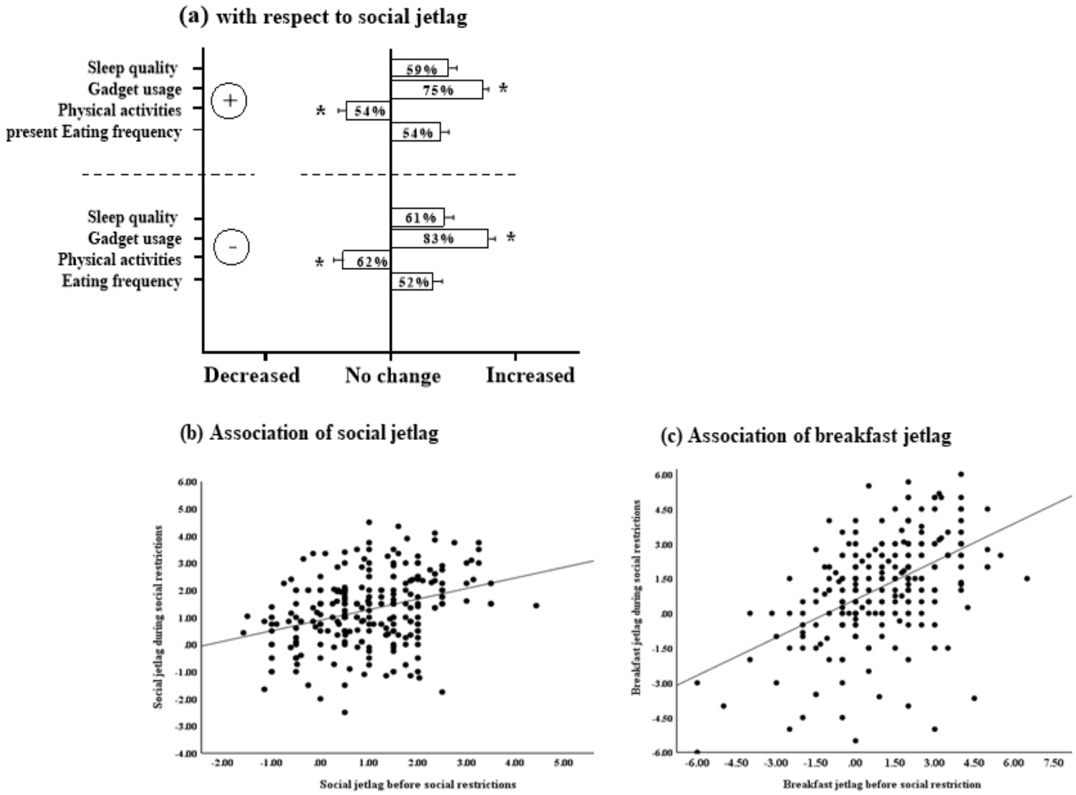

FIGURE 2 The graph (a) represents the changes in other circadian behaviors during the social restriction with respect to social jetlag. The x- axis represents the changes (decrease, no change and increase) in all the categorical variables while, y-axis represents the categorical activities during social restrictions. The plus sign indicates social jetlag present and minus represents social jetlag absent The graph (b) shows the association of social jetlag and (c) shows the association of breakfast jetlag before and during social restrictions respectively.

4. Discussion

This study investigated the association between social jetlag and breakfast with daily circadian activities such as sleep, eating, and other daily behaviors in the Indian population before and during social restrictions. The social restrictions during the COVID-19 pandemic have resulted in significant changes in our routine activities. To our knowledge, this is the first study, to investigate the association of SJL and BJL with circadian activities before and during social restriction. Further, we observed the significant association of SJL and BJL during versus before social restriction ($p<0.001$) (In Table 1). After concluding the association between SJL and BJL before versus during SR we individually studied the association of SJL and BJL with circadian behaviors in the participants which are summarized in the following sections: -

4.1 The association of social jetlag with the circadian behavior "During SR"

According to (Cao et al., 2020) delayed sleep-wake cycle is associated with poor mental and physiological health. The literature suggests that there is a significant behavioral change in the circadian characteristic of sleep (such as time to sleep, time to wake up, sleep duration) during the lockdown. Based on SJL, before the social restriction, the participants with SJL had sleep time (23.96 h ± 0.14), wake-up time (08.95 h ± 0.13) on weekends, and increased sleep duration with 4 h ($p<0.001$). We observed a significant delay in wake-up time by 3.88 h but there was no delay observed in time to sleep when it was compared between SJL absent and present groups. Their time of breakfast was delayed by 1.15 h when compared with weekdays.

The data collected during SR reveals the significant change in sleep and eating characteristics in the participants. When compared within the SJL absent and present groups the individuals with SJL reported their sleep time (23.67 ± 0.13), wake-up time (09.02 ± 0.14), sleep duration (9.35 h) and there was a significant delay in wake-up time ($p<0.001$). In the present scenario, artificial light at night and use of electronic gadgets such as mobile, television, or computer before going to bed can lead to delay wake-up time which can further result in the delay of eating and decrease in physical activities (Cellini et al., 2020). Likewise, our data shows that during SR, people experiencing social jetlag resulted in late sleep time, longer sleep duration, and delay in wake-up time which may be due to long exposure to electronic gadgets ($p<0.05$). Also, we found a significant reduction in physical activities ($p<0.05$) in the participants experiencing SJL which may be due to relaxation from the burden of their office work, school, and other social activities due to the implementation of lockdown.

Overall, the pattern of the delay was same in both conditions “Before SR” and “During SR days”. The significant difference in sleep characteristics was stronger on weekends which was almost similar during the SR condition. Hence, SR days were similar to that of the weekends before SR. In context to social jetlag, there was no significant difference in the time to breakfast before and during SR conditions. The sleep bouts and depression were also non-significant in both non SJL and SJL present group during SR.

4.2 The association of breakfast jetlag with circadian behavior “During SR”

Till now, few studies have shown the effect of social jetlag on food intake. According to (Mota et al., 2019) individuals with social jetlag showed later meal times. Similarly, we found a significant delay in the breakfast timings among the participants with SJL in both the conditions before and during SR. Before SR, the time of breakfast was statistically different among the three categories of BJL in both SJL absent and present groups ($p<0.05$). In SJL present group the participants falling under the "Delay" category were having a delay of 0.25 h on weekdays, falling under advance were delayed by 2.43 h on weekdays, and under maintenance were having advanced timings by 2.66 h on weekdays in comparison with weekends.

The data analyzed based on breakfast jetlag during SR days shows that sleep characteristics such as time to sleep, time to wake up, and sleep duration were statistically non-significant during SR days in comparison to weekdays. During SR in SJL present group, the timings for breakfast were delayed by 0.28 h in "Delay", advanced by 0.80h in "Advance" and maintenance was earlier by 0.21 h in the "Maintenance” category of BJL when compared with SJL absent group. During SR, the time to breakfast was significantly different among the three categories of BJL in both SJL present and absent groups ($p<0.05$). Previous studies have shown the variation in the breakfast, lunch, and dinner timings on weekends (Gill & Panda, 2015) Overall, we found the variation in the timings of breakfast among the categories of BJL despite the presence and absence of SJL.

Our study shows that during social restriction (SR) the sleep-wake cycle was significantly delayed, increased in sleep duration, and delayed in breakfast timings. This clearly shows that social jetlag is directly associated with sleep characteristics and having no association with breakfast timings. The breakfast jetlag is directly affected by eating behavior despite social jetlag. Social jetlag has significantly affected daily circadian activities such as gadget usage, sleep quality, physical activities. We also found a significant linkage of social jetlag with gadget usage and physical activities. The present study showed the significant association of SJL and BJL during “before” versus “during SR condition”. This shows how SJL and BJL have resulted in the changes in daily behaviors during social restriction in the Indian population.

5. Acknowledgment

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7. Conflict of interest

None of the authors have a conflict of interest.

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