Variation in sleep traits in the Indian population during social restriction

Abstract:

Aim: We conducted this study to investigate the impact of social restrictions on chronotype categories, social jetlag, and sleep parameters in the Indian population.

Material and Methods: A cross-sectional study was conducted in 2021 with 139 participants. We used anonline questionnaire (G~~g~~oogle F~~f~~orm) enclosing respondents' sociodemographic information.~~,s~~Social jetlag and sleep parameters were measured with the µ-MCTQ and chronotype was assessed by the r-MEQ. Chi-square, paired t-tests, and One-way ANOVA were used to analyse the data.Pearson correlation was used to determine the strength of the relationship between the variables.

Results: Our results highlighted that a total of 23.8% of volunteers reported social jetlag before social restriction and it significantly reducedto 13.7% (*P*= .001) in the social restricted condition. There is no significant difference in sleep duration during the workday and free days of socially restriction (*P*=.11). We found a difference between midsleep free day (MSf) and midsleep free day corrected (MSfsc) (mean of 13 min before restrictions (*P*=.05) and 10 min during restrictions; *P*= .001).

Conclusion: Our findings provide crucial insights into variations in sleep/wake schedule stability, as seen by changes in the decrease of social jetlag between~~during~~ restriction. It was established that the individuals had significantly equivalent total sleep at both time points, as well as a later sleep-wake time under the social restriction.

Keywords (Chronotype, Sleep, Social Jetlag, Social restrictions)

Abbreviations:

h/hr	Hours
SR	Social restriction
SJL	Social Jetlag
µ-MCTQ	micro-Munich Chronotype Questionnaire
r-MEQ	reduced Morningness Eveningness questionnaire
CT	Chronotype
MT	Morning type
ET	Evening type
NT	Neither type
MSW	Mid-Sleep Workday
MSF	Mid-Sleep Free day
MSFsc	Midpoint of sleep on work-free days sleep corrected
STW	Sleep time work day
STF	Sleep time work free day
WUTW	Wake up time work day
WUTF	Wake up time work free day

1. Introduction:

In humans, sleep timing is governed by an interaction between the circadian and homeostatic oscillators, which determine spontaneous bedtime and wake time in synchronisation with the earth's light/dark cycle[1].Similar to most other living forms, humans and other mammals possess an internal body clock known as the circadian clock, which has a self-sustaining, nearly 24-hour periodicity (derived from the Latin circa diem, which means approximately one day). Many physiological and behavioral processes, including sleep, body temperature, heart rate, metabolism, and hormone secretion, as well as neurobehavioral processes, are given rhythmicity by this system, which also enables an organism to anticipate daily recurring environmental changes like the light-dark cycle, food availability, and predator activity. To remain synchronized with the day-night cycle, the circadian clock is reset daily by light, the primary entraining signal for circadian rhythms[2,3].All mammals appear to have a fundamental need for sleep, with humans on average spending one-third of their lives sleeping or attempting to sleep[4]. Sleep timing is regulated by two overlapping processes: the sleep-dependent homeostatic drive for sleep, which increases with increasing time spent awake, and the circadian process, which imposes a 24-hour pattern on sleep/wake behaviour[5]. The right timing of sleep, along with other sleep elements such as sleep quality and sleep duration, is emerging as an essential component of health and well-being.

Modern lifestyles and artificial light allow us to spend more time indoors, depriving us of natural light during the day. Over the last 200 years, the human lifestyle has dramatically changed as a result of the modernization of our society, the widespread availability of artificial light, the nightwork inherent to our 24/7 economy, and the possibility of rapid travel~~ling~~ across time zones[6,7]. While these technological improvements have undoubtably~~fully~~ eased our daily liv~~f~~es (e.g., constant access to light, energy, and food), they also introduced a new phenomenon in our population, known as “circadian misalignment” [6,7]. Circadian misalignment occurs when there is a mismatch between the environmental time and the body's internal time. It is frequently noticed in those who have jetlag or in shift workers[8,9].Given the extensive range of physiological processes regulated by the circadian clock, circadian misalignment is expected to negatively affect human health, with effects in the short- and long-term[6]. It has been established that circadian misalignment is associated with acute effects such as poor and shorter sleep, reduced alertness, poor performance, hypertension, and abnormal inflammatory status[10,11].

Comment [NK1]: combined into effective sentences

Depending on our social time, our sleep timing may be in or out of sync with the internal circadian timing determined by the circadian clock. Circadian disruption or social jetlag refers to the condition in which social time differs from biological time[12]. Chronotypes may influence both sleep needs and the ability to adjust sleep schedules between weekdays and weekends. In addition to variations in sleep timing between chronotypes, previous research has indicated that evening types spend less time in bed and have shorter workday sleep than morning types, but sleep longer on weekends[13]. In addition, sleep timing is known to vary between individuals. Sleep/wake regulation exhibits trait-like dimensions related to circadian and homeostatic traits, resulting in an inter-individual difference known as morningness-eveningness preference or chronotype. The physiological process of sleep is highly influenced by social and environmental cues and varies substantially with levels of stress[14]. Conceivably, environmental and social

Comment [NK2]: combined into effective sentences changes introduced by the pandemic create sleep disturbances[15,16]. However, the greatest risk for negative health effects is not from a short sleep duration but rather from self-reported poor sleep quality[17].

During ~~the~~ COVID-19 a lockdown (social restriction) situation was created and affected peoplesuggested quarantine to stop the spread of the pandemic.Quarantine is the separation and limitation of movement of persons who have potentially been exposed to a contagious disease to ascertain if they become unwell, ~~so~~ reducing the risk of them infecting others[18]. The lockdownis a challenging psychological and social experience for most people; it demands physical and social isolation, including separation from family and friends, as well as irritation from the commitment to sit at home. This new life configuration has a substantial impact on sleep and mental health[19].Normally, about 80% of people in Europe use an alarm clock on workdays[20], showing that many experience sleep deprivation due to the conflict between their internal body clock (which follows a roughly 24-hour cycle and influences when we feel sleepy and awake) and the need to wake up early for work or school. This conflict, known as social jetlag, refers to the difference in the timing of midsleep (the midpoint between when we fall asleep and when we wake up) between workdays and days off [21]. Midsleep timing on days off, adjusted for any sleep debt accumulated during the workweek, is thought to reflect the phase of our internal body clock (the timing of our body's rhythms relative to a 24-hour day)[22].Therefore, midsleep timing on days off can be used to determine someone's chronotype (their natural preference for going to bed and waking up early or late), as differences in people's internal body clocks show up as differences in when they prefer to sleep and wake up[23]. In societies where school and work start early, people who naturally prefer to go to bed and wake up later may experience more social jetlag and have more differences in sleep timing between workdays and days off[24].In this study, we aimed to explore these effects by analyzing sleep/wake timings to enhance a deeper understandingof social jetlag and the association between alterations in key sleep characteristics following the implementation of restrictions. Furthermore, we investigated the link between chronotype and social jetlag during the restrictions.

2. Material and methods:

To study population and data collection,a descriptive cross-sectional study was conducted from May11,2021, to May 31, 2021; 21 days, in India. For both conditions (BSR and DSR), data were collected at the same time point. We collected data using aquestionnaire,which included ~~including~~ three sections. The first one containssociodemographic information such as the age and gender of participantsand their professional profile, besidesinformation on their sleeping routines at homebefore and during the lockdown stage. The two remaining sectionsconsisted of a short version ofthe Morningness Eveningness Questionnaire and the μ-Munich Chronotype Questionnaire test.We conducted and transferred the electronic version (G~~g~~oogle F~~f~~orm) of thequestionnaire to theIndian population. The survey was self-applied,considering the pandemic conditions requiring physicaland social distancing, and lockdown. The survey was addressed tothe targeted population through email, and social media networks like WhatsApp, Facebook groups, etc.Participants consented to being part of this study and their anonymity and privacy were ensured.

2.1 Tests and scoring:

2.1.1 Micro Munich Chronotype Questionnaire (μ-MCTQ):

The µ-MCTQ was developed from the original MCTQ[25,26]. µ-MCTQ is a validated and reliable questionnaire to assess Social Jetlag (SJL).SJL is believed to represent a misalignment between the internal circadian clock and psychosocial schedules[27].The µ-MCTQ asks simple questions about sleep-wake behaviour, separately for work and work-free days. SJL was calculated by the standard procedure, SJL= Mid sleep of free days(MSF) minus Mid sleep of workdays (MSW). As such, the MCTQ differs from other instruments that assess diurnal preference, in that it is a measure of sleep/wake behaviour and not of psychological preference for the timing of sleep/wake behaviour [28].A "free" day is any day when sleep starts (the night before the free day) and sleep ends (in the morning of the free day) times are not dictated by work or school commitments and time schedules. As per standard protocol for calculating mid-sleep values for free days, a sleep correction was applied to free day midsleep timing (MSFsc) for participants who had longer sleep duration on free day; these participants slept longer on free day to compensate for sleep debt accumulated over the week, which was adjusted ~~for~~ to reflect their true free day midsleep timing as accurately as possible (MSFsc = MSF (SDF-SDweek)/2)[29]. Key sleep parameters, such as sleep start and end and duration were also calculated for both before and during restrictions. The participants were divided into two groups: the presence of social jetlag (>1 h) and the absence of social jetlag (<1 h) in the participants, respectively[30].

2.1.2 Reduced-Morningness Eveningness Questionnaire (r-MEQ):

The r-MEQ was developed by [31] and only includes items 1, 7, 10, 18, and 19 of the original MEQ[32].r-MEQ is used to self-assess the chronotype (CT) of the individuals. The questionnaire has 5 questions and the score range from 4 to 26. Whereby the higher score indicates the Morningness chronotype. The same cut-off scores for determining CT groups were used in [31](Eveningness chronotype: < 12; Neither chronotype: 12–17; morning: >17). The validated scoring was used where the first four questions were scored 1–5 and question 5 was scored 0–6.

2.2 Statistical analysis:

Categorial variables were shown as frequency and p~~P~~ercentage. The normality of the data was checked by the Kolmogorov–Smirnov test. Categorial variables were compared between the groups using the chi-square test. A Paired t-test/Wilcoxon signed-rank test was used to compare the paired variables. Means and standard deviations were computed for all continuous outcomes.Z-scores for skewness and kurtosis were used to determine the distribution of the data[33]. Pearson correlation was used to determine the strength of the relationship between the variables. In all our analyses, P = .05 was considered to indicate statistical significance in two-tailed tests. The time is written in hours (hr: hr). In addition, based on age the subjects were assigned to one of the following four groups: Group A (ages in years 18-21), Group B (ages ~~in years~~ 22-25), Group C (ages ~~in years~~ 26-29), Group D (ages ~~in years~~ 30-33). The data analysis and graph preparation were performed using Statistical Package for the Social Sciences (SPSS) 26.0 (IBM Corporation, NY, USA) and GraphPad Prism Software version 8.0, San Diego, USA.

3. Results:

3.1 Demographics

Table 1 shows the demographic profile of the study sample.Participants were invited toparticipate in the study via an online form. Participation was voluntary and unpaid. Allparticipants were students and gave their electronic informed consent before completing the questionnairesonline, and were informed that all data collected would be stored anonymously. The final sample of 139 respondents (55.4% female) with a meanage of 24.4±3.6years (range: 18–33y) with a statistically significant difference between genders (*P*=.019).In the studied population, we found Morning type (MT) 24 (17.3 %), Evening type (ET) 40 (28.8%) and Neither type (NT) 75 (54.0%) individuals (*P* =.001).

Figure 1a shows the individual plot of SJL in both conditions. The range of SJL before SR was -3.00 to +2.50 hrs. while during SR it was -2.04 to +2.83 hrs. Where minus indicates the delay and plus indicates the advance SJL. The SJL decreased by 26 minutes from before SR. **Figure 1b** shows the number of individuals in which SJL were present during the BSR and DSR. We found that during the SR condition (10%) SJL was decreased (*P* =.001).

Table 1. Demographic characteristics of the sample.

Variables	N (%) N=139 (100%)
Gender	
Male	62 (44.6)
Female	77 (55.4)
Chronotype (CT)	
MT	24 (17.3)
ET	40 (28.8)
NT	75 (54.0)
Age (Mean ± SD)	24.4 ± 3.6
18-21	32 (23.0)
22-25	51 (36.7)
26-29	44 (31.7)
30-33	12 (08.6)
Jet Lag (BSR)	
Present	33 (23.7)
Absent	106 (76.3)
Jet Lag (DSR)	
Present	19 (13.7)
Absent	120 (86.3)

Abbreviations: N, number; SD, standard deviation; CT, chronotype; MT, morning type; ET, evening type; NT, neither type, BSR, before social restriction; DSR, during social restriction

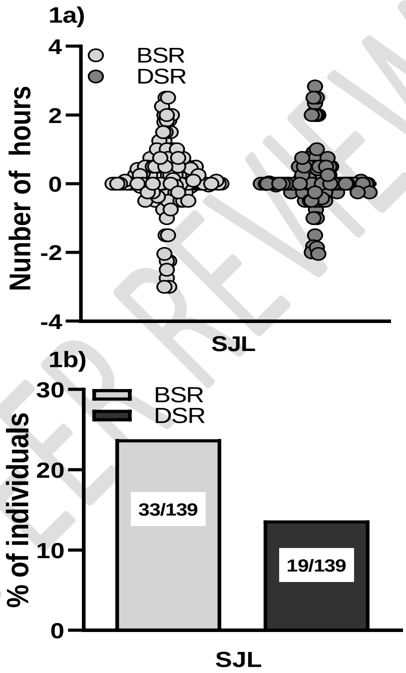

Figure 1a shows the individual plot of the SJL in both conditions while **Figure 1b** shows the number of individuals having SJL before and during the social restriction.

BSR; Before social restriction, DSR; During

Table 2 represents the characteristics of sleep, before and during SR. We found that the TSF (*P*=.05) and MSF (*P*=.05), STF (*P*=.05) andWUTF (*P*=.001) were found to significantly increase ~~during~~ before SR. During SR no significant difference was noted between the TSF (*P*=.05) and MSF (*P*=.05) whileSTF (*P*=.05) and WUTF (*P*=.001) were significantly increased in SR. Before the SR, t~~T~~otal sleep was found to have significantly increased in the WFD while no significant change in TSF and TSW was reported during the SR.

Table 2. Overall comparison between the WD and WFD of BL and DL.								
	Before Social Restriction				**During Social Restriction**			
Variables	WD	WFD	t value	*P* value	WD	WFD	t value	*P*value
TS	7.45±1.95	7.82±2.02	2.273	**.05**	7.73±2.01	7.94±1.90	1.609	.11^{ns}
MS	3.73±0.97	3.91±1.01	2.272	**.05**	3.86±1.00	3.97±0.95	1.606	.11^{ns}
ST	23.61±1.86	23.90±1.80	2.005	**.05**	23.59±1.59	23.91±1.68	3.490	**.001**
WUT	7.08±1.58	07.74±1.91	5.693	**.001**	7.32±1.69	7.85±1.86	4.586	**.001**
TS; Time of sleep, MS; Mid sleep, ST; Sleep time, WUT; Wake up time, Data presented in Mean±SD. ns; non-significant								

Consequently, the amount of sleep deficit accumulated in the working week reduced during restrictions, reflected in a reduction of the difference between MSf and MSfsc (mean of 13 min before restrictions (*P*=.05) and 10 min during restrictions; *P*=.001). However, the average sleep duration for work days was only 16 minutes longer than before restrictions (*P*= .05) and free day sleep duration was longer by a mean of 7 minutes during restrictions (*P*=.05).

3.2 Sleep duration and social jetlag before and during social restrictions

Table 3. Sleep duration and social jetlag before and during restriction.			
	Before Social Restriction N (%)	During Social Restriction N (%)	*P* value
MSWD			**.001**
Midnight – 2am	8 (5.8)	7 (5.0)	
2am – 4am	94 (67.6)	87 (62.6)	
4am – 6 am	35 (25.2)	41 (29.5)	
Later than 6am	2 (1.4)	4 (2.9)	
MSWFD			**.001**
Midnight – 2am	5 (3.6)	5 (3.6)	
2am – 4am	88 (63.3)	84 (60.4)	
4am – 6 am	42 (30.2)	48 (34.5)	
Later than 6am	4 (2.9)	2 (1.4)	
SJL			**.001**
Present	33 (23.8)	19 (13.7)	
Absent	106 (76.2)	120 (86.3)	

There was a decrease in the~~a~~number of participants with MSW in the early hours of the morning (midnight-2am and2am-4am), and an increase in later MS (from 4am to 6amand later than 6am; (*P*=.001). Similarly, on free day, there was adecrease in the number of participants with early MS between2a.m. and 4a.m., but there was an increase in MS between 4a.m.and 6a.m. (*P*=.001). Notably, the percentage ofparticipants reporting no SJL increased from 76.2% before SR to 86.3% during SR (*P*=.001). Pearson's correlation method was used to show the correlations between the change in social jetlag during SRfollowing the imposition of restrictions on other sleep parametersduring social restrictions. SJL was found to be positively correlated with the MS (r= 0.339,*P*=.001)and ST(r= 0.215, *P*= .05) while the WUT (r= -0.322, *P*= .001) and MSFsc (r= -0.171, *P*= .05) were found to be negatively correlated with the SJL.

4. Discussion:

This study highlights the strong influence of workday schedules on sleep/wake cycles and the potential benefits of reducing social jetlag by adjusting sleep timing on workdays. The most marked changes were associated with social jetlag (SJL) before and during SR. The range of SJL before SR was -3.00 to +2.50 hrs. while during SR it was -2.04 to +2.83 hrs. As a result of the SR, respondents in our survey reduced theirsocial jetlag (SJL) by almost 26 minutes because the total sleep of the participants was approximately the same at both time points. It has been shown that social jetlag of more than two hours dropped from 52.1% before COVID-19 to 6.3% during the pandemic. Due to SR, not only sleep butalso depression were~~was also~~ significantly increased in the population[34]. A survey of subjects from Austria, Germany, and Switzerland[15] observed reduced SJL as well as a slight reduction in their self-reported sleep quality, increased subjective burden, and lower mental and physical wellbeing, during the pandemic.Furthermore, a recent study in a normative population found only a weak correlation between sleep quality and the social jetlageffect[24]. The data suggests a significant lack of sleep before the pandemic due to social time pressures, offering insights into the actual sleep requirements of various age groups. It also indicates that ~~a~~ tolerable sleep jet lag (SJL) is approximately 20 minutes. When social time pressures are reduced, individuals tend to sleep more, experience less SJL, and rely less on alarm clocks[35]. Our findings support a more comprehensive examination of how the pandemic may have impacted human sleep patterns.

In this present study, we didnot find any significant difference between TSW and TSFofsocial restriction (*P*= .05) but before the SR, TS significantly differed in all theparameters ofsleep among the participants.During the lockdown, there was a notable delay in the times people went to bed and woke up, particularly among younger individuals. Despite this delay, young people reported sleeping longer during this period. All age groups, especially males, showed an increase in the time spent on digital media. However, females experienced more delays in sleep and meal times, yet reported longer sleep durations during the lockdown[36]. Changes in t~~T~~otal sleep (TSF), go to sleep (TSF), and wakeup time (WUTF) were measures significantly increasing before the restriction, indicating that the participants had less sleep in the workdays as compared with the workfree days before restrictions, but social restriction imposed~~ing~~ on participants found the TS~~found~~ to beapproximately the same, it means the subjects had approximately equal sleep in the workday and workfree day. It may be because the participants are in their homes in the rest phase or work from home. Sleep-wake times are now spread to a wider window compared to before SR. Additionally, workdays versus work-free days differenceshave gotten smaller with increased working-from-home situations. It has been indicated that working and studying from home allows~~ed~~ people to plan their sleep according to their body clock, instead of the clock on the wall[37]. The SR decreases the mobility of the participants to not spread the virus which causes them to work from home and the workday from home also becomes a workfree day. Several studies indicate that the COVID-19 pandemic and the resulting restrictions caused a significant decrease in global human mobility[38].

There was a significant difference in the ST (19 min) (*P*= .001) and WUT (31.8 min) (*P*=.001) during SR and ST (17.4 min) (*P*= .05) and WUT (39.6 min) (*P*= .001) before SR between the work and workfree days. A study analysing 958 responses found that compared to the pre-lockdown period, there was a trend towards later bedtimes and waking times. This shift was accompanied by a decrease in nighttime sleep and an increase in daytime napping[39]. These changes showed the participants had~~ve~~ almost the same ST and WUT but the total sleep and mid sleep were different in work and workfree days before and during restriction. Changes on free days were lesser, although we report a later time of midsleep on free days during restrictions because social jetlag is linked to several negative health outcomes, such as metabolic disorders[40], cognitive and affective impairments[41], lower academic achievement, and a lower quality of life[42], these changes may have had a positive effect by reducing social jetlag. However, reduced social jetlag and longer sleep duration during SR were found in this study as well as Blume and colleagues[15].During SR, TS ~~was~~increased, it may be because ~~of~~ the participants were free to plan their day and had a longer sleep duration. The study suggested that pandemic-induced changes in lifestyle, such as remote work and lockdown policies, may have facilitated later sleep timing but that these changes may diminish as restrictions are lifted[43]. In fact, during COVID-19 restrictions, several studies have found a high prevalence of insomnia and daytime sleepiness[44], indicating that potential benefits from adjusting sleep timing and reducing social jetlag may be outweighed by other important COVID-19-related factors.

The implementation of restrictions correlated with alterations in the timing of midsleep and social jetlag during work and work-free days. During SR, there was a reduction in the proportion of individuals midsleep during the early morning hours (midnight-2a.m. and 2a.m.-4a.m.) on workdays, alongside a rise in later midsleep periods (from 4a.m. to 6a.m. and later than 6a.m.; *P*= .001). This shift in sleep patterns could be attributed to the imposed restrictions, leading participants to fall asleep later at night. Before the restrictions, 67.6% of participants were asleep between 2am and 4am, and 25.2% were asleep between 4a.m. and 6a.m. on workdays. During the restrictions, these figures changed to 62.6% and 29.5%, respectively, indicating a tendency for participants to sleep later during the SR.
According to[43]the lifestyle changes imposed by the pandemic, such as remote work and lockdown policies, may have contributed to a shift towards later sleep schedules. Likewise, on free days, there was a decline in the number of participants experiencing early midsleep between 2 a.m. and 4 a.m., coupled with an increase in midsleep between 4am and 6am (*P*= .001). In both scenarios, there was a higher number of participants experiencing midsleep between 4am and 6am on workdays and work-free days during the restrictions. This may be attributed to the fact that all subjects were free to sleep at their preferred times, without the constraint of work ~~on~~ the next morning and the ~~no~~ need to wake up early for daily responsibilities. Schools or ~~/~~ Offices were also closed these days, so there were no early morning duties, allowing participants to delay both their sleep and wake-up times. Significantly, the percentage of participants who reported experiencing no social jetlag increased from 76.2% before the restrictions to 86.3% during the restrictions (*P*= .001).The findings from[45]indicated that the pandemic had an impact on various sleep characteristics, including longer sleep durations, later bedtimes, and poorer sleep quality. These changes were associated with shifts in family routines during the pandemic period.It has been shown thatwhen compared to adolescents who experienced a regular school schedule, the "natural experiment" initiated by the COVID-19 pandemic shutdown

of schools resulted in a 2-hour shift in sleep patterns, longer sleep duration, better sleep quality, and less daytime sleepiness [46].

However, we did not record affective status in the current study, so we cannot directly test the relationships between changes in sleep quality and their ~~its~~effect. It is evident that the impact ofthe social restriction on sleep behaviors may not be uniform across the population and could be influenced by factors such as household composition, family structure, socioeconomic status, age, and caregiving duties.

Conclusion:

Our findings provide crucial insights into variations in sleep/wake schedule stability, as seen by changes in the decrease of social jetlag during restriction. It was established that the individuals had significantly equivalent total sleep at both time points and a later sleep-wake time under the social restriction. Overall, understanding the effects of COVID-19 on sleep-wake patterns and implementing strategies to support healthy sleep can contribute to overall well-being during these challenging times. Further studies are needed on the changes in sleep-wake patterns in the post-pandemic period.

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