Relationship of chronotype to sleep pattern in a cohort of college students during work days and vacation days

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To study whether the chronotype is linked with the sleep characteristics among college going students assessed during college days and vacation days, adult female students at undergraduate level were asked to answer the Hindi/English version of the Munich Chronotype Questionnaire (MCTQ), fill a sleep log, and drinking and feeding logs for three weeks covering college and vacation days. Based on chronotype categorization as morning type, intermediate type and evening type, sleep onset and offset times, sleep duration and mid-sleep times for each group were compared, separately for college and vacation days. Results indicate that the sleep duration of the morning types was significantly longer than the evening types, both, during college and vacation days. Similarly, the sleep onset and sleep offset times were significantly earlier in the morning types than the evening type students. During the vacation days, the individuals exhibited longer sleep duration with delayed mid-sleep times. Further there was no significant difference among the chronotypes regarding their feeding and drinking frequency per cent during the college and the vacation days. It is suggested that the students should be made aware of their chronotype, so that they can utilize their time optimally, and develop a schedule more suitable to their natural needs.

Keywords: Chronotype, College days, MCTQ, Sleep characteristics, Sleep log, Vacation days

The chronotype in humans is defined by the circadian system and represents the relationship between the phase of one’s endogenous rhythm and external synchronizers. Horne and Ostberg developed the questionnaire (MEQ) which was used for selecting the ‘morning’ and ‘evening’ type of people. The MEQ questionnaire is widely used for qualitatively estimating the early (lark, morning), intermediate (neither) and late (owl, evening) chronotypes. Individuals showing an inclination towards an early endogenous circadian phase are called the morning types, while those with a late endogenous circadian phase are called the evening types. The phase of endogenous circadian rhythm in the morning types is different from that of evening types. This qualitative estimation of chronotype is defined by the genetic factors, besides other attributes such as age, sex, cultural traditions and social habits, ecological factors and season of birth. Another questionnaire, the Munich Chronotype Questionnaire (MCTQ) helps in assessing the effect of a number of exogenous factors along with the quantitative assessment of chronotype.

Morning types are known to have earlier sleep times, they wake up early and go to bed at an early hour in comparison to the evening types. Whereas, the evening types are generally related with a later time to bed and wake-up time, even more on weekends. As a result, the evening types are known to have unusual sleep/wake timings. A sleep debt occurs in such individuals on workdays and consequently they tend to make up their lost sleep by prolonging their sleep duration on weekends. Thus, a sleep debt is created by the difference between work days and free days sleep timing. Such a difference observed between social and endogenous time is termed as “social jetlag”. Evidently, the evening type subjects show larger social jetlag than the morning type subjects. Researches accounting for the effect of chronotype on sleep/wake characteristics are mostly carried out on individuals who are affected by social cues, such as school and work programs. Weekends are taken as free days, and are compared with weekdays taken as workdays, to assess the contradictions in sleep time.

Till now, studies considering vacation as free days in place of weekends, in order to reduce sleep rebound effects, have not been published. Comparisons between, college days and vacation days, will help in finding as to how (i) chronotype...
differ and (ii) if they do, then to understand the adjustment of the circadian system to conditions with different social restrictions.

Therefore, the present study has been carried out to assess the sleep characteristics of college students with different chronotypes with the purpose to investigate whether there is any correlation between chronotype and sleep parameters?

**Material and Methods**

Healthy female undergraduate students (40) from a college in Lucknow, India volunteered to participate in this study. Their mean age was 19.6 years ranging from 19 to 21.5 years with a mean BMI of 18.05 (±2.85). Before agreeing to be a part of the study every student was clearly informed about the purpose and the method of the study. They were also asked to sign a declaration informing them that they could stop being part of the study at any point of time. The students were also told about their data being coded so that data evaluation could be done anonymously. They attended college regularly during the study phase. For all participants, college usually started at 0900 hrs and ended approximately at 1330 hrs. This was the regimented social environment. During vacation days the participants lived in their own houses and were in a free social environment. The students answered a Hindi/English version of the Munich Chronotype Questionnaire (MCTQ) for determination of diurnal preference.

The study was carried out during October, 2012. For the study two time period were marked out as college days and vacation days and considered as the social environment. At the start the participants were segregated on the basis of their chronotype with the help of MCTQ. According to this questionnaire the students self rated themselves among 7 chronotype classes from ‘extreme early’ to ‘extreme late’ with intermediate type in between. All the early and the late types were clubbed together, separately, resulting into three types viz., morning types, intermediate types and evening types.

*MCTQ, sleep logs (SL), drinking and feeding logs* — Chronotypes were assessed by MCTQ that was given in both English and Hindi version. Additionally, the questionnaire was used for assessing sleep timing of the subjects by asking simple questions about sleep-wake behavior separately for college days and vacation days. The participants were asked questions, regarding bedtime, time to fall asleep, time of awakening and getting up, etc. Age, sex, height and weight were also inquired. The questionnaire was completed during the normal college schedule (0900-1330 hrs). The assessment sessions lasted approximately 20 min and were always carried out in the morning. The quantification of the human phase of entrainment can be done accurately, with the help of MCTQ.

The sleep logs were kept by the participants, in order to validate the responses from the MCTQ and the actual sleep behaviour was assessed with the help of a sleep log during the study period. In addition, the participants were asked to fill in the drinking and feeding logs daily for the study period. Any intake of liquid or solid was entered in the drinking and feeding logs, respectively. The entries in the logs started from the morning on an hourly basis, marked as 0600-0700 hrs and so on till 2200-2300 hrs. Each event of liquid (drinking) or solid (feeding) intake was given a value of 1 and plotted as frequency (%) value.

**Data analysis** — Data were analysed using One-way analysis of variance (one-way ANOVA), followed by post hoc test (Bonferroni’s Multiple Comparison Test) and two-way ANOVA to determine the significance when two variables (chronotype vs social environment) were involved. Significance was taken at \( P < 0.05 \). The statistical analysis was done by using Graph Pad Prism Software version 5.0, San Diego, USA.

**Results**

For each chronotype and the social environment, the sleep parameters for the study are plotted in Fig. 1 and the frequency of feeding and drinking behaviour is plotted in Fig. 2. Differences were found among the chronotypes, during the college days and vacation days.

*College days* — Morning types (MT) had earlier sleep onset and sleep offset times than the intermediate (IT) and evening types (ET) during the college days. Analysis of data showed that sleep onset time differed significantly, with delayed sleep onset in evening type from morning and intermediate type, while no difference was found among morning and the intermediate types (\( F_{2,37} = 9.380, P = 0.0005 \), 1-way ANOVA) (Fig. 1a). Whereas, there was no difference in the sleep offset times among the three chronotype classes from ‘extreme early’ to ‘extreme late’ with intermediate type in between. All the early and the late types were clubbed together, separately, resulting into three types viz., morning types, intermediate types and evening types.
differ with morning and evening types ($F_{2,37} = 4.749$, $P = 0.0146$, 1-way ANOVA) (Fig. 1c). The mid-sleep time was delayed in the evening types showing a significant difference only with the morning types ($F_{2,37} = 4.645$, $P = 0.0159$, 1-way ANOVA) (Fig. 1d).

**Vacation days** — During the vacation days the morning and intermediate types had earlier sleep onset times than the evening types (Fig. 1a), while morning types had earlier sleep offset times than the intermediate and evening types (Fig. 1b). Sleep onset time was delayed in the evening types showing a significant difference with morning and the intermediate types ($F_{2,37} = 27.01$, $P < 0.0001$, 1-way ANOVA), but there was no significant difference among the groups in their sleep offset times ($F_{2,37} = 1.649$, $P = 0.2061$, 1-way ANOVA) (Figs 1a and b). During vacation period, the sleep duration of evening types was the shortest as...
compared to the morning and intermediate types ($F_{2,37} = 6.021, P = 0.0054, 1\text{-way ANOVA}$) (Fig. 1c). The mid-sleep time was delayed in the evening types showing statistical difference with both the morning and the intermediate types ($F_{2,37} = 11.62, P = 0.0001, 1\text{-way ANOVA}$) (Fig. 1d).

**Effect of chronotype and social environment on sleep characteristics** — Data were analysed for the effect of social environment (factor 1) and chronotype (factor 2) using two-way ANOVA. There was a significant effect of social environment as well as the chronotype on sleep onset times of individuals (Factor 1: Social environment $- F_{1,74} = 10.09, P = 0.0022$; Factor 2: Chronotype $- F_{2,74} = 29.43, P < 0.0001$, Interaction: $F_{2,74} = 3.579$, 2-way ANOVA). Similarly, sleep offset times were significantly different in all the three chronotypes during the two social environment, with delayed sleep offset time in individuals during the vacation days (Factor 1: Social schedule $- F_{1,74} = 31.15, P < 0.0001$; Factor 2: Chronotype $- F_{2,74} = 6.757, P = 0.0020$, Interaction: $F_{2,74} = 0.9601$, 2-way ANOVA).

The social environment had significant effect on the sleep duration of individuals of intermediate chronotype with increased sleep duration during the vacation days, however it was unaffected in the morning and evening types (Factor 1: Social environment $- F_{1,74} = 7.220, P = 0.0089$; Factor 2: Chronotype $- F_{2,74} = 5.092, P = 0.0085$, Interaction: $F_{2,74} = 1.245$, 2-way ANOVA).

During the two social environment, the mid-sleep times also varied significantly among all the three chronotypes (Factor 1: Social environment $- F_{1,74} = 28.17, P < 0.0001$; Factor 2: Chronotype $- F_{2,74} = 15.89, P < 0.0001$, Interaction: $F_{2,74} = 2.394$, 2-way ANOVA). Individuals showed later mid-sleep times during vacation days than college days (Fig. 1).

**Frequency of feeding and drinking behaviour** — The frequency of feeding (Figs 2a and b) and drinking (Figs 2c and d) behaviour from both college days (C) and vacation days (V) in the morning and intermediate types is shown in Fig. 2. Feeding was initiated in both, the morning and the intermediate types between clock hour 0700-0800 hrs during the two social environment. The per cent of individuals feeding peaked in between clock hour 0800-0900 hrs in the morning types during the two social environment (C=39.26% and V=33%, Fig. 2a) and in the intermediate type during college days (C=40.17%, Fig 2b). But during vacation days the peak in the intermediate types was delayed by an hour occurring in between clock hour 0900-1000 hrs (V=39.1%, Fig. 2b). The second peak of feeding during the college days occurred in between clock hour 1400-1500 hrs in the morning types and in between clock hour 1300-1400 hrs in the intermediate types with 47.41 and 41.88% individuals feeding, respectively (Figs. 2a and b). In between clock hour 2100-2200 hrs, the feeding pattern closely matched in morning (C=44% and V=40%, Fig. 2a) and intermediate types (C=38.46% and V=41.7%, Fig. 2b) during both the social environments. During the vacation days, feeding pattern in the morning and intermediate types between the 1st and 2nd peak appeared to be very flexible (Figs. 2a and b). No clear feeding pattern was observed in the evening type individuals during the two social environments.

There was no rhythmic pattern in the drinking frequency during college and vacation days, in all the chronotype groups (Figs 2c and d).

**Discussion**

The present study analysed the sleep characteristics of subjects influenced by two social environments. It is known that sleep and wake times are affected by proximate social cues and social constraints.\textsuperscript{17} It is yet to be determined, whether social stimuli impact the timing of the circadian system independent of their function in regulation of light exposure.\textsuperscript{18} This is the first study presenting the sleep-wake data with feeble social obligations.

The results from the present study conform to those of previous studies suggesting that, when exposed to strong or weak social constraints, the morning type individuals had earlier sleep onset and offset times and evening types had later sleep onset and offset times.\textsuperscript{1,2,15,19-21} All chronotype groups showed a delay in their sleep offset and mid-sleep times with an increase in duration of sleep during vacation days.

Interestingly, in the present study the intermediate types slept longest, compared to the morning and evening type individuals, both during school and vacation days. Such a result has not been reported previously. Studies done earlier have showed that evening types slept longer than the morning types.\textsuperscript{16,22}

The sleep behaviour of extreme morning and evening types assessed for two week with a sleep log showed that the morning types went to bed and got up earlier than the evening types, had a stable sleep length and wake up time and took naps for short
periods in comparison to the evening types\textsuperscript{23}. It was observed that the morning type retired earlier by 82 min compared to the evening types. In the present study also, the morning types retired earlier by 166 and 212 min during college days and vacation days, respectively, as compared to the evening types. But, the two studies differ in many aspects, such as climate, culture and socio-economic conditions and therefore are difficult to compare.

A significant correlation between wake up time and academic performance, showing good grades and better quality with early time of arising has been observed in medical students\textsuperscript{24}. Initiation of class in the morning can affect the sleep wake pattern of students and which further has an influence on academic performance\textsuperscript{25}.

It has been suggested that the morning and evening types require nearly similar duration of sleep. Also, in the morning types the sleep need and its duration of sleep is closely matched over the week\textsuperscript{25}. On the contrary, in the present study, the evening types slept for a shorter duration than the morning types during both the college and vacation days.

Less number of evening types reported in the present study, indicating that the chronotype preference is influenced by the social set up. In our culture, the behaviour of the girl child is very much influenced by the social constraints and societal do’s and don’ts. For example, females are less likely to go out on late nights, return late and be late in sleeping, and are motivated from the early childhood to stick to early bedtimes and early rising times, which further may modulate their sleep-wake pattern.

It has also been observed that morning types tend to be more regular in their daily lifestyle than are the evening types\textsuperscript{26}. In a study, it was found that Junior high school children were supposedly more morning type when oriented to an outdoor lifestyle in contrast to those oriented for an indoor lifestyle. Such a result could be interpreted due to the exposure of the existing light in the daytime\textsuperscript{27}. This finding is in contrast to the present observation that an indoor oriented lifestyle tend to make the individuals morning types. However, it could be cultural also. For example, among Japanese junior high school students, being morning type is considered to starting every day with a pleasant feeling\textsuperscript{28}.

There are a limited number of studies that have assessed the interaction between chronotype and eating behaviour. In a study, using food logs it was reported that individuals with morning chronotypes consumed less fast food and caffeinated drinks with an increased intake of dairy products\textsuperscript{29}. The midpoint of sleep has been found to be significantly associated with dietary intake of certain nutrients of food and other eating behaviours\textsuperscript{30}. Individuals with a preference for eveningness have been suggested having less healthy lifestyles than those with a preference for morningness\textsuperscript{31}.

However, in the present study no such relationship was investigated. The findings suggest that on an average the morning and the evening types have different sleep requirement. The morning types were able to keep up with their duration of sleep closely during the two social environments. The present findings also suggest that the evening types sleep less than the morning types and consequently extend their sleep duration during the vacation days, to catch up on lost sleep during the college days.

**Future perspectives**

The conclusions drawn from the present study are based on self-reported sleep timing, which sometimes may not be very accurate. Also, no supplementary information about the social factors was taken, such as sleeping environment, quality of sleep, mood on waking up, feel good factor, etc. which may affect the sleep characteristics. Therefore, studies of this kind in future, should take into account these factors, if they have any influence on the chronotype.

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