



## CIRCADIAN PREFERENCES AND ASSOCIATION WITH BODY MASS INDEX: A CROSS-SECTIONAL STUDY AMONG INDIAN MEDICAL UNDERGRADUATES

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### Abstract

**Background:** Differences in preference for sleep-wake habit and physical or mental performance across individuals underlies the concept of morningness-eveningness/chronotype. Chronotype have been found to influence diverse aspects of one's life. To date few studies have explored the morningness-eveningness preferences particularly among Indian student populations.

**Aims and objectives:** To fill this knowledge gap, the present study was conducted to determine the circadian preferences of Indian medical students. In addition, association between chronotype and body mass index (BMI) was also investigated.

**Methods:** The study followed cross-sectional, observational design was conducted on 110 apparently healthy medical undergraduates of either gender (82 males, 28 females) at a government medical college in Southern Haryana, India. Demographic and anthropometric information of the participants was collected. A well-validated instrument, Morningness-Eveningness Questionnaire (MEQ), was used to identify participant's chronotype. Frequency distribution of the sample in relation to chronotype was determined. Association between chronotype and overweight was evaluated using Pearson's Chi-square test.  $P < 0.05$  was considered statistically significant.

**Results:** The study showed that around two-fifth of the students could be classified as belonging to the two extreme typologies i.e., morning- or evening type. Females exhibited greater predisposition for morningness, though differences were not significant ( $p = 0.55$ ). Average body mass index (BMI) did not differ significantly across chronotypes; however, association between chronotype and overweight was found to be significant ( $\chi^2 = 15.91, p = 0.003$ ). Overweight students were much more likely to be evening-oriented than being morning type in comparison to normal weight participants [Odd's ratio 95% CI (adjusted for effect of gender): 2.16 (0.82 – 5.71)]

**Conclusion:** Frequency distribution in relation to chronotype among Indian medical student population is similar to worldwide figures reported in literature, with major fraction of the population belonging to the intermediate/neutral chronotype. Being evening-oriented predisposes to overweight/obesity but this relationship needs to be explored using a multivariate approach to arrive at a definite conclusion.

**Keywords:** Chronotype, Indian/South Asian, medical students, mornigness-eveningness preference, overweight/obesity

## Introduction

Almost all biological functions exhibit an endogenous circadian rhythm of about 24-hrs. Inter-individual differences have been observed in these ubiquitous 24-hr daily cycles. Based on the circadian time preference for sleep-wake behaviour, physical or mental performance, the human population has been classified into three categories known as chronotypes or circadian typology. There are “*morning/early types*” (**Larks**) who get up easily and are more alert in the morning than in the evening. By contrary, “*evening/late types*” (**Owls**) prefer late night hours (more alert at night and often sleep late). Then there are *intermediate/neutral types* who neither have an early morning nor extreme evening behaviour, but prefer in between. [1] Literature has reported that only about 10% to 15% of the people fall within categories of being pure morning or evening type, majority of them belong to the intermediate group. [2]

The circadian preferences are determined by internal factors (eg: expression of clock genes, cortisol and melatonin levels) and by environmental factors (eg: social habits, light/darkness cycle, season). [3,4] Age and gender also influence morningness-eveningness preferences. Chronotype characteristics may change during an individual’s lifespan. children are usually predisposed toward morningness until the start of adolescence, when a shift toward eveningness begins and peaks around the end of adolescence. Later in life, morning habits become more pronounced and peak around age fifty to sixty. [5-6] Studies involving both sexes showed that females are more inclined to be morning oriented than males. [7-8]

The cyclic fluctuations in physiological and psychological functions are thought to influence diverse aspects of an individual’s life. Chronotype influences attitudes, lifestyle, cognitive functions, motor skills and personality traits. [9-11] Morning (M)-types tend to be more conscientious, agreeable, and achievement-oriented, whereas evening (E)-types show marginally more extroversion and some neurotic traits and may be more disposed to mental or psychiatric, mood and personality disturbances and eating disorders. [12-14] The morning chronotype university students have been found to perform better in academics than their evening counterparts, irrespective of the time of class or examination time. [15] This may be due to greater conscientiousness and achievement orientation, better sleep quality, less use of alcohol and caffeine, and less social jetlag, since M-types are better aligned with their class schedules. [16-17]

The worldwide prevalence of obesity is reaching pandemic proportions. The WHO had estimated that in 2016, more than 1.9 billion adults worldwide (39%) were overweight, and over 650 million (13%) were obese (worldwide prevalence nearly tripled from 1975 to 2016). It is predicted that more than half of the world’s population would be overweight or obese by 2035 without significant action. Rates of obesity are rising especially in children and lower income countries. Obesity is a disease impacting most body systems. According to the WHO, obesity is a major risk factor for noncommunicable diseases such as heart disease, stroke, type 2 diabetes, certain cancers (endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon), and osteoarthritis. [18]

The scarcity of research in the area of chronobiology especially among Indian populations prompted us to undertake this research project. We aimed to determine the frequency distribution of morningness-eveningness preferences in a sample of Indian medical students. In addition, the relationship of chronotype with body mass index (BMI) was also investigated. It was hypothesized

that evening-oriented students would have higher BMI and greater prevalence of overweight/obesity than the morning preferring students.

## Materials and Methods

### Subjects

This was an observational, cross-sectional study involving medical undergraduates of a government medical college (Shaheed Hasan Khan Mewati) in Southern Haryana, India. Medical students of either gender not suffering from any acute or chronic illness and showing willingness were considered for inclusion in the study. A total of 120 students enrolled in the study; after exclusion of ten students as they submitted incomplete questionnaires yielded a final sample size of 110. Participants were informed about the nature and purpose of the study. Study procedures were explained to them and informed written consent was obtained. Approval was ratified by institutional review board (IRB) who deemed that the research proposal did not require a full committee review.

### Instrument

General information related to the demographics of the participants was collected. Height of each participant was measured using a stadiometer and rounded off to the nearest 1 cm. Each participant was weighed on an electronic weighing machine and body weight recorded to the nearest 1 kg. Body mass index (BMI) for every participant was calculated using the following formula:  $BMI = \text{Weight (Kg)}/\text{Height(m)}^2$ . Based on WHO classification of BMI, subjects were grouped into three categories: “Under-weight”, “normal-weight” and “over-weight”.

Participant’s chronotype was identified following self-administration of one of the most frequently used and well-validated questionnaire, **Morningness-eveningness questionnaire (MEQ)**, developed by Horne and Ostberg 1976. The questionnaire consists of 19-items (multiple-choice type) regarding the individual’s preferred time to wake up and sleep, the ideal time for maximum activity and other useful information for identifying circadian preference. Scores on the MEQ range from 16 to 86. Those individuals who score below 42 are regarded as evening types and those above 58 are identified as morning types. Scores from 42 to 58 indicate neither accentuated morning or evening preference and such individuals are categorized as being intermediate or neutral type.

### Data analysis

All data were analyzed using Statistical Package for Social Sciences (SPSS) for Windows version 20.0 (SPSS Inc., Chicago, IL, USA). Mean and standard deviation was calculated for continuous variables and categorical variables were represented through frequency (percentage). A univariate analysis of variance (ANOVA) was performed to compare the average BMI across the chronotype categories. Pearson’s Chi-square test was used to examine the association between BMI based weight groups and chronotype categories. Regression analysis was also done to identify the confounding effect, if any, due to gender.

**Table 1:** Descriptive statistics of the study cohort (n=110)

Variable	Value
Gender	
<i>Males</i>	82 (75%)
<i>Females</i>	28 (25%)
Age (Years)	20.49 ± 1.20
Height (m)	1.68 ± 9.60
Weight (Kg)	63.85 ± 12.12
Body mass index (Kg/m <sup>2</sup> )	22.68 ± 3.93
<i>Under-weight</i>	13 (12%)
<i>Normal-weight</i>	72 (65%)
<i>Over-weight</i>	25 (23%)

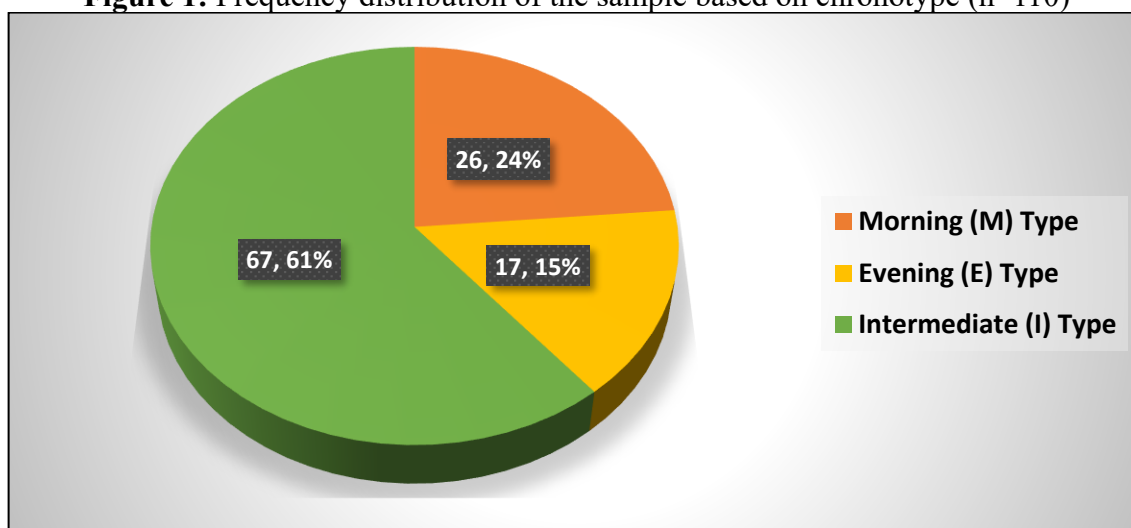
\*Quantitative data expressed as Mean ± Standard deviation and categorical as frequency (%)

**Table 2:** Relationship between BMI categories and chronotypes

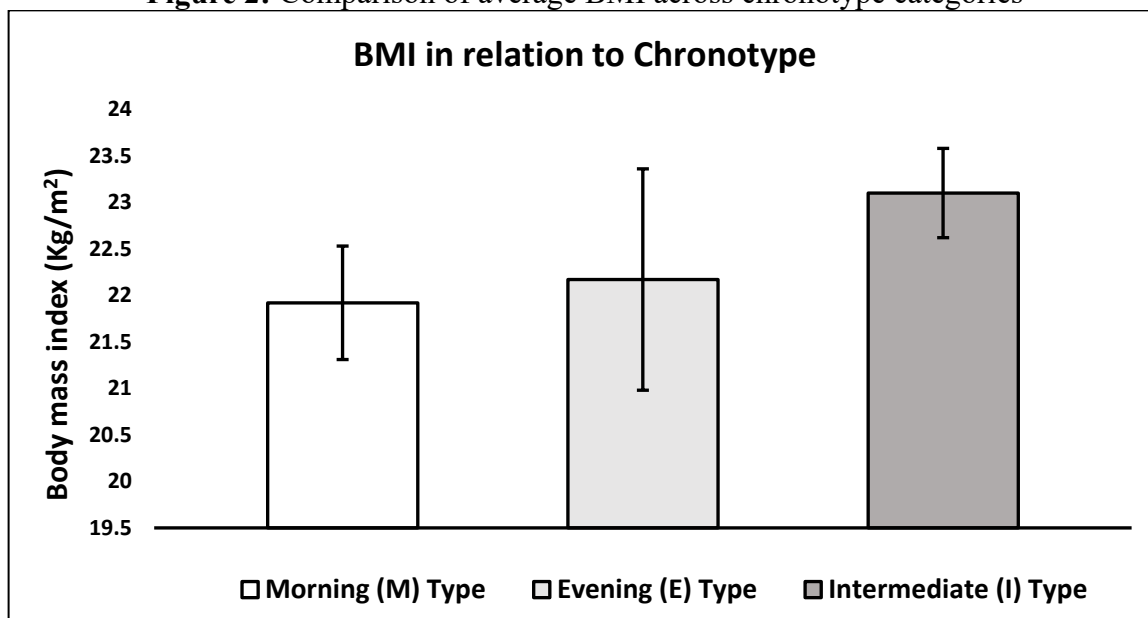
		Chronotype			Effect size (Cramer's V)
		Evening Type (E)	Intermediate Type (I)	Morning (M) Type	
<b>Body Mass Index (BMI) Category</b>	Under-weight	6 (35%)	5 (7%)	2 (8%)	0.27
	Normal-weight	7 (41%)	43 (65%)	22 (84%)	
	Over-weight	4 (24%)	19 (28%)	2 (8%)	
	Total	17	67	26	

\* Association highly significant ( $p < 0.01$ )

**Figure 1:** Frequency distribution of the sample based on chronotype (n=110)



**Figure 2:** Comparison of average BMI across chronotype categories



\*Data shown as Mean (Standard error of mean error bars)

## Results

Present study cohort of 110 apparently healthy medical undergraduates aged 18-25 years had an over-representation of males [82 (75%)]. About one in four students was over-weight. Other characteristics of the participants are listed in **table 1**.

Stratification of the sample with respect to chronotype showed that majority (61%) of the students belonged to the intermediate (I) type (**figure 1**). Morningness was more frequently preferred by females as compared to males (28% vs. 22% respectively); however, chronotype preferences did not differ significantly between gender ( $p = 0.55$ ).

### ***Association of chronotype with body mass index (BMI)***

In the present study, it was found that intermediate types had higher average BMI as compared to the evening types and morning types (**figure 2**) but the differences were not statistically significant [F (2,107): 1.029,  $p = 0.36$ ,  $\eta^2 = 0.019$ ]. However, we did get a moderate (*Cramer's V* = 0.27) significant ( $\chi^2 = 15.91$ ,  $p = 0.003$ ) association between chronotype and overweight. Greater percentage of intermediate- and evening types were overweight as compared to morning types (**table 2**). Odds of overweight subjects to prefer eveningness than morningness were about six times more as compared to normal weight participants [*crude odds Ratio* (95%CI): 6.29 (0.94-41.96)]. Participants within overweight category were also around five times more likely to have intermediate chronotype than morning type [OR (95%CI): 4.86 (1.04-22.78)]. Gender seems to have an enhancing effect on the observed relationship especially in the evening/morning chronotype categories [(*adjusted odds ratio: Evening/Morning type: 2.16 (0.82 – 5.71); Neutral/Morning type: 4.42 (0.92 – 21.28)*).

### **Discussion**

The current research aimed to investigate the circadian preferences of Indian medical students showed that majority of the students belong to the intermediate/neutral type, followed by morning type. Eveningness was least frequently preferred by the participants. Authors were expecting a higher frequency of evening-oriented students than observed given the excessive bedtime electronic media use and curricular load on student populations which favour acquisition of evening chronotype. The observed low frequency of late chronotypes could be due to the influence of early teaching schedule (lectures commencing at 8:00 am in this institute) on chronotype preferences. However, overall, the distribution of students into three chronotype categories is in coherence with the previous literature. In one review, it was concluded that intermediate type accounts for major fraction of the population and about 40% of the population belonging to the two extreme circadian types, a figure quite similar to the one observed in the present study. [19] Montaruli A et al., 2019 stated that N-type was the most common chronotype (65.5%), followed by E-type (24.3%) and M-type (10.2%) for both the male and the female subgroups. [20] Similar findings were also reported by Adan et al., 2002. [7] On the contrary, Arifuddin MK et al., 2021 reported very high prevalence of evening type (47%) and only 9% were intermediate type. [21]

Exploration of gender differences in distribution of participants among chronotype categories revealed that female students were more morning oriented while their male counterparts preferred to be evening type; though the results were not statistically significant which could be due to small size available for analysis. In regard to gender, results from previous studies are somewhat inconsistent, although it appears that women tend to have a greater disposition towards morning characteristics than do men. [4,7] A meta-analysis conducted by Randler, 2007 suggests a weak but significant effect of gender on morningness with females being more morning oriented than males. [22]

Given the high prevalence of obesity (around 38% of world's population been overweight or obese as of 2022), [23] the present study also investigated the influence of chronotype on BMI and prevalence of overweight/obesity. Though the mean BMI did not differ significantly across the chronotype categories in the current study; however, circadian preferences of medical students did have a significant effect on the prevalence of being overweight or obese. A greater percentage of intermediate- and evening- types were found to be overweight as compared to the morning types. Odds of overweight participants to be evening oriented as compared to those falling within normal weight category were also significantly higher. These results are in coherence with previous studies which also suggest a positive significant association between evening chronotype and obesity. [24-26]

There are several hypotheses that may explain the association between evening chronotype and obesity. First, the observed association might be mediated by sleep deprivation/insufficient sleep duration. A late sleep-wake cycle may lead to long-term sleep deprivation. [27] Independently, insufficient sleep duration has been reported to be associated with obesity. [28] Second, the association could be mediated by unhealthy diet habits, such as eating late or consuming energy-dense foods, or eating disorders. Unhealthy eating habits such as eating late and a tendency towards binge eating were associated with evening chronotype and eating late has been associated with higher BMIs. [29-31] Third, psychological factors such as personality and depression might also play a role as mediators of the association between chronotype and obesity. Depression has been reported to be strongly associated with evening chronotype and obesity at the same time. [32] Late chronotypes tend to be less self-regulated and self-controlled; hence, more likely to adopt poor dietary and exercise habits predisposing them to weight gain. [33] Finally, changes in light exposure, melatonin secretion profile, appetite regulating hormones such as ghrelin and genetic factors might also play a mediating role in the association between evening chronotype and obesity. [34-37] In the present study, data pertaining to the aforementioned variables that could possibly mediate the association between chronotype and obesity was not collected; thus, underlying mechanism(s) responsible for the findings obtained could not be commented.

### **Strengths and limitations**

Present study had few limitations that should be acknowledged. Firstly, sample size was small and included only undergraduates, thereby limiting the generalizability of the findings to the medical student population at-large. In addition, cross-sectional nature of study design precluded us from deriving any causal inferences. Furthermore, variables such as sleep duration, eating behaviour, personality character, among others that could potentially influence the relationship between chronotype and BMI were not considered. Nevertheless, to our knowledge, this is one of the few studies conducted in our local population that assessed the circadian preferences of medical students. In addition, relationship between chronotype and overweight/obesity was also explored.

### **Conclusion**

Present study showed that frequency distribution in relation to circadian preference among medical students is similar to that in general adult population with majority of the students classified as belonging to the intermediate/neutral type. Morningness was more frequent among female students than their male counterparts. Eveningness was found to have a significant positive association with overweight/obesity. It is recommended that a large-scale study including students from various disciplines and levels be carried out for characterizing circadian preferences among college student population. Better insights about the relationship between chronotype and obesity and its underlying mechanism(s) could be obtained by following a multivariate approach.

### **Acknowledgment**

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### **Conflict(s) of interest**

None present or perceived

### **Ethical approval**

Study protocol was approved by the institutional Scientific Review Board (SRC) who deemed that a full committee review is not required in view of the observational study design not posing any risks to the study participants.

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