

# To Study the Relationship of Human Circadian Rhythm with Body Mass Index & Mini Mental State Examination

Anupama V. Betigeri<sup>1</sup>, Rinku Garg<sup>2</sup>, Vithalkumar M. Betigeri<sup>3</sup>, Himanshu Thukral<sup>4</sup>

<sup>1</sup>Reader, Department of Physiology, Manav Rachna Dental College, Faridabad, India

<sup>2</sup>Professor, <sup>4</sup>PhD Scholar,

Department of Physiology, Santosh Medical College & Hospitals, Santosh Deemed to be University Ghaziabad, India

<sup>3</sup>Professor, Department of CTVS, Govind Ballabh Pant Institute of Postgraduate Medical Education and Research, New Delhi

Corresponding Author: Himanshu Thukral

## ABSTRACT

**Background:** There is individual difference of morningness-eveningness based on intrinsic biological rhythms of a person. Many studies shows a relationship between measures of morningness - eveningness preference (MEQ) score with mini-mental state examination (MMSE) & body mass index (BMI). Our study explores the relationship of these factors to grading the cognitive state of undergraduate dental students.

**Method:** A total of 49 individuals provided with morning-evening questionnaire (MEQ) for the information on circadian rhythm. Their cognitive ability was assessed using mini mental state examination questionnaire (MMSE). Shapiro-Wilk test and Wilcoxon test were applied using R software (v.3.2.2). P value was considered to be significant at ( $p < 0.05$ ).

**Results:** On the basis of analysis, the students were divided into evening type and morning type. Cognitive assessment of both morning type and evening types shows significant difference between them with evening type have significantly lower MMSE score. Also evening type participants were having higher BMI than morning types.

**Conclusion:** In this study it seen that evening chronotype participants are more obese with low cognitive score in comparison to morning chronotype participants.

**Keywords:** Cognition, circadian rhythm, chronotype

## INTRODUCTION

Circadian rhythm is a 24 hour internal physiological cycle that regulates physical, mental and behavioural changes. Although it can be modulated with the external environment such as sunlight-moonlight and temperature. [1,2] It is clearly evident that activities in the brain, enzyme-hormonal balance, cells regulation and many other biological activities are related to circadian clock. If there is any disturbance in harmonization between environments externally and internally, we

may experience serious health consequences which further damages body and leads us to increased risk for various diseases.

Morning-Evening pattern of circadian rhythm in humans or their chronotype patterns are predicting markers for various factors affecting life of individuals whether it is related to health, academics or emotions. Morning individuals are those who wake up early in the morning, fresh, highly active and healthy generally known as lark "a morning bird". [3] Evening type are those who have difficulty in waking

up early and sleepy, unhealthy, inactive generally known as owl "a night bird". [3] Evening types are having low cognitive performance, high level of stress and difficulty in social adjustment. [4] There are many studies which have shown significantly positive linear relationship with cognitive balance and circadian pattern in morning type individuals while negative relationship in evening type individuals. [5,6,7] These individuals based on their shift towards morning type or evening type they can be differentiated into different chronotypes such as early chronotypes (ECTs) and late chronotypes (LCTs). [8] It has also been reported that cognitive performance are better in morning types along with features such as fine motor skills and good short term memory. [9]

Chronotypic variations during morning time, shows high in alertness while low in sleepiness, otherwise opposite occurs during the evening time. These variations have also been found in lots of tasks which includes, sensory, [10] fine skill, [11] reaction time, [12] estimation of time, [13] memory task, [14] verbal task, [15] mathematic calculations [16] and simulated driving tasks. [17] These performance increases during the day time and decreases during the night time. [18] Homeostatic process also plays a role in performance as there is decrease in execution of task with awake time (i.e. sleep deprivation), whereas performance is refuelled with sleep. [19]

Variation in performance of human being may be the result of chronotypic rhythms in cognitive process which is crucial for the execution of most of the tasks. In this manuscript, we have tried to review recent results on circadian rhythm in healthy individuals focusing on cognitive performances and body mass index.

## **MATERIAL AND METHODS**

### **Subject Selection**

This study was carried out on 90 female 2<sup>nd</sup> year dental students, out of which 41 participants were excluded and 49 were included in the study. The distribution of

selected demographic parameters of the participants is presented in Table 1. Exclusion criteria for the study were - any history of smoking, alcohol & drugs. Any other disorder of respiratory, neurological and orthopaedic where excluded. A written consent was taken from all participants before commencement of the study. All the participants were assessed clinically through history taking and detailed clinical examination before the study. The study protocol was approved by the Institutional Ethical Committee on the use of Human as an Experimental Subjects and experiment conforms to the principles outlined by the Declaration of Helsinki protocol, 1964.

### **Experiment Design**

A total of 49 individuals were recruited in the study. These participants were provided with morning-evening questionnaire (MEQ) [20] for the information on circadian rhythm. MEQ is questionnaire for the assessment of problems related to sleep rhythms having 19 points on sleep habits and hygiene. Individuals with MEQ score above 60 are morning type while score with less than 40 are evening type. Participants were categorized according to their circadian rhythm into two groups. Further, both groups cognitive ability were assessed using mini mental state examination questionnaire (MMSE).

### **Statistical Analysis**

Statistical analysis was performed using R software (v. 3.2.5). All data was presented as mean±standard deviation (SD) values. On the basis of morningness-eveningness questionnaire, individuals were divided in two groups: morning type and evening type. Shapiro-Wilk test was used to check the normal distribution of the data. For comparison among the groups, t test was used to compare the normally distributed parameters and Wilcoxon test was used for parameters which are not normally distributed.  $p < 0.05$  was considered statistically significant.

## RESULT

The distribution of selected demographic parameters of the participants according to circadian rhythm on basis of morning - evening type is presented in Table 1. Both

groups' characteristics in terms of age, height, weight and BMI are presented below.

**Table 1: Baseline demographic data of individuals characterized on the basis of circadian rhythm.**

Sr. No.	Parameters	Morning Type (N=28)	Evening Type (N=21)	p-value
1	Age (in years)	18.64±1.06	18.43±0.93	0.5542
2	Height (cm)	160±4.89	159.59±3.8	0.4958
3	Weight (Kg)	61.43±7.41	67.29±6.21	0.0209
4	BMI (kg/m <sup>2</sup> )	23.98±3.75	26.49±2.94	0.0116

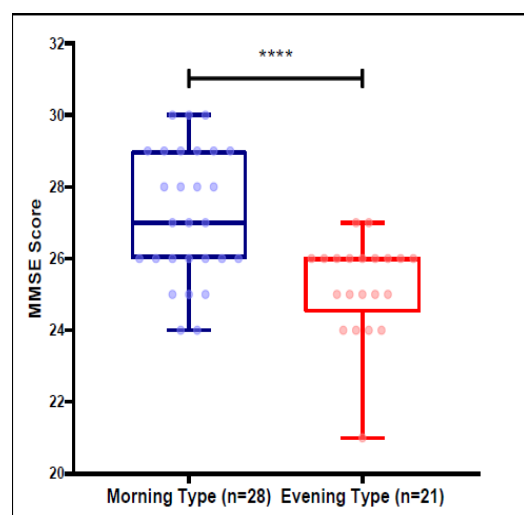
Values expressed in Mean±S.D; cm, centimeters; Kg, Kilogram; m, meters

Circadian rhythm, defined as a MEQ scores i.e. morning type with score 63.04±3.08 and evening type with score 36.71±3.49 shows the internal clock time of body is presented in Table 2 i.e. circadian rhythm among the individuals participated in the study.

**Table 2: Comparison of MEQ parameters among two groups.**

Parameters	Morning Type (N=28)	Evening Type (N=21)	p-value
MEQ Score	63.04±3.08	36.71±3.49	2.84E-09

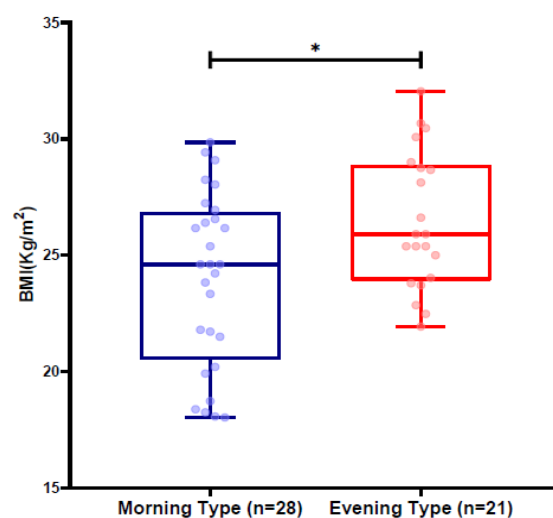
In Figure 1, MMSE score in morning type is 27.2±1.8 which is higher in comparison to evening type score i.e. 25.2±1.3. On applying Wilcoxon test between the two groups, result was found statistically significant with p-value 0.0005 (p< 0.001)



**Figure 1: Comparison of MMSE in morning type and evening type.**

Further there is comparison among two groups i.e. morning type and evening type in parameters such as BMI. BMI in morning type participants is 23.9±3.7 comparatively low to BMI in evening type 26.5±2.9 (Figure 2). On application of student's t-test, there is significant difference is seen among

BMI of two groups with p-value 0.0116 (p<0.05).



**Figure 2: Comparison of BMI in morning type and evening type.**

## DISCUSSION

In the present study, healthy adults were questioned on their sleep habits and hygiene using MEQ questionnaire. Based on the MEQ questionnaire they were divided into two chronotypic group i.e. morning type and evening type. Majority of student were found to be morning type. Cognitive assessment was done for both morning type

and evening type participants using MMSE questionnaire.

On analysing the MMSE score it was seen that population with morning type of circadian rhythm had higher cognitive scores than evening circadian rhythm population. This is in association with performance, individuals with morning types show best execution, while evening types shows an opposite pattern with errors. [21] Sleepiness and subjective alertness are also modulated when you are awake and having disturbed circadian rhythm. It is also seen that alertness is positively correlates with the temperature of the body. [12,22] It was observed that two hormones i.e. melatonin and cortisol are markers for the circadian rhythm oscillation. [23] When the levels of cortisol are at its peak, melatonin secretion is at decline. [23] Both of these hormones are sensitive to light and stress. In late evening there is increase in the level of melatonin, stimulating thermoregulatory cascade, leading to increase in blood flow to distal proximities, decreasing core body temperature (CBT) and favouring sleep initiation [24] and decrease in alertness. It was also noted that best cognitive performance occur when the CBT is high and lowest performance is seen when CBT is low. [25]

It is also seen that BMI of morning chronotypic population is lesser in comparison with the evening type of population. BMI of evening type is more towards obesity i.e.  $26.49 \pm 2.9$  which may be related to metabolic or any lifestyle disorders in the later future. Sleep deprivation or short sleep was independently quoted for weight gain, particularly in young age groups when a systemic review was done for around 36 studies. [26] Circadian rhythm plays a very important role in fluctuation of enzymes and regulating major metabolic process. [27,28] There are many peripheral clocks in every cell of the body which are involving organs such as pancreases, skeletal muscles, liver, gastrointestinal tract and adipose tissue. [29] Clocks in this system receive signals via

hormones and projections from autonomic nervous system and external factors including light, sleep and food timing. It was seen that light at night (LAN) is been the major precipitating factor for disruption in normal circadian rhythm. [30] LAN is sensed by the retina and its ganglions, projecting it to the neurons of suprachiasmatic nucleus (SCN), producing signals that leads to changes in Per1(Period 1) and Per2(Period 1) CLOCK (circadian locomotor output cycles kaput) gene expression. [30] In outcome to this, circadian oscillation in SCN shifts to abnormal circadian rhythm. This leads to decline in amount of time spent in asleep, disrupting synchrony in periods of fasting, feeding, energy storage and utilization.

## CONCLUSION

Being attentive is a kind of cognitive process which is crucial for the performance of all activities performed by humans, either it is learning, working, playing sports, arts, social interface or any leisure activities. Any disturbances in sleep or circadian rhythms, interferes with performance of humans. Our performance improves during the daytime, while it decreases to its lowest level during the end of the day. There is increase in the errors and accidents during the night and it also affects work performance and school or college learning process. Data analyzed in this paper suggests that there is strong need to programme your schedule which is convenient and compatible with the needs of human physiology and their circadian rhythm.

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