

**Association between circadian rhythm and risk of dental caries in 13-18 year olds**

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**Abstract**

**Introduction:** Dental caries is the most common chronic disease in the global population. The circadian rhythm is a type of internal biological clock controlled by the hypothalamus in the brain and has a daily rhythm of about 24 or 25 h or more. This makes individual differences in the preference for a specific time of day to carry out activities during morning or the afternoon/ evening hours.

**Aim:** With this background, the aim of the present study was to investigate the association between circadian rhythm and dental caries among the school and college students of 13-18 years.

**Materials and Methods:** A group of 100 adolescents (13-18 years old) were divided into two equal groups based on caries risk (case = high risk; and control = low

risk).Before dental examination, participants were asked to fill a questionnaire. The questionnaire included: demographic variables, questions to assess circadian rhythm, oral hygiene and dietary habits. Thesestudy participants were further divided into three circadian rhythm types: evening types, neutral types and morning types based on the Circadian rhythm assessment questions. The statistical tests used were chi square test and logistic regression, the p- value is set at  $\leq 0.05$

**Results:** The results of the present study showed that most of the study participants were neutral type (48%) followed by morning type (30%) and evening type (22%). The association was found to be statistically significant for dietary habits and oral hygiene habits among circadian rhythm types. It was also found that cases with Circadian

rhythm of evening types have 2.9 times (0.86-10.86) chances of having high caries risk than neutral types and association was found to be not significant with a p-value of 0.08.

**Conclusion:** Dentist's attitude towards health promotion and disease prevention needs an essential transformation.

**Keywords:** Prevention, caries risk, dietary habits

### **Introduction**

Dental caries is the most prevalent chronic disease in the global population.<sup>1</sup> There are various risk factors involved in developing dental caries. These are related with physical, biological, environmental, behavioral and lifestyle related factors such as decreased salivary flow, high number of cariogenic bacteria, excessive consumption of sugary foods and drinks, insufficient fluoride exposure, poor oral hygiene.<sup>2</sup> As dental caries is mainly related to the individual's lifestyle and behavioral factors within a person's control, it can be prevented by good dietary habits and good oral habits. The circadian rhythm is a type of internal biological clock which is controlled by the hypothalamus in the brain and has a daily rhythm of about 24 hours.<sup>2</sup> The circadian clock acts as a device regulating the body's time keeping, temperature fluctuations and enzymes. Possession of such circadian rhythms enables organisms to expect predictable changes in the environment and thus get habituated accordingly. This temporal control over metabolic processes also allows cells and organisms to separate opposing biochemical pathways, for example, redox reactions and anabolism vs. catabolism.<sup>3</sup>

Morningness-eveningness (M/E) can be measured as a range between two ends: morning ("larks") and evening types ("owls"). This separation makes differences in individual preferences for a specific time of day to carry out the activities during the morning or the afternoon/evening hours. These differences are seen in timing of

sleep, the peak of cognitive abilities, academic performance, personality, psychological and physical dysfunctions. Those who have a circadian rhythm of 24 h or more, belong to the evening sleep-cycle group. These evening people are active in the evening and tired in the morning. People belonging to the morning group have a short circadian rhythm, close to 24 h. Morning people are tired in the evening and active in morning.<sup>4</sup> As the morning approaches, the body begins to wake up as there will be change in certain hormone levels, body temperature rises and the metabolism starts. If people are not hungry in the morning, it may be because of eating late the night before or they might have been forced to wake up earlier than it is natural for their particular circadian rhythm. For people who have a stable circadian rhythm and regular meal habits, hunger will occur at about the same time every day.<sup>2</sup>

With this background, the aim of the present study was to investigate the association between circadian rhythm and dental caries among the school and college students of 13-18 years.

### **Materials and Methods**

A comparative cross-sectional study was conducted to investigate the association between circadian rhythm and dental caries among the school and college students of 13-18 years.

The study population comprised of school and college going students of 13-18 years old who attended the outpatient department of the Oxford dental college and hospital. The study protocol was reviewed and approved by ethical board, The Oxford dental college and hospital, Bangalore. The setting for the present study was The Oxford dental college, Bangalore and Permission to conduct the study was obtained from the Oral medicine and radiology department of The Oxford Dental College. The pilot study had been carried out on 10% of the sample

in The Oxford Dental College. The data was collected by using a self prepared questionnaire. The pilot study had not been included in the main study. A data was collected in the month of July and August 2016

### Sample size estimation

From the study conducted by Lundgren AMet al in 2015[2],it had been observed that the probability of having a high risk of caries was 3.8 times higher in the evening type person than for a morning type individual. The sample size was calculated in openepi version 3 with 5% significant value and 80% power. The sample size of 88 i.e 44 in case group and 44 in control group was found out by Fleiss method *with* the correction factor.

Considering non-response rate of 10% the total sample size taken will be 100 for the study, 50 in each group.

The inclusion criteria for the study was:School and college students in the age group of 13-18 years;school and college students who has given the consent to take part in the study and ;students who understand English. The exclusion criteria for the study was: Students with a general disease that might influence the development of dental caries,school and college students who are not willing to participate in the study.

### Data collection

Based on the American academy of pediatric dentistry (AAPD) caries risk assessment tool, the individuals will be classified into high risk, moderate and low risk.[5] The data was collected by using the questionnaire which had been content validated using lawshe criteria 1975 .[6] Individuals with high and moderate risk of caries will be categorized as cases and individuals with low risk of caries will be categorized as controls. The consecutive inclusion was continued until both groups were evenly distributed with regard to gender.

The validated questionnaire included 15 questions regarding demographic data, circadian rhythm, dietary habits and oral hygiene habits.

To assess circadian rhythm an instrument developed by Ostberg and modified by Torvall and Akerstedt <sup>8</sup> is used. The instrument consisted of seven items which dealt with preferences and habits concerning activities and time.According to Chelminsky and co-workers,based on the mean value of the sum of the seven questions, the participants were characterized into three groups of circadian rhythm types: evening types, neutral types and morning types. A mean value between 1.0 and 2.0 was categorized as evening type, between 2.01 and 2.99 as neutral type, and between 3.0 and 4.0 as morning type.<sup>7</sup>

### Statistical analysis

Microsoft Excel (2007) was used for data entry. The Statistical software namely statistical package of social sciences (SPSS) version 20 was used for the analysis of the data. Chi –square test was used to find the significance of categorical data between two groups. A logistic regression was performed with case/control as the dependent variable and circadian rhythm as independent variables. Level of significance was set at 0.05.

### Results

For the Circadian rhythm type, among 100 study subjects, majority 48(48%) were neutral types followed by 30 (30%) morning types and 22(22%) evening types.(Table/fig 1)

The association was found to be significant among circadian rhythm types based on cases and controls, tooth paste used, brushing or rinsing habit after meals/snacks, breakfast consumption frequency,sugar consumption frequency per week(Table/fig 2-6).When the multinomial regression is done it was found out that cases with Circadian rhythm of evening types have 2.9 times (0.86-10.86) chances of having high caries risk than neutral

types and the association was found to be not significant with a p-value of 0.08.(Table/fig7)

Table 1: Distribution of study subjects according to circadian rhythm types, oral hygiene habits and dietary habits

Variables	Frequency (N)	Percentage (%)
I)Circadian rhythm type		
Evening	22	22.0
Neutral	48	48.0
Morning	30	30.0
Total	100	100.0
II)Oral hygiene habits		
1) How many times do you clean the teeth?		
Once a day	58	58.0
Twice a day	40	40.0
>2 times/day	2	2.0
Total	100	100.0
2) Materials used for cleaning your teeth:		
Toothbrush and toothpaste	90	90.0
Toothpowder	10	10.0
Tooth brush alone	0	0.0
Total	100	100.0
3) Tooth paste used		
Fluoridated tooth paste	79	87.7
Non fluoridated tooth paste	11	12.2
Total	90	100.0
4) Do you brush your teeth or rinse your mouth after having meals/snacks?		
Yes	67	67.0
No	33	33.0
Total	100	100.0
III) Dietary habits		
5) How often do you have breakfast in a week?		
Everyday	64	64.0
Several times/week	33	33.0
Never/seldom	3	3.0
Total	100	100.0
6) How many times do you take sweets in a week?		
Everyday	30	30.0

Several times	62	62.0
Not at all	8	8.0
Total	100	100.0
7) In everyday, how many times a day do you take sweets?		
≤2	25	83.3
>2	5	16.7
Total	30	100.0
8) Do you take sweets in between meals?		
Yes	67	67.0
No	33	33.0
Total	100	100.0

Table 2: Distribution of circadian rhythm types and brushing frequency

Brushing frequency	Circadian rhythm type				P –value
	Evening N (%)	Neutral N (%)	Morning N(%)	TOTAL N (%)	
Once a day	12(12)	31(31)	15(15)	58(58)	0.316
Twice a day	10(10)	15(15)	15(15)	40 (40)	
>2 times/day	0(0)	2(2)	0(0)	2(2)	
TOTAL	22(22)	48 (48)	30(30)	100(100)	

Chi-square test

Table 3: Distribution of circadian rhythm types and tooth paste used

Tooth paste	Circadian rhythm type				P –value
	Evening N (%)	Neutral N (%)	Morning	TOTAL N (%)	
Fluoridated Tooth paste	20(22.2)	43(47.8)	16(17.8)	79(87.8)	0.001
Non-fluoridated Tooth paste	1(1.1)	2(2.2)	8(8.9)	11 (12.2)	
TOTAL	21(23.3)	45 (50)	24(26.7)	90(100)	

Chi-square test

Table 4: Distribution of circadian rhythm types and brushing or rinsing habit after meals

Brushing or rinsing habit after meals	Circadian rhythm type				P –value
	Evening N (%)	Neutral N (%)	Morning	TOTAL N (%)	
Yes	11(11)	31(31)	25(25)	67(67)	0.03
No	11(11)	17(17)	5(5)	33 (33)	
TOTAL	22(22)	48 (48)	30(30)	100(100)	

Chi-square test

Table 5: Distribution of circadian rhythm types and breakfast consumption frequency

Breakfast frequency/week	Circadian rhythm type				P –value
	Evening N (%)	Neutral N (%)	Morning N(%)	TOTAL N (%)	
Everyday	11(11)	38(38)	15(15)	64(64)	0.003
Several times/week	11(11)	7(7)	15(15)	33 (33)	
Never/seldom	0(0)	3(3)	0(0)	3(3)	
TOTAL	22(22)	48 (48)	30(30)	100(100)	

Chi-square test

Table 6: Distribution of circadian rhythm types and sugar consumption frequency per week

Sweet consumption frequency/week	Circadian rhythm type				P –value
	Evening N (%)	Neutral N (%)	Morning N(%)	TOTAL N (%)	
Everyday	13(13)	11(11)	06(06)	30(30)	0.02
Several times	8(8)	33(33)	21(21)	62 (62)	
Not at all	1(1)	4(4)	3(3)	8(8)	
TOTAL	22(22)	48 (48)	30(30)	100(100)	

Chi-square test

Table 7: Multinomial logistic regression of cases and controls with Circadian rhythm types

Circadian rhythm type	Caries (Cases and controls)	
	OR (95%CI)	p-value
Neutral	-	-
Evening	2.948 (0.86-10.86)	0.08
Morning	0.073(0.01-0.27)	0.00*

**Discussion**

In the present study, majority 48% were neutral types followed by 30% morning types and 22% evening types. Whereas, in the study conducted by Lundgren AM et al<sup>2</sup> most of them 50% were neutral type followed by 37% evening types and 13% of morning types.

In the present study, when oral hygiene habits are concerned, out of 100 study subjects, majority 58% study subjects cleaned their teeth once a day followed by 40% study subjects twice a day and 2% study subjects >2 times/day. Whereas, in the study conducted by Lundgren AM et al<sup>2</sup> 72% brushed their teeth twice daily. Similarly, majority 90% study subjects used tooth brush and tooth paste and 10% study subjects used tooth powder and none used tooth brush alone. Among 90 Study subjects using toothpaste, majority 87.7% study subjects used fluoridated toothpaste. Similarly, majority 67% study subjects rinsed their mouth after having meals/snacks and 33% study subjects did not rinse their mouth after having meals/snacks.

Similarly, for the dietary habits, out of 100 study subjects, majority 64% had breakfast everyday in a week, whereas, in the study conducted by Lundgren AM et al<sup>2</sup> 72% had breakfast regularly.

In the present study, among cases, majority 58% were neutral types followed by 36% evening types and 6% morning types. Whereas, among controls, majority 54% were morning types followed by 38% neutral types and 8% evening types. The association was found to be highly significant among cases and controls for Circadian rhythm types. Whereas, in the study conducted by Lundgren AM

et al<sup>2</sup> among cases majority 22% were evening types followed by 20% neutral types and 4% morning types. Whereas, among controls majority 30% were neutral types followed by 14% evening type and 10% morning type.

In this study, among males, majority 40% were neutral types followed by 36% morning types and 24% evening types. Similarly, among females, majority 56% were neutral types followed by 24% morning types and 20% evening types. The association was found to be not significant among males and females for Circadian rhythm types. However, there are no previous studies with respect to this variable, hence comparison cannot be made.

In the present study, among three circadian rhythm types most of them brushed their teeth once a day followed by brushing their teeth twice a day and none brushed >2 times a day. The association was found to be not significant among circadian rhythm types for brushing frequency. Whereas, in the study conducted by Lundgren AM et al<sup>2</sup> most of the neutral type brushed their teeth ≥2 times a day followed by evening types and morning types. Among study subjects having breakfast everyday in a week, most of them 38% belong to neutral circadian rhythm type, followed by 15% belonging to morning circadian rhythm type and 11% belong to evening circadian rhythm type and only 3(3%) who never/seldom had breakfast in a week all belong to neutral circadian rhythm type. Whereas, in the study conducted by Lundgren AM et al<sup>2</sup>, 41% of the adolescents who were neutral types reported that they had breakfast every day compared to 22% of evening types and 10% of morning types. The association was found to be significant.



In the present study, among study subjects consuming sweets everyday, with a frequency of  $\leq 2$  times and  $>2$  times per day most of them belong to evening circadian rhythm type followed by neutral and morning circadian rhythm types. The association was found to be not statistically significant.

In this study, it was found that Circadian rhythm of evening types have 2.9 times chances of having high caries risk than neutral types and the morning circadian rhythm types was found out to be a protective factor of 0.07 having caries risk. Whereas, in the study conducted by Lundgren AM et al<sup>2</sup>, the predicted probability of being at high risk of caries was 3.8 times higher for evening types than for morning types.

The limitations of the study include Small sample size and the categorization of circadian rhythm relied entirely on the participant's own responses to the questionnaire .

Further studies on relationship between salivary factors, Circadian rhythm types and dental caries risk should be assessed.

### Conclusion

To conclude, this study has found that the cases with Circadian rhythm of evening types have 2.9 times (0.86-10.86) chances of having high caries risk than neutral types .The morning circadian rhythm types was found out to be a protective factor of [OR=0.07(0.01-0.27)] having caries risk. It was also found that people with evening circadian rhythm type less likely to brush less than two times a day, use fluoridated tooth paste and less likely to brush or rinse their mouth after meals compared to morning and neutral types.

Different circadian rhythms have been found to affect young people's general health. For the adolescents with high caries risk circadian rhythm of a person should also be considered when planning oralhealth education and also further studies on relationship between salivary

factors, Circadian rhythm types and dental caries risk should be assessed.

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