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Circadian Rhythm of Body Temperature and Chronotype in Night Shift Students and Workers

ORIGINAL

Carla Parada Pazinatto Andreoli[1], Milva Maria Figueiredo De Martino[2], Kézia Katiane Medeiros da Silva[3], Karla Figueiredo De Martino Pasetti[4]

1 PhD in physical education. University Paulista. Campinas, São Paulo, Brazil.
2 PhD in nurse. Visiting Professor Federal University of Rio Grande do Norte. Natal, Rio Grande do Norte, Brazil.
3 Nurse. Master in nursing. Universidade Federal do Rio Grande do Norte. Natal, Rio Grande do Norte, Brazil.
4 Dentistry, graduate student in Periodontal School of Dentistry. São Leopoldo Mandic. Campinas, São Paulo, Brazil.

Contact information:

Carla Parada Pazinatto Andreoli.

Address: Universidade Estadual de Campínas. Unicamp. Rua: Vergílio Cremasco, 42. Campinas, São Paulo, Brazil. CEP: 13271320.

carlapazinatto@yahoo.com

Abstract

This is a descriptive and exploratory study aiming to analyze the circardian rhythm of oral temperature and classify chronotypes in two groups (56 students and 34 nursing workers). The Horne&Ostberg questionnaire (1976) and digital thermometers were used. The average age of nursing workers was 34.4 years old; and of students was 26.2 years old. Working time showed significant difference ($p < 0.0001$). Morning students showed cosinor parameters: mesor = 36,4609, amplitude = 0,2335 and acrophase = 14,4658, with p-value = 0.0009; evening students showed mesor = 36,4215, amplitude= 0,2263 and acrophase= 14.3009, with p-value < 0.0001. Morning shift nursing workers presented: mesor = 36,2196, amplitude = 0,4007 and acrophase =15,0746, with p-value < 0.0001. Indifferent chronotype was prevalent for the population of nursing professionals and the evening type for students. The findings showed circadian rhythm.

Keywords
Circadian Rhythm; Oral Temperature; Students; Nursing.

Introduction

It is known that rhythms in human beings have the capacity for adapting to daily changes in light/dark cycle and temperature in their environment. These rhythms are endogenously produced, expressed by parameters in periods during the 24 hours of the day, and are under control of a pacemaker located into the suprachiasmatic nucleus in the anterior hypothalamus in the brain [1, 2].

The body temperature is one of the physiological events strictly controlled by the human body. The system responsible for this function allows variations between 0.2° and 0.4° Celsius (°C), around 37°C, for maintaining its metabolic functions. This process occurs in the preoptic area of the hypothalamus, which stimulates a behavioral and autonomic response of body temperature [3].

The homeostatic regulation is reached via feedback mechanism, controlling production and loss of heat. In addition, the central circadian clock acts directly on the thermoregulatory center of the brain: the body temperature falls during the resting phase and increases during the activity phase [3].

The basic characteristics of temperature measurement consist in achieving a minimum (knocking phase or nadir), around 4 a.m., with approximately 36ºC. After this phase, temperature begins to increase and reaches its maximum peak (acrophase) in the beginning of the night, around 6 p.m., with approximately 38.5ºC. These expressions depend on individual and environmental characteristics and present an amplitude between 0.4 and 0.5° C in young adults [4].

The modern society brings challenges to the biologic temporization system, for example, body temperature, school time and shift works, which determine compromising manifestations both in physical and emotional aspects [4].

These individuals usually are characterized by an advancement or phase advance in most of their endogenous rhythms such as body temperature, cortisol levels and melatonin, when compared with the general population [5].

Recent researches show that chronotype study or circadian typology, mainly in individuals who work in shifts, is important for determining better performance periods, even providing a study that relates this work profile with quality of life and its different domains [6-7].

In this context, we highlight nurses, who are at high risk of physical wear and illness due to contingencies in routine work, observing more frequently psychic disturbances such as symptoms of anxiety and depression, sadness, fatigue, reduced concentration, somatic concern, irritability and insomnia [8].

Students should also be recognized because they are workers who have a daily routine work and even study during the night period, developing a behavior that also generates sleep deficit and can lead to a certain degree of somnolence in routine activities.

Analyze oral temperature circadian rhythm and classify chronotype of students and nursing professionals working night shifts.

Method

The research characterized as a quantitative, transversal, descriptive and comparative study.

This research comprised 56 university students and 34 nursing professionals, i.e., nurses, technicians and nursing assistants for day and night shifts, who agreed to answer questionnaires and perform oral temperature measurements. All of them signed the free and clarified consent term.

The research was carried out in the Santa Casa de Misericórdia, hospital of the city of Valinhos and in the Polytechnic Integrated Faculty of the city of Santa Barbara d'Oeste, State of São Paulo, Brazil. The data collection was performed in the hospitalization units: Nursery, Maternity, Pediatrics, Department of Internal Medicine and Surgery and Intensive Care Unit (ICU). The work regime of day shift professionals was a daily 6 hours journey with one day off a week, and for the night shift group, 12 hours of activities with 36 hours rest. Two study periods were observed for morning students, with activities beginning at 7:10 a.m. and finishing at 12:25 a.m., and for evening students, with activities beginning at 7:00 p.m. and finishing at 10:35 p.m.

The ethical aspects were respected according to rules of the Ethics Research Committee of the Faculty of Medical Sciences – University of Campinas

(FCM-Unicamp), approved and recorded on CEP's opinion n. 841/2010.

The Identification Questionnaire of Morning and Evening Individuals, translated into Portuguese, was used for studying chronotype. The instrument consists of 19 questions with multiple choice, allowing the individual to express their preferences regarding sleep and wake time, start and end of work time, alert feeling or somnolence when waking up, disposition for physical practices in predetermined times and fatigue states in some day/night times. The final score of the questionnaire is a numerical value that varies between 16 (extreme evening) and 86 (extreme morning), in which the individual can be classified within five chronotypes: definitely morning (70-86), moderately morning (59-69), indifferent (42-58), moderately evening (31-41) and definitely evening (16-30) [4, 7, 9].

Sociodemographic information such as personal data, life habits and professional aspects were collected by using a self-report questionnaire.

Digital clinical thermometers of flexible stem/ Med FLEX of INCOTERM Industry of Thermometers, which had measurement range between 32°C and 43°C, resolution 0.1°C, with maximum indication error at ± 0.2°C were used to verify temperature measurements. Before the collection, they were calibrated by the PolyScience Digital Controller of the Fluid Laboratory at the Faculty of Mechanical Engineering of the University of Campinas (Unicamp). This equipment provides performance for demanding applications and optimizes temperature stability automatically adjusted by the control system.

Physiological measures of oral temperature were collected by autorhytmometry, i.e., by the own subject, for a five-day period, with intervals of three hours from the waking time up to the sleeping time, being, therefore, measured during the working and study periods.

The criteria adopted for verifying oral temperature were accommodated seated; not eating or drinking hot food or drinks 30 minutes before and not smoking for 30 minutes before verification.

For studying circadian rhythm, a circadian cycle of 24 hours was considered, and the cosinor method was applied. For studying the circadian rhythm of oral temperature, it was considered a 24-hour circadian cycle, and the cosinor methodwas used. It was necessary a minimum of four different times of measurement per cycle to define the senoidal curve by three parameters: mesor (intermediate level of oscillation), amplitude (oscillation extent from mesor) and acrophase (time necessary to reach maximum value of temperature) [10].

The statistical study consisted of a descriptive analysis based on measures of central tendency, dispersion and by frequency distribution. The chi-square, Fischer's exact, Mann-Whitney and Kruskal – Wallis tests were used to compare chronotype scores and other sociodemographic variables. The study of circadian rhythm of oral temperature followed the criteria suggested by the cosinor method (11), and for data analysis, the non linear regression was used by the PROC NLIN of the statistical pack SAS for Windows. The function used was: *temperature = mesor + amplitude x cos (2 π / 24 x hour + acrophase).* The significance level adopted for statistical tests was 5 %.

Results

The studied subjects were divided into two groups: nursing professionals, with average age of 34.4 (SD±9.3) years; the other group comprised students with average age of 26.2 (SD±9.2).

It was observed an average of 10.9 years (SD±8.4) when considering the working time among nursing professionals, and an average of 10.1 years (SD ±9.6) for students who worked, demonstrating a significant difference by the Mann-Whitney test ($p < 0.0001$).

Table 1 presents the descriptive analysis of individual characteristics of both groups and compari-

Table 1. Descriptive and comparative analysis of individual characteristics of nursing professionals and students of the cities of Valinhos and Santa Bárbara D'oeste, SP, Brazil, 2012.

Variables	Groups						P-value
	Nursing professionals		Students		Total		
	n	%	n	%	n	%	
Gender							
Female	28	82.35	54	96.43[a]	82	91.11	p = 0.0492[a]
Male	6	17.65[a]	2	3.57	8	8.89	
Total	34		56		90		
Working Time							
Morning	10	30.30[b]	1	2.38	11	14.67	p < 0.0001[b]
Afternoon	4	12.12	11	26.19	15	20.00	
Both	6	18.18	30	71.43 b	36	48.00	
Evening	13	39.39[b]	0	0.00	13	17.33	
Total	33		42		75		
Medicine use							
Yes	7	20.59	38	67.86 c	45	50.00	p < 0.0001[c]
No	27	79.41 c	18	32.14	45	50.00	
Total	34		56		90		
Own means of locomotion							
Yes	28	84.85 d	35	62.50	63	70.79	p = 0.0251[d]
No	5	15.15	21	37.50	26	29.21	
Total	33		56		89		

*: Fisher's exact test: [a]: p = 0.0492; [b]: p < 0.0001; *: Chi-square test: [c]: p < 0.0001; [d]: p = 0.0251

sons by the Fisher's exact test and chi-square test among average values of variables with significant difference.

While the group of students comprised 96.43% of females and 3.57% of males, the group of nursing professionals comprised 82.35% of females and 17.65% of males.

Regarding working time, it was verified that 30.3% of nursing professionals work in the morning and 39.39% at night. According to distribution, it was found that one subject among these professionals did not answer the referred question. Among students, 71.43% work during the morning

Table 2. Chronotype percentages according to nursing professionals and students. Cities of Valinhos and Santa Barbara D'oeste, SP, Brazil, 2012.

Group	Chronotype					
	Morning		Afternoon		Indifferent	
	n	%	n	%	n	%
Nursing professionals	10	38.46	5	26.32	19	42.22
Students	16	61.54	14	73.68	26	57.78
Total	26	100	19	100	45	100

*: Chi-square test: p = 0.4855.

Table 3. Comparative analysis between chronotype and sex of students and nursing professionals in the cities of Valinhos and Santa Bárbara d'Oeste, SP, Brazil, 2012.

Group	Chronotype					
	Morning		Afternoon		Indifferent	
	n	%	n	%	n	%
Female	25	96.15	19	100.00	38	84.44
Male	1	3.85	0	0.00	7	15.56
Total	26	100	19	100	45	100

*: Fisher's exact test: p = 0.0870

and afternoon periods, i.e., they work during the day and study at night; and 14 students only study. Data showed significant differenced by the Fisher's exact test (p < 0.0001).

Concerning medicine use, it was verified that 67.86% of students use medicine in a general way, and 79.41% of nursing professionals did not indicate medicine use, demonstrating significant difference by the chi-square test (p < 0.0001).

It was identified that 33 nursing professionals have their own means of locomotion in a total of 84.85%; while students do not, with a significant difference by the chi-square test (p = 0.0251).

In the general classification of chronotypes presented in **Table 2**, it was verified that 38.46% of nursing professionals are classified as morning, while 73.68% of students are classified as afternoon.

Table 3 presents a comparative analysis of chronotypes by sex. Concerning females, it was obser-

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ved that 96.15% were classified as morning, 100% as afternoon and 84.44% as indifferent. In relation to males, 3.85% were morning, 0% afternoon and 15.56% indifferent, which did not show a significant difference.

Oral body temperature

The results of cosinor analysis for oral temperature of students on the course of 24 hours, grouping values of five days of collection to verify the presence of circadian rhythm are demonstrated in **Figures 1**, **2** and **3**.

Figure 1 shows median values of oral temperature of students during the evening period. It was observed that the temperature curve model adjusted to a cosine curve with the following parameters: mesor = 36,4215, amplitude = 0,2263 and acrophase =14,3009, with p-value < 0.0001. Temperature values started at 36.2º, increasing through the hours during the day, acrophase occurred in approximately 14hrs with a temperature of 36.6º.

Figure 2 shows cosine curve of oral temperature results in morning students, observing the following parameters: mesor = 36,4609, amplitude = 0.2335 and acrophase =14,4658, with (p - value = 0.0009).

Temperature values started at 36.4º, increasing through the hours during the day, acrophase occurred in approximately 14 hours, with temperature of 36.6º.

Figure 3 shows cosine curve of oral temperature results in morning nursing professionals, grouping the values to verify the presence of seasonality with the following parameters: mesor = 36,2196, amplitude = 0,4007 and acrophase =15,0746, with (p-value < 0.0001).

Since there was not data collection during the day, the circadian rhythm model was not well adjusted for evening nursing professionals.

Figure 1: Temporal series of median values of oral temperature of evening students.

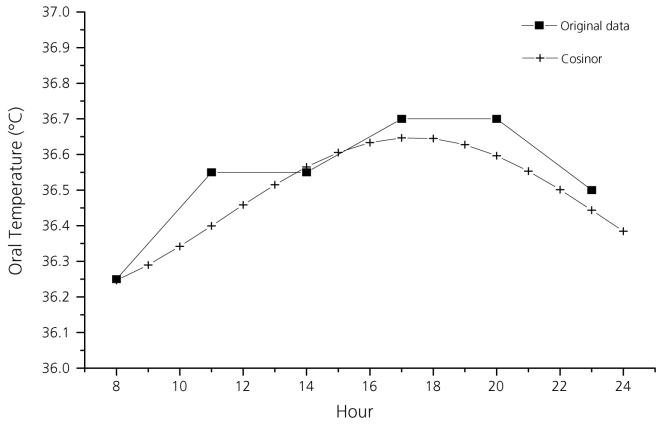


Figure 2: Temporal series of median values of oral temperature in morning students.

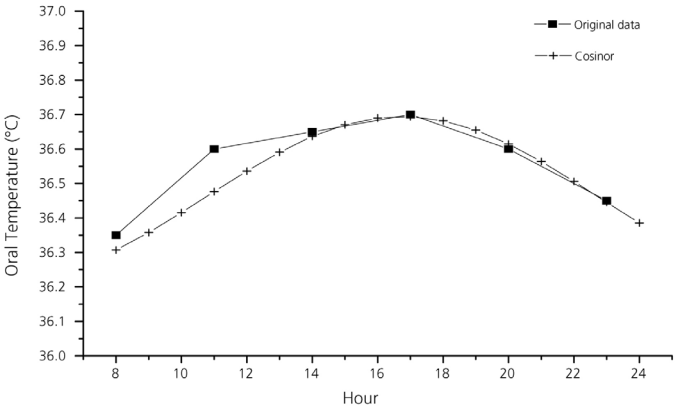
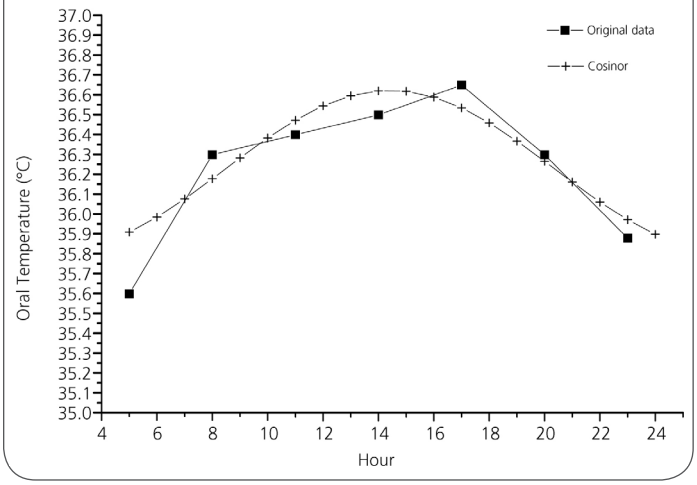


Figure 3: Temporal series of median values of oral temperature of morning nursing professionals.



Discussion

This research aimed to evaluate the circadian rhythm of oral temperature using the cosinor method in two groups of subjects with different characteristics, i.e., students who work during the day and study at night, and nursing professionals who work during the day or night. It is important to highlight that the evening activities were a common and particular situation to nursing professionals because of the workday extension and hours [11].

Evening work and study conditions may cause compromising effects to the organism, which is justified by nonconventional time.

Thus, although the two classes suffer consequences, it is understood that it is the opportunity for students to improve their professional qualification, and the possibility of a better income for nursing professionals, even that it leads to physical and emotional disturbances [5].

The prevalence of the female sex found in the research may be justified by attribute sampling, which consisted in nursing professionals and students of the esthetics course, in which there is an larger incidence of the female population [5, 12].

Nursing professionals demonstrated a higher average age when compared with students. It can be understood that they belong to a group of individuals who opted for a professional qualification even during the intermediate education, which led them to insert into the labor market, to extend their studies, or even for not having access to higher level education at the adequate age or school in the place where they lived [13].

It was verified that low-aged working students prefer a short-term course on technology teaching modality, which meets the demand for higher education and the real needs of technological and generic informative development required by the labor market [14].

The working time for both groups was approximately 10 years. This is the period in which students need to perform their goals regarding a career classification or go further like a dream come true, desire to learn more about their field to manage their own business and obtain their career consolidation with a compatible education level [15].

Concerning working time, 30.3% of nursing professionals referred to work during the morning period and 39.39% during the evening period. It was supposed that nursing professionals prefer work during the evening period because of the additional income.

Conversely, 71.43% of students perform their professional activities during the morning and afternoon periods, i.e., they work during the day and study at night, which confirms the alternative to those who are already into the labor market and need an upper-level course with a more flexible schedule [5].

Concerning medication use, it was observed a significant difference by the chi-square test ($p < 0.0001$), considering that students showed a higher use. This is a worrying situation, since this group also showed lower age. Most in this same group also used their own means of transport.

In one of the categories analyzed regarding chronotype, the morning classification was more frequent in subjects with average values of higher ages [32, 8].

In a meta analysis performed by Randler, the findings of the study showed that children and the elderly are usually morning and young people, afternoon; females are also usually morning in comparison with males. In adolescence, either females or males are frequently afternoon. The number of morning girls and women are significantly higher than boys and men [16].

Another aspect consisted in the understanding of the circadian temporization system of oral temperature in subjects. It was observed in **Figures 1**, **2** and **3** that the temperature range indicated modifications that occurred with the individual temperature on the course of the day. It was observed that in each day temperature started with a low value, gradually

increasing on the course of the day until reaching a maximum value at the end of the afternoon, which value tends to reduce at night. However, it was possible to verify, by cosinor method, fluctuating oral temperature.

This daily temperature fluctuation is associated with a sine curve, representative of oscillatory events, from which some oscillation parameters may be defined, such as: mesor, amplitude and acrophase [4].

One of the most important functions of this rhythmicity is to assure that behaviors of internal physiological adaptations are temporized in relation to environmental cycle, i.e., shiftwork, irregular times for study may contribute to a non-synchronization between internal rhythms and external events, which is known as entrainment.

From this reference, studies on populations of evening students and workers may contribute to the identification of changes, since this is a group represented by a vulnerable population that suffers from several physical, psychic and social consequences.

Conclusion

Sociodemographic data showed peculiarities for the population of students and nursing professionals, with prevalence of the female gender and age with significant differences.

Concerning working time, there was a significant difference regarding distribution of nursing professionals for morning and evening periods, while students showed higher percentages for morning and afternoon periods.

It was observed that nursing professionals usually do not take medications, while students do, which is justified by the fact that they work during the day and study at night.

In the studied sample, it was verified that nursing professionals had their own means of transport, while students used school or public transport.

There was prevalence of indifferent chronotype for the population of nursing professionals; conversely, the afternoon type was predominant for students in a general way.

Oral temperature measurements of evening students showed values that started at 36.2º, increasing on the course of the day, with acrophase at 2:30 p.m. (36.6º). For morning students, values started at 36.4º, increasing on the course of the day, with acrophase around 2h00 p.m. (36.6º).

For morning nursing professionals, acrophase occurred at 2:00 p.m. (36.6º).

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