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EVALUATION OF THE CHRONOBIOLOGICAL PROFILE AND ITS RELATION WITH THE NUTRITIONAL STATE OF NIGHT SHIFT INDUSTRIAL WORKERS

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ABSTRACT

Chronobiology is responsible for studying the temporal properties of living matter, including all levels of organization, as well as the study of circadian rhythms, which are biological rhythms that oscillate around 24 hours. The objective of the present study was to reveal the chronobiological profile of night workers in an industry, as well as to detect the degree of influence of shift work conditions on sleep habits and nutritional status of workers, evidencing determining factors and attenuating expected complications. A descriptive, transversal study with a quantitative approach was carried out. The data were collected through a questionnaire that evaluated the workers' sleep habits, applied during the period in which employees ate their meals in the industry. Subsequently, anthropometry was performed to evaluate nutritional status, where weight, height, arm circumference and waist circumference were measured. It was verified in relation to its chronotype 72% are morning, 26% moderately morning and 2% are moderately evening. When analyzing the nutritional status of the workers, 78% are diagnosed as overweight / obese and 22% are eutrophic. When the diagnosis of Arm Circumference was analyzed, the majority (84%) were in a state of eutrophy, and (16%) were overweight. Another parameter analyzed was the Abdominal Circumference, where 28% presented a risk of cardiovascular diseases and 72% presented Circumference of the Arm without risks of cardiovascular diseases. It is concluded that the chronotype does directly affect the work of the individual, and can cause health problems with the change of schedules other than the chronotype.

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INTRODUCTION

The circadian expression and the endogenous rhythms are distributed in a specific population in different types, allowing to undergo some adaptations, and therefore, longevity (Meira, 2017).

These consecutive events, which are repeated in the same order and in the same intervals, are called rhythms or biological cycles (Couto, 2011). The science that studies the biological cycles is Chronobiology.

Chronobiology is responsible for studying the temporal properties of living matter, including all levels of organization, and the study of circadian rhythms that are biological rhythms that oscillate around 24 hours and can be biochemical, physiological or behavioral events which are essential for survival (Schmitt, 2013). Sleep is more than just a basic physiological need, and its deprivation can cause disturbances to the human health (Lins, 2017). Human being has an internal timing system, the biological clock, which is responsible for the number of times that the individual wakes up without the alarm clock or when they feel hungry even without visualizing food. This facts, that occur exactly at the same time, are called biological rhythms (Mendoza, 2007). Work in shifts is a social condition with irregular hours that usually differs from the hours practiced throughout the evolution of the human being. This condition deregulates the biological rhythms, since they alter the synchronization with the environment, interfering in the periods of sleep and wakefulness, temperature and release of some hormones. These alterations can potentiate some diseases, such as metabolic and cardiovascular, gastrointestinal pathologies, cancer and some mental disorders, increasing morbidity and mortality (Pereira, 2009). Each individual is regulated by their own internal clock and the endogenous factors, such as the preference of a certain time to sleep and wake up. According to this context, humans can be classified in morning (individuals who sleep and wake up early), evening (individuals who sleep late and wake up late) and intermediaries, those who have greater flexibility of schedules, from which, they can adapt better according to their routine (Padovani, 2011). Over time, night works favors gastrointestinal, psychological, and sleep disturbances. Modifications in the schedules and sequences of meals during the night period leads to the appearance of these problems. The body does not support the same amount and type of meals that are normally consumed during the day, which can cause peptic ulcer and gastroduodenitis (Li *et al.*, 2012). Given this context, the objective of this study is important because it reveals the chronobiological profile (morning, evening or intermediate) of the industrial night workers, detecting the level of work conditions and its influence on the nutritional status and health of those involved, evidencing factors that are determinants and extenuating of the expected complications.

METHODOLOGY

This is a quantitative research, with a descriptive observational aspect and with a cross-sectional design. It uses a quick and objective questionnaire adapted from Seibt¹⁰ to evaluate the nutritional status, based on the sleep habits of the workers and classification on the chronotypes. The sample consisted of 50 regular industrial workers who work at night. They all signed the Free Informed Consent Term (FICT), an important document that is part of the research protocol. The data were collected in April and May of 2016. Data collection was made through the application and evaluation of the questionnaire involving questions referring to sleep habits of night workers for the identification of the chronotype. Later anthropometry was performed to evaluate the nutritional status, through the calculation of Body Mass Index (BMI), Arm Circumference (AC) and Abdominal Circumference (AbC). The anthropometric values of weight (kg) and height (m) were obtained through a G-tech portable scale with a maximum capacity of 130 kg and a precision of 0.1 kg and a tape measure adhered to a wall without skirting boards with an extension of 2.00m.

Employees were weighed and measured without shoes at meal interval. In addition, BMI was calculated and the nutritional status was classified according to the World Health Organization recommendations (Maynardes, 2009). The workers were classified according to the chronotype in: morning, moderately morning, intermediate, definitely evening and moderately evening. The relation of the chronobiological profile of the collaborators and their nutritional status was made. The results were tabulated in Excel Microsoft Office Excel® version 11.0. Statistical analysis was performed using the chi-square test with significance index of 5%, using software S.P.S.S. Version 17.0

RESULTS AND DISCUSSION

Chronobiological evaluation studies the biological cycles, which are responsible for certain physiological changes that occur in the body during certain times of the day. When there is any change in the biological cycles, it will result in the decrease of the rhythmicity, which may lead to some health problems. Thus, 50 workers were evaluated, 34.0% (n=17) where female and 66.0% (n=33) where male. There was observed a relation between the overload caused by night work and females, due to the reduction of daily sleep, increase of activities at home and childcare, which could be the reason for dismissal of women of this shift, as evidenced by the relevant difference between the number of female and male workers of the sample studied (Maynardes, 2009).

Table 1. BMI classification of industrial night workers from Fortaleza, 2016

BMI classification*	n	%
Eutrophy	11	22,0%
Overweight/Obesity	39	78,0%
Total	50	100,0%

Source: Research Data

* World Health Organization. Physical status: the use and interpretation of anthropometry. Geneva: WHO; 1995. WHO The Scientific Report Series, n.854.

Table 2. Arm Circumference (AC) classification of industrial night workers and the influence on their nutritional status. Fortaleza, 2016

AC*classification	N	%
Eutrophy	42	84,0%
Overweight/Obesity	8	16,0%
Total	50	100,0%

Source: Research Data

* CHUMLEA WC, ROCHE AF, MUKHERJEE D. Nutrition assessment of the elderly through anthropometry - Ross Laboratory, Columbus, Ohio, 1984..

Table 3. Abdominal Circumference (AbC) classification of industrial night workers and the influence on their nutritional status. Fortaleza, 2016

AbC*classification	n	%
Without risk of cardiovascular diseases	36	72,0%
Risk of cardiovascular diseases	14	28,0%
Total	50	100,0%

Source: Research Data

* III Brazilian Guidelines on Dyslipidemias and Guidelines for the Prevention of Atherosclerosis of the Department of Atherosclerosis of the Brazilian Society of Cardiology. Arq. Bras. Cardiol., Nov. 2001, vol.77 suppl.3, p.1-48.

The sample were classified according to its chronotype in: 72.0% (n=36) definitely morning, 26.0% (n=13) moderately morning and 2.0% (n=1) moderately evening. Man is a diurnal animal and tends to be active by day and rest at night, but the

preference for rest and activity hours may differ significantly between individuals and depends on both genetic variation and environmental influences (Hidalgo, 2011). Individuals with morning chronotype are people who feel better waking up early, are more disposed throughout the day, and as the sun goes down are less alert.

The evening chronotype is represented by people who are willing to perform activities later, to rest late and to reduce alertness in the morning (Martins, 2010). A study by Souza (2012) and his colleagues with 101 nursing workers from a university hospital in Rio Grande do Sul evaluated the chronotype and life quality through Horne-Ostberg Matutineness-Vesperity

Table 4. Relation between BMI classification and AbC classification of industrial night workers and the influence on their nutritional status. Fortaleza, 2016

Relation	AbC classification				Total	p**
	Without risk of CD*		Risk of CD*			
BMI classification	n	%	n	%		
Eutrophy	2	4,0%	9	18,0%	22,0%	0,6014
Overweight/Obesity	4	8,0%	35	70,0%	78,0%	
Total	6	12,0%	44	88,0%	100,0%	

Source: Research Data

*Cardiovascular diseases

** Chi-square test with $p < 0.05$

Table 5. Relation between the nutritional status of the workers and the chronotype found in the research

Relation	Nutritional Status				Total	p
	Eutrophic		Non-Eutrophic			
Chronotype	n	%	n	%		
Morning	8	16,00%	28	56,00%	72,00%	1,0000
Moderately morning	3	6,00%	10	20,00%	26,00%	
Moderately evening	0	0,00%	1	2,00%	2,00%	
Total	11	22,00%	39	78,00%	100,00%	
Relação	Eating Disorder				Total	p
Chronotype	Presence		Absence			
Morning	33	66,00%	3	6,00%	72,00%	0,6018
Moderately morning	12	24,00%	1	2,00%	26,00%	
Moderately evening	0	0,00%	1	2,00%	2,00%	
Total	45	90,00%	5	10,00%	100,00%	
Relation	Average Number of Hours Slept				Total	p
Chronotype	5 hours or less		6 hours or more			
Morning	20	40,00%	16	32,00%	72,00%	0,7610
Moderately morning	6	12,00%	7	14,00%	26,00%	
Moderately evening	1	2,00%	0	0,00%	2,00%	
Total	27	54,00%	23	46,00%	100,00%	
Relação	Nutritional Status				Total	p
Average number of hours slept	Eutrophic		Non-Eutrophic			
5 hours or less	5	10,00%	22	44,00%	54,00%	0,7333
6 hours or more	6	12,00%	17	34,00%	46,00%	
Total	11	22,00%	39	78,00%	100,00%	

Table 6. Relation between the nutritional status of the workers and the chronotype found in the research

Relation	Use of substance for sleep induction				Total	p
	Use		Does not use			
Chronotype	n	%	n	%		
Morning	2	4,00%	34	68,00%	72,00%	0,3102
Moderately morning	1	2,00%	12	24,00%	26,00%	
Moderately evening	1	2,00%	0	0,00%	2,00%	
Total	4	8,00%	46	92,00%	100,00%	
Relação	AbC classification				Total	p
Chronotype	Risk		Without risk			
Morning	7	14,00%	29	58,00%	72,00%	0,0417
Moderately morning	6	12,00%	7	14,00%	26,00%	
Moderately evening	1	2,00%	0	0,00%	2,00%	
Total	14	28,00%	36	72,00%	100,00%	
Relation	AC classification				Total	p
Chronotype	Eutrophy		Over weight /Obesity			
Morning	32	64,00%	4	8,00%	72,00%	0,0656
Moderately morning	10	20,00%	3	6,00%	26,00%	
Moderately evening	0	0,00%	1	2,00%	2,00%	
Total	42	84,00%	8	16,00%	100,00%	

Questionnaire (Horne *et al.*, 1976) and the WHOQOL-Brief. The sample consisted of 65 subjects who worked at night, which 87.5% (n=14) were morning, 76% (n=38) were indifferent and 37.1% (n=13) were evening, corroborating with the present study. When analyzing the nutritional status of workers, 78% were diagnosed with overweight and obesity and 22% were eutrophic (Table 1). In this research, 78% of the workers were overweight or obese, this result agrees with other studies which shown that night workers have a higher Body Mass Index (BMI), eat later and in greater abundance at the end of the day, have worse eating habits (consume more fastfood and soft drinks, and less vegetables and fruits, fish and whole grains), have lunch fewer time in the week and have a higher risk of cardiovascular disease and eating disorders (Kovac *et al.*, 2009; Mendoza *et al.*, 2007). This result is similar to the study by Silveira¹⁹, which showed a significant relation between BMI and work shifts, besides that, the daytime workers, were overweight (42.7%) and obese (39.42%) comparing to the night workers, who were overweight (57.1%) and obese (57.3%). A study by Lopes²⁰ with 94 night workers from a metallurgical industry in the city of São Paulo showed that 50.0% were overweight, 13.9% were obese, 34.1% were eutrophic and 2.7% were low weight. Most of the participants in the research had food problems, such as frequent consumption of fat, fried foods and sweets and low consumption of vegetables and fruits. When the diagnosis of Arm Circumference (AC) was analyzed, the results showed that the majority (84.0%) were eutrophic, and (16.0%) were overweight (Table 2). AC is a parameter of nutritional evaluation that allows to evaluate the nutritional status of the individual, for instance, eutrophy or depletion of muscular mass. When we compare the nutritional status obtained by the classification of BMI and the risk of cardiovascular diseases by the classification of Abdominal Circumference, there is no positive relation ($p = 0.6014$) (Table 4).

Table 4 Relation between BMI classification and Abdominal Circumference (AbC) classification of industrial night workers and the influence on their nutritional status. Fortaleza, 2016. A study carried out by Rezende and colleagues (Rezende *et al.*, 2006) at the Health Division of the Federal University of Viçosa, with 231 servers, proved, that according to BMI, the frequency of overweight and obesity was 42.5% and 24.5%, respectively, in females and 40.0% and 15.2%, in males. Regarding to Abdominal Circumference (AbC), 32% of the women had AbC in the range of 80 to 88 cm, and 42% above 88 cm. In males, 23.9% had AbC in the range of 94 to 102 cm and 22.2% above 102cm. Individuals with excess weight, especially with abdominal obesity, are more susceptible to cardiovascular diseases involved in the metabolic syndrome and, therefore, have a higher risk of morbidity and mortality when not treated. Regarding to the chronotype and the risk of cardiovascular diseases, there was a positive relation ($p = 0.0417$), showing that sleep may interfere with the worker's health (Table 5). In our sample, 10% presented eating disorders and worked in the night shift. Although it can not be the direct cause for the nutritional status of the workers, it affects the adequate food consumption of these people, with an oscillation in energy consumption, macro nutrients and the number of meals (Table 5). It was observed that there is a relation between the control of food intake and the deprivation of sleep, where there is an increase of the hormone ghrelin, which is orexigenic. This indicates that lack of sleep can lead to increased of hunger (Morais, 2013).

Leptin is a hormone that regulates hunger/satiety and food intake. At night, when appetite decreases, the blood plasma presents higher levels of leptin, contributing to the fasting and rest phase. During the day, when hunger increases, leptin decreases, with the lowest values being between 8 AM and 4 PM. Restricted sleep favors increased appetite, affecting levels of leptin and ghrelin (Spiegel, 2004). In this study, 54% of the respondents sleep 5 hours or less per day, different from the findings of Marqueze, Silva and Moreno²⁵ in their research, which showed that most of the workers (52.7%) used to sleep less than 7 hours a day and 36.8% sleeps an average of 6 to 7 hours a day, and the rest of the workers (10.5%) sleeps from 5 to 6 hours a day. Sleep disturbances may occur due to changes in durability, time (because it is unusual or irregular) or quality (Gomes, 2005). Another parameter analyzed was the Abdominal Circumference, which 28% (n=14) presented a risk of cardiovascular diseases and 72.0% (n=36) had no risk (Table 3).

A study carried out with 27 employees of the Hospital das Clínicas de Porto Alegre (HCPA) with both sexes showed that there is a relation between shift work and the development and/or the early appearance of clinical manifestations indicative of metabolic alterations, making the work a risk factor for metabolic syndrome. The literature shows that several diseases are associated with increased abdominal circumference, so this variable is one of the central diagnostic criteria for metabolic syndrome in several guidelines, such as the Brazilian Society of Cardiology and Brazilian Society of Endocrinology and Metabolism, therefore shift work may be an important factor for the development or acceleration of the pathogenic process of metabolic syndrome (Antunes, 2009).

Conclusion

Considering the data found in this study, when the chronotypes were evaluated, it was verified that the majority of the industrial workers who work at night presented morning chronotype and have an average sleep period of 6 or more hours per day. Workers who are overweight or obese presented a morning chronotype, evidencing risk factors for the development of sleep-related disorders, which may directly interfere with their health and productivity at work. Then it is concluded that the chronotype does directly affect the work of the individual, and can cause health problems due to the schedule changes other than the chronotype.

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