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ORIGINAL RESEARCH

SLEEP DISORDERS IN ROTATING SHIFT WORKERS

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ABSTRACT

Introduction: Human being has evolved over the years, and has changed the way he behaves as the environment changes, including the need to carry out activities that allow them to receive an economic reward. In order to increase productivity, work shifts created, leading to problems in the quality of life and sleep quality.

Methods: The files of 83 policemen with three types of shift rotation were analyzed. The objective was to determine their demographic characteristics and to identify any association between shifts rotation and the presence of sleep disorders. Obstructive sleep apnea was the most common sleep disorder. Insomnia and nocturia were also frequent findings.

Results: 83 patients were included, 64 men and 19 women, from 23 to 67 years old. 44 worked on a 12x12 shift, 13 were on the 24x12 shift and 26 corresponded to the 24x24 shift.

Conclusions: Our results showed that the most frequent disorder in this population was moderate apnea. We did not find any statistical association between the different work shifts and sleep disorders, although, we found statistically significant associations between the different types of rotating shift work patterns, finding a greater impact in sleep variables in the 24x24 rotation, especially when related to alcohol consumption.

1. INTRODUCTION

Health status is directly related to working conditions and performance, and we know that when a worker has good health conditions, his work performance would be better.

It is very important to identify the many factors involved in working and in the adaptation of the worker to his job, within these are the psychosocial risk factors, which are derived from the functions nature of the position, such as the type of work shift, sleep-wake disorders and exposure to severe traumatic events or acts of workplace violence.[1]

Human being is a species that spends at least a third of its life sleeping, with highly variable natural sleep patterns between individuals and with bodies programmed to work during the day and rest at night. It is, therefore, a living being with a basically diurnal rhythm. This rhythm is determined by biological clocks that control the physiology and biochemistry of the body, adjusting it every 24 hours, known as circadian cycle.[2]

The demands of modern life have led the population to increase work hours to meet the requirements of the labor society such as productivity, costs, skills and technological changes. To face this situation, workers have modified their lifestyles in order to cover their daily needs. Sleep has been a part of people's lives that has been most affected due to the constant changes that are made in it, having to rotate

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work shifts and causing sleep disorders that in most cases are not diagnosed and treated, resulting in physiological and mental maladjustment.

Night work, as well as shift rotation, has increased significantly in recent years, and 20% of the world's population is currently working under this regime.[1] The modification of working hours leads to changes in resting patterns of the workers, thus affecting the biological rythm and consequently leading to the appearance of sleep disorders. More than 60% of people with work shifts may present sleep disorders, sleeping a mean of five to six hours per day, and presenting problems to stay awake during the night when they have a nocturnal shift after a resting day.[3]

In most Countries, the percentage of workers under this labor regime is, in general, similar: In the United States 20%, the United Kingdom 22%, Greece and Finland 25%, the Czech Republic 24%, China 17.5% and Senegal 20%.[4]

Shift rotation has frequently faced organizational problems, being the following the most common:

1. Number of employees per position and duration of each shift: the number of people needed to cover 24 hours. It must be considered the number of working hours per week, in Mexico it is generally 48 hours.

2. Frequency of shift changes and their rotation: shifts rotation may vary depending on the employer. Rotation changing every week is the most widespread pattern worldwide. As for the shift rotation sequence, it could be changed chronologically, starting in the morning, continuing in the afternoon and ending at night (rotation forward or in an advanced phase) or starting in the morning, continuing in the evening. night and ending with the afternoon (reverse rotation or delayed phase). In most cases, this is not in this way that shift rotation is carried out, as mixed rotations are commonly used. There are some studies showing that reverse rotation leads to more adaptation problems for workers.[5]

3. Duration of the rotation cycle: This duration will change depending on the number of available employees, referring to the time it takes for a worker to have the same order of days of work and rest over time. Short rotation is when the employee remains on the same shift for up to six days, and long rotation is when the employee remains on that shift for more than six days. There is not a general consensus on which are the duration of the rotations that may affect the worker less. Some authors point out that long rotations are more convenient, even when the same shift is maintained for more than 3 consecutive weeks,[6] while other refer that short rotations, especially when they are forward, do not last more than two weeks and with two resting days.[7]

In Mexico, not enough studies have been carried out to determine the proper diagnosis and management for the working population that suffers from sleep disorders, and this includes individuals on rotating shift work. Rotating shift is currently exercised by 20% of the economically active world population; this has caused workers to have problems in their quality of life, including this fundamental part as it is their sleep. With the interruption of resting, the sleep and wake regulation system gets affected, thus leading to the development of sleep disorders. The objective of this study was to determine the demographic characteristics of a group of rotating police officers in Mexico City, as well as to identify if there is an association between rotation of shifts with the appearance of sleep disorders of them.

2. METHODS

83 files from the Mexican Institute of Integral Sleep Medicine, all of them police shift workers of a private security company in Mexico City, were anayzed. The data were collected in the period between 2012 and 2016. All patients underwent a polysomnography as part of their study protocol

Data were analyzed with the SPSS 21.0 software for windows (LEAD Technologies,
Chicago IL). Statistical significance was established at the $P < 0.05$ level. Central tendency measures for the demographic data. Chi-square was used for associations of the qualitative variables.

3. RESULTS

Demographic features of our population behaved as follows: We found a total of 83 workers, 64 men (77.1%) and 19 women (22.9%). The age range ranged between 23 and 67 years old, with a mean of 49.35 and a standard deviation of 8.1. Height ranged from 149 to 185 cm, with a mean of 165.34 and a standard deviation of 7.3. Body weight was in a range between 56 and 158 kgs, with a mean of 92.7 and a standard deviation of 19.1. Neck circumference range was from 14 to 19 inches, with a mean of 16.3 and a standard deviation of 0.98.

Rotating shifts of the 83 workers the following distribution: 44 (53%) of them had 12x12 pattern (12 hours working and 12 hours resting), 13 (15.7%) had 24x12 pattern (24 hours working and 12 hours resting) and 26 (31.3%) corresponded to the 24x24 pattern (24 hours working and 24 hours resting).

Prevalence of sleep pathologies in each shift pattern

In the group of 12x12 workers, moderate sleep apnea presented a prevalence of 15.7, mild sleep apnea prevalence was 13.3 and severe sleep apnea prevalence 9.6. Primary

	24x24 Shift Mean (SD)	12x12 and 24x12 Shifts Mean (SD)	P value
Total sleep time (min)	383.12 (78.61)	394.00 (80.20)	0.566
N 1 (%)	4.62 (2.59)	5.30 (6.90)	0.627
N 2 (%)	51.85 (9.93)	57.19 (8.99)	0.017*
N 3 (%)	23.42 (8.66)	21.39 (8.56)	0.320
REM (%)	22.92 (15.07)	19.46 (12.29)	0.271
Arousals index	20.05 (11.29)	21.72 (11.08)	0.529
Apnea-Hypopnea index	16.66 (13.50)	17.68 (13.31)	0.746
Snoring index	61.00 (59.00)	40.05 (29.97)	0.031*
Lower oxygen saturation during sleep	64.77 (14.37)	69.91 (11.08)	0.078*
Awake oxygen saturation	70.92 (12.25)	76.11 (10.43)	0.075*

*Table 1. SD: Standard deviation. *Statistical significance.*

snoring prevalence was 8.4, insomnia 4.8 and other sleep disorders 1.2.

The 24x12 group showed a moderate sleep apnea prevalence of 6, mild sleep apnea 3.6, primary snoring and insomnia 2.4 and severe sleep apnea 1.2.

In the 24x24 group, prevalences were: moderate sleep apnea 9.6, mild sleep apnea 9.6 primary snoring 4.8, severe sleep apnea 3.6, insomnia 3.6.

Obstructive sleep apnea syndrome was the most frequently sleep condition found in our group of patients: Mild 22 patients (26.5%), moderate 26 (31.3%) and severe 12 (14.5%).)

Polysomnographic and clinical findings may be found in tables 1 and 2.

With the variables found to be statistically significant in the bivariate analysis, a logistic regression was performed with the control variable that in our study was the amount of alcohol that the worker drank to be able to sleep (Table 3).

4. DISCUSSION

This study addresses a topic that has been poorly studied, specially in Mexico. In similar articles in Mexican population,8, 9 we found many methodological deficiencies, such as the lack of polysomnographic diagnosis or of an adequate description of the methods.

83 workers files were analyzed because it was our total sample that met all the selection criteria. This small number of patients could lead to a diminished internal validity, due to the possibility of the lack of statistically normal distribution of our population.

There are strengths in this study such as the use of polysomnography, which is the gold standard in the diagnosis of sleep disorders. In the Mexican literature, we found only one study published in 2016 using polysomnography for diagnosis. Other articles made their diagnosis based only on questionnaires, which may lead to inaccurate.

One of our objectives was to identify sleep disturbances in the different rotating shifts on this group of police officers. As observed, the most frequently found disorder was moderate obstructive sleep apnea syndrome, followed by mild sleep apnea. Insomnia was the fifth disorder in terms of frequency, unlike what is reported in the world literature, where it is the most prevalent sleep condition. This may be due to the phenotypic characteristics of the Mexican population and the high prevalence of obesity and overweight, since these two conditions are associated with an increased incidence of sleep-disordered breathing.

Regarding the distribution of the sleep conditions in the different working shifts, we found that in workers with a 12x12 rotation shift, moderate obstructive sleep apnea syndrome remains the most common disorder. In this shift, the distribution of the sleep conditios was similar to the whole population, and this, could be explained by being the group with a higher number of subjects. It should be noted that according to the world literature, this is the shift pattern that shows the lower impact on the workers health.

Regarding the 24x12 shift, a higher prevalence of moderate obstructive sleep apnea was also found. Insomnia was as frequent as snoring. In the 24x24 shift, mild and moderate apnea were both present as the most frequent sleep

Variable	Number 24x24	%	Number 24x12 and 12x12	%	P value
Nocturia	23	27.71%	47	56.62%	0.485
Sleep talking	8	9.63%	12	14.45%	0.337
Limbs movements during sleep	15	18.07%	14	16.86%	0.003*
Bruxism	5	6.02%	8	9.63%	0.546
Insomnia	3	3.61%	6	7.22%	0.891
Snoring	4	4.81%	9	10.84%	0.962
Mild apnea	8	9.63%	14	16.86%	0.552
Moderate apnea	8	9.63%	18	21.68	0.941
Severe apnea	3	3.61%	9	10.84%	0.610

Table 2

disorder, primary snoring in second place, and third place was shared by insomnia and severe sleep apnea.

In the group of 12x12 shift rotation type, moderate sleep apnea had a prevalence of 15.7. The prevalence of mild obstructive sleep apnea was 13.3, and severe sleep apnea was 9.6, primary snoring 8.4, insomnia 4.8 and others sleep conditions1.2.

In the 24x12 shift rotation group, the prevalence of moderate sleep apnea was 6, mild sleep apnea 3.6, primary snoring and insomnia 2.4, and severe apnea 1.2. And finally, in the 24x24 rotation group, the prevalence of moderate sleep apnea was 9.6, mild sleep apnea 9.6, primary snoring 4.8, severe sleep apnea 3.6, insomnia 3.6

Since the diagnostic gold standard for sleep disorders is polysomnography, we took the findings in this study as the definitive diagnosis, and the distribution of sleep conditions was as follows:

Obstructive sleep apnea syndrome was the most frequently sleep condition found in our group of patients: Mild 22 patients (26.5%), moderate 26 (31.3%) and severe 12 (14.5%). This severity classification is related to the number of apneas and/or hypopneas found in polysomnography per hour of sleep: mild: from 5 to 15 events per hour, moderate from 15 to 30 per hour, and severe more than 30 events per hour.

Variable	Coefficient	P value
N 2 %	**0.267**	**0.017**
Lower oxygen saturation during sleep	**0.224**	**0.044**
Awake oxygen saturation	**0.201**	**0.075**
Snoring index	**0.253**	**0.024**
Limbs movements during sleep	**0.511**	**0.000**

Table 3. Logistic regression of the statistically significant variables.

The total number of patients with sleep apnea was 60, which corresponds to 72.28% of our study population. 9 patients (10.8%) had the diagnosis of insomnia. It is noteworthy that prevalence of insomnia in this group of workers was relatively low, despite the world literature describes insomnia as the most prevalent sleep disorder in the general population. (table 4).

We found oxygen saturation levels as low as 35% in this series. This is a very important factor associated to sleep apnea syndrome comorbidities, such as systemic arterial hypertension, which was actually one of the most commonly found clinical diagnoses in this series of workers, and for the presence of polyglobulia. Some relevant clinical aspects are shown in table 5.

In the search for an association relationship between work shifts and sleep disorders, a bivariate analysis was performed, using a chi square test, since they were two qualitative variables. In this analysis, the significance is 0.986, meaning it is not statistically significant (table 6). Statistically significant variables were found in workers with 24x24 rotation in the bivariate analysis, such as the percentage of sleep stage 2 with values of P 0.017, snoring index P 0.031, oxygen saturation during sleep P 0.078, oxygen saturation in wakefulness P 0.075, movement of arms and legs P 0.003.

97.6% of the studied population said that it is difficult for them to wake up and get out of bed. This shows us that the population may have sleep symptoms but the they do not pay propper attention to these sleep manifestations. 81.9% reported drowsiness during the day.

Finally, we found that a 24x24 shift worker who consumes alcohol has a 26% higher probability of having a n2 deficiency than a worker with a different shift due to the fracture of the sleep architecture. Regarding oxygen saturation during sleep, it is 22% lower in the 24x24 rotating shift group.

5. CONCLUSIONS

From the data obtained, we can say that there is a lack of quality scientific publications on the issue addressed in this study especially from the methodological and statistical point of view. The shift work pattern with the largest number of patients in our population was 12x12 with 53%, followed by 24x24 with 15.7% and finally 24x12 with 15.7%.

The most important demographic features found in our population were a greater number of men than women, 77%-23%. 90.4% of the population had some degree of obesity or overweight, the average being 92 kg, with an average height of 165 cm, and this is also consistent with the high prevalence of obstructive sleep apnea.

The amount of alcohol, tobacco and caffeine taken by the patients was observed to be lower than expected, with the average intake being 0.48, 1.14 and 1.12 per day, respectively.

		Polysomnographic diagnosis						total
		Insomnia	Primary snoring	Mild sleep apnea	Moderate sleep apnea	Severe sleep apnea	Other	
Rotation shift work type	12x12	4	7	11	13	8	1	44
		4.8%	8.4%	13.3%	15.7%	9.6%	1.2%	53.0%
	24x12	2	2	3	5	1	0	13
		2.4%	2.4%	3.6%	6.0%	1.2%	0.0%	15.7%
	24x24	3	4	8	8	3	0	26
		3.6%	4.8%	9.6%	9.6%	3.6%	0.0%	31.3%
total		9	13	22	26	12	1	83
		10.8%	15.7%	26.5%	31.3%	14.5%	1.2%	100.0%

Table 4. Presentation of sleep disorders in the different shift work patterns.

	24X24 SHIFT Mean (SD)	24X12 and 12X12 SHIFT Mean (SD)	P VALUE
Age	50.19 (8.44)	48.96 (8.05)	0.6343
Weight	89.38 (17.91)	94.31 (19.61)	0.222
Height	163.83 (7.48)	166.01 (7.25)	0.264
Body mass index	33.49 (6.69)	34.19 (6.46)	0.655
Neck circumference	16.12 (.993)	16.49 (.966)	0.113
Coffee cups per day	1.23 (1.70)	1.070 (1.20)	0.4916
Energy drinks per day	1.30 (1.25)	.929 (.863)	1.5942
Number of alcohol drinks before going to bed	.038 (.196)	.684 (2.08)	0.024
Cigarretes/day	1.50 (3.33)	.98 (2.34)	0.8134
Number of hours of sleep per night	5.038 (1.61)	5.842 (1.32)	0.564
Number of naps	.5 (.812)	.368 (.671)	0.7743
Number of nocturnal awakenings.	2.615 (1.812)	2.596 (1.888)	0.428

Table 5. Clinical aspects and shift work. SD: Standard deviation

VARIABLE	P value
N2 %	0.017
Snoring index	0.031
Oxygen saturation during sleep	0.078
Awake oxygen saturation	0.075
Periodic limbs movements	0.003

Table 6. Statistically significant variables in the bivariate analysis.

As previously mentioned, shift work rotation may have consequences on many aspects of workers' health, and this was observed in our study. Emotional issues were present in 15.7%, circulatory conditions in 36.1%, gastrointestinal conditions in 16.9% of which 10.8% were gastric ulcers or gastritis, this being the most common digestive condition in rotating and night shift workers worldwide.

An interesting issue found in this study was the prevalence of insomnia, which was low compared to that reported in the scientific literature, where it is the most prevalent worldwide. In our population, insomnia presented in the fourth place, and this can be associated with the physical characteristics of our patients.

In this study, statistically significant associations were found between the different types of rotating shift work patterns, finding a greater impact in sleep variables in the 24x24 rotation, especially when related to alcohol consumption.

Some previously unreported findings were found. This allows us to expand the study on rotation shift workers in order to identify propper measures to improve job performance and to decrease the impact on the workers' lifestyle.

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