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Sleep Science

Sleep Architecture in Night Shift Workers Police Officers with Obstructive Sleep Apnea-hypopnea Syndrome

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ABSTRACT

Introduction: Reduced sleep to increase work hours is common among police officers, when this situation is combined with Obstructive sleep apnea/hypopnea syndrome (OSAHS), health consequences are greater, therefore we believe there is a need of research for these alterations. The aim of this study was to measure the changes in sleep architecture (SA) in police officers who currently have Night shift work (NSW) and OSAHS. **Methods:** We compared SA in 107 subjects divided in three groups: the first group included police officers with NSW and severe OSAHS (n = 48); the second group were non-police officers with diurnal work time and severe OSAHS (n = 48) and the third group was formed by healthy controls (n = 11). Polysomnography (PSG) variables and Epworth sleepiness scale (ESS) scores were compared. **Results:** SA was more disrupted in the group of police officers with NSW and OSAHS than in patients with OSAHS only and in the control group. Police officers with NSW and OSAHS presented an increased number of electroencephalographic activations, apnea/hypopnea index, and sleep latency, and showed lower scores of oxygen saturation, and in the ESS. Multivariate analysis revealed significant influence of age and Body mass index (BMI). **Conclusions:** Data suggested with caution an additive detrimental effect of NSW and OSAHS in SA and ESS of police officers. However age and BMI must be also taken into account in future studies.

Keywords: Sleep Apnea Syndromes. Polysomnography. Night Work

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INTRODUCTION

Adaptation to special work hours, for example, when night working time is required, demand reducing total a mount of sleep time and resulting in inadequate sleep and several disorders[1]. Today, an increasing number of subjects are compelled to work at night, which eventually translates in excessive daytime somnolence with increased risk of traffic, work, home accidents and a significant decrease in their cognitive abilities[2]. Thus, research sleep disorders in this population is crucial[3].

If a subject that works the night shift work (NSW) additionally suffers from a respiratory sleep disorder, such as Obstructive sleep apnea/hypopnea syndrome (OSAHS)[4], with several events of respiratory pauses and increased number of arousals per sleep hour, his/her sleep time will have a more disrupted architecture[5]. Today, OSAHS is recognized as a significant risk factor for other diseases, such as arterial hypertension, stroke, myocardial infarction, metabolic disturbances, and decreased of Quality of life (QoL)[6].

Police work proves to be very demanding both physically and mentally as it usually depends on unpredictable incidents reports. In addition it also often involves working long hours, including those when most people sleep. For ´police officers time for rest and leisure seems to be short[7-9]. Thus, their QoL, and Sleep quality (SQ) in found to be altered and merits more research.

Interactions among NSW and OSAHS has been studied, including in police officers[10,11], however sleep alterations deserve more research. As a result, this study aimed to assess several measures of sleep architecture (SA) in police officers with both: NSW and OSAHS and in their daytime somnolence and SQ in search for more knowledge of sleep alterations.

METHODS

Subjects

The subjects of study consisted of a sample of 107 subjects, who were divided in three groups. The first group included police officers from the Police Department of Mexico City with NSW and severe OSAHS (n = 48, median = 46 years of age). Police officers were recruited by means of a periodic program of clinical consultation at our clinic of sleep disorders. The second group included non-police officers subjects who performed diurnal work time and had severe OSAHS and without NSW (n = 48, median = 49 years old) recruited by the same way. Patients from both groups were studied for the first time in our clinic, had not treatment for OSAHS before diagnosis nor had been evaluated by a Polysomnography (PSG) study. Additionally, we studied a third group including healthy subjects within the same age range and who sleep regularly at night. This last group was used as the control for comparison purpose (n = 11, median = 36 years old). Control subjects were recruited from available friends and family members of workers of our clinic and who willingly wanted to participate in the study. Inclusion criteria for patients on NSW and OSAHS were as follows: male or female subjects, ages ranging from 18-60 years old age, 24-hour on duty and 24-hour off (24 x 24), or 48-hours on duty and 24 h off (48 x 24). OSAHS diagnosis were carried-out following American Academy of Sleep Medicine criteria[12], severity was confirmed by a PSG study (>31 events of apnea/hypopnea *per* sleep hour). The inclusion criteria for the group of OSAHS only were: male and female subjects, age between 18-60 years, diurnal work time, and severe OSAHS diagnosed in the same fashion. Control group with healthy individuals included subjects in the same age range of patients, without NSW and OSAHS. Exclusion criteria for all groups were: other chronic no-controlled diseases, and other sleep disorder such as primary chronic insomnia, narcolepsy, parasomnias, wake/sleep cycle disorders, periodic limb movements, or others. Clinical features of subjects in each group, is shown in Table 1. Protocol of the study was approved by the Research and Ethics Committee of the participant institutions. Informed consent was obtained for every subject after a wide explanation of the research objectives and importance of their participation. Patients and control subjects signed the informed consent according to Declaration of Helsinki.

Epworth sleepiness scale and Clinical Measurements

We utilized the Epworth sleepiness scale (ESS) to measure daytime somnolence. The ESS is a simple self-administrated questionnaire (eight questions), that asks the subject to rate on a scale of 0-3 the chances of sleep in different situations in their daily lives (sum of eight questions can vary from 0 to 24). Scores >10 are considered as abnormal sleepiness[13]. We also queried for subjective SQ, subjective sleep latency, number of sleep hours a night, number of awakening per night, number of nights with insomnia, naps, and difficulty to wake-up.

Polysomnography (PSG)

All night Polysomnography (PGS) recordings were performed in a digital Alice device with Sleepware version 2.8.78 (Respironics Inc., Koninklijke, VA). For electroencephalography (EEG) recording, five silver plate surface electrodes were positioned at the F4, C4, O2, Cz sites, and were linked to A1 according to the International 10-20 EEG System[14]. Electromyography (EMG) recordings were obtained by means of skin plate electrodes located on the chin and over the tibialis muscles on both legs. Electro-oculography (EOG) recordings were obtained from skin electrodes placed in lateral canthi of each eye. For Electrocardiogram (EKG) recordings, disposable surface electrodes were placed over the second intercostal space and mid-clavicular line. Respiratory flow was measured by means of a thermistor in nostrils, and plethysmographic belts in thorax and abdomen (Pro-Tech, Velcro Strap, Kego Corp., Lexington, Kentucky). Oxygen saturation was measured with a pulse oxymeter (Masimo Corp., Irvine,, California), finally snoring was recorded by placing a microphone on anterior neck side (Pro-Tech).

Interpretation of the PSG recording was carried-out by qualified technicians following standards of the American Association of Sleep Medicine for sleep scoring and associated events[15]. Our technicians are certified by the local association of research in sleep medicine and receive a yearly refresher

Table 1. Clinical features of the three groups of the study.

Subjects	Gender (n)	Age (years ± SD)	Weight (Kg ± SD)	Height (m ± SD)	BMI (± SD)
NSW-OSAHS	39 males 9 females	49 ± 1.5	90.5 ± 3.5	1.70 ± 0.1	34.4 ± 0.8
OSAHS	37 males 11 females	46 ± 2.5	100.5 ± 2.0	1.70 ± 0.1	36.2 ± 1.4
Controls	4 males 7 females	40 ± 3.5	75.8 ± 5.0	1.63 ± 0.2	25.6 ± 0.9
p		<0.001	<0.001	0.15	0.01
THD		n/o > o > c	n/o < o > c	ns	n/o < o > c

SD = Standard deviation. NSW = Night shift work. OSAHS = Obstructive sleep apnea/hypopnea syndrome. BMI = Body mass index. p = probability. THD Tukey honest differences test. n/o = Night shift work/OSAHS group. o = OSAHS group. c = control group.

course that includes performance evaluations. Compared variables were as follows: Total sleep time (TST), Sleep latency (SL), SL to Rapid eye movements (REM) sleep, Percentage of light sleep in N1-N2 stages, and of deep sleep in N3 stage (N3%), REMs (REM%), and Electroencephalographic (EEG) activations (awakenings), we also calculated Apnea-hypopnea index (AHÍ) and classified as follows: mild (6-15 events/hour), moderate (16-30 events/h), and severe level (=31 events/h).

Theory/calculation

Statistical analysis

We calculated the mean (x), and Standard deviation (SD) of quantitative variables. For qualitative variables we calculated percentages (%). A one-way Analysis of variance (ANOVA) to compare means across groups was used, and Tukey honest differences (THD) test *post-hoc* serve to find the location of significant differences, however since we tested homogeneity of variances by the Levene method and not all compared variables fulfilled with the criteria, we corrected our search for differences among groups with the Dunnett method. Afterward, we also executed carried-out a multivariate analysis controlled by age, and BMI effects. We chose an *alpha* value of p =0.05 to determine differences as significant.

RESULTS

Overall data

Clinical characteristics of subjects such as gender, age, weight, height and body mass index (BMI) in the groups of police officers on NSW and OSAHS, OSAHS only, and controls is shown in Table 1. We found that controls had more female subjects, they were also younger, lighter and had less BMI than the other two groups. However, subjects in the control group had scores within clinical normative data, and are in agreement with previous results from our laboratory in this age range[16].

Comparisons

SA in PSG study is shown in Table 2. A significant larger SL in both groups of patients when compared to the control group, and greater number of EEG activations in patients on NSW and OSAHS, when compared to patients with OSAHS only and to control group was observed.

Table 2. Sleep architecture (SA) comparison and Polysomnographic (PSG) variables in the three studied groups.

Variable	Group	Mean ± Standard deviation	p	THD
Total sleep time (minutes)	NSW-OSAHS OSAHS C	407.27 ± 7.90 399.16 ± 9.92 376.07 ± 12.08	0.09 ns	n/o-o > c
Sleep latency (minutes)	NSW-OSAHS OSAHS C	32.58 ± 5.83 31.33 ± 6.96 13.58 ± 2.62	0.008	n/o-o > c
Light sleep %	NSW-OSAHS OSAHS C	58.89 ± 9.23 62.14 ± 12.86 63.58 ± 9.16	0.34 ns	ns
Deep sleep %	NSW-OSAHS OSAHS C	21.67 ± 8.21 18.84 ± 7.24 18.11 ± 7.82	0.21 ns	ns
REM sleep %	NSW-OSAHS OSAHS C	19.43 ± 0.92 19.28 ± 1.31 18.53 ± 0.96	0.79 ns	ns
REM latency (minutes)	OSAHS-NSW OSAHS C	141.78 ± 13.53 125.33 ± 7.17 106.55 ± 9.98	0.09 ns	n/o > o > c
Electroencephalographic activations	NSW-OSAHS OSAHS C	178.36 ± 16.69 142.98 ± 9.26 59.07 ± 7.25	<0.001	n/o > o > c

NSW = Night shift work. OSAHS = Obstructive sleep apnea/hypopnea syndrome. C = controls. p = probability. ns = no significant difference. THD Tukey honest differences test. n/o = Night shift work/OSAHS group. o = OSAHS group. c = control group.

Cardio-respiratory variables are shown in Table 3. We found significant higher AHI scores in the group of patients on NSW and OSAHS, in comparison with the patients with OSAHS only and the control group. Mean and minimum oxygen saturation were significantly lower in patients on NSW and OSAHS, than the ones found in patients with OSAHS only and in the control group.

SQ variables are shown in Table 4. We found the lowest EES score in the group of patients on NSW and OSAHS in comparison to the patients with OSAHS only and to control group. Sleep hours a day was significantly low in the group of patients on NSW and OSAHS than in patients with OSAHS only, additionally this group of patients had also less sleep hours a day when compared to control group. Nap minutes a day showed a higher score in both group of patients than the control group.

Multivariate analysis

We found that age had a significant between subjects effect in Total sleep time ($F = 4.08$, $p = 0.04$). On the other hand we found that BMI had significant between subjects effects in Total sleep time ($F = 3.27$, $p = 0.04$), Sleep latency ($F = 5.47$, $p = 0.006$), Electroencephalographic activations ($F = 8.38$, $p < 0.001$), AHI ($F = 22.00$, $p < 0.001$), mean oxygen saturation ($F = 4.89$, $p = 0.009$), and minimum oxygen saturation ($F = 3.91$, $p = 0.02$).

DISCUSSION

Our main finding of this study was that SA is worst disrupted in police officers on NSW and OSAHS than in patients with OSAHS only and control subjects. Our three groups design allowed us to measure how the additive effect of NSW and OSAHS results in more SA and SQ alterations. Alterations were influenced mainly by BMI.

Night shift workers experienced several troubles such as a circadian disruption, increased frequency of sleep disorders, and social and family issues [3]. Searching for better work conditions, the Work International Organization and the Work and Social Affairs Ministry of Spain have recommended many actions for improve QoL of night workers. These included mandatory night nap into the work horary, reduced work horary, and flexible work horary[17,18]. These measures should be used in a preventive setting in order to reduce the expected health risks, opposed to rehabilitative actions. Medical surveillance and a counselling service are recommended before and during engagement in shift and night work. Sleep, digestive, metabolic and cardiovascular diseases should be noted and followed up. Medical counselling is especially necessary in the first months of shift and night work exposure and after long-term follow-up. The postulate time of surveillance and intervention is matter for research[19], such as the one reported here. Importance of the health measures is underlined by direct interest of the relevant literature[20]. Recommendations that should be applied in many countries and enterprises are in accordance with the Night Work Convention of 1990 above quoted, and include: appropriate occupational health services provided for night and shift workers, including counselling; first aid facilities during all shift hours; the option of transfer to day work when certified unfit for night work for reasons of health; and measures for women with night shifts, in particular special maternity protection[21].

Table 3. Cardio-respiratory variables comparison in the three studied groups.

Variable	Group	Mean ± Standard deviations	P	THD
Apnea/hypopnea index	NSW-OSAHS OSAHS C	79.11 ± 5.19 59.55 ± 6.55 1.32 ± 0.22	<0.001	n/o > o > c
Mean oxygen saturation	NSW-OSAHS OSAHS C	85.17 ± 1.52 89.33 ± 0.43 93.79 ± 0.36	0.001	n/o < o < c
Minimum oxygen saturation	NSW-OSAHS OSAHS C	71.48 ± 2.12 80.13 ± 1.46 87.05 ± 2.54	0.009	n/o < o < c

NSW = Night shift work. OSAHS = Obstructive sleep apnea/hypopnea syndrome. C = controls. p = probability. THD Tukey honest differences test. n/o = Night shift work/OSAHS group. o = OSAHS group. c = control group.

Table 4. Sleep quality (SQ) variables in the three studied groups.

Variable	Group	Mean ± Standard deviation	p	THD
Epworth sleepiness scale score	NSW-OSAHS OSAHS C	11.24 ± 0.76 10.18 ± 0.41 5.27 ± 0.63	<0.001	n/o > o > c
Sleep hours a day	NSW-OSAHS OSAHS C	4.31 ± 0.15 6.87 ± 0.15 6.28 ± 0.25	<0.001	n/o < o > c
Nap minutes	NSW-OSAHS OSAHS C	55.45 ± 5.93 52.73 ± 15.77 34.21 ± 4.44	<0.001	n/o-o > c

NSW = Night shift work. OSAHS = Obstructive sleep apnea/hypopnea syndrome. C = controls. p = probability. THD Tukey honest differences test. n/o = Night shift work/OSAHS group. o = OSAHS group. c = control group.

On the other hand, police officers live with and face stress conditions on a daily basis during work hours which may impact negatively in their sleep patterns and overall health[22], such as incidence of injuries, and frequency of metabolic syndrome[23,24]. Furthermore, if these police officers had also OSAHS, these alterations would have significant adverse effects in their health, SQ and QoL[7]. Unfortunately, in many countries is not uncommon to find police officers who are in overweight or obese, conditions that are well known related to OSAHS [25]. Data from this research and results from many other investigations, suggested that police officer must had: i) shorter work time and more time for leisure for a better mental health and SQ, ii) more rest time and time for sleep in mandatory fashion into their work time for a better cognitive performance and to make more adequate choices in their particular work; iii) exercise in their work time to prevent chronic degenerative diseases and obesity and promote a good health. Our results suggested to include an emphasis in health promotion, and work life to their working schedules and shifts in order to incorporate time and self-care education[26].

Sleep disorders are more common than we think in police officers, and are largely unrecognized because they believe that excessive sleepiness is part of their daily life and work[27]. Sleep disorders prevalence investigations found that 40.4% of police officers reported symptoms of at least one sleep disorder, the majority had not been previously diagnosed or are not currently receiving treatment; OSAHS was found to be the most frequent disorder, with one-third of officers testing positive to at least one disorder[10,11]. Given that being overweight and being obese are the major known risk factors for OSAHS, the high prevalence of weight disorders among police officers is expected to be a great deal of concern[25].

Sleep restriction could be a factor that worsens the effects of respiratory sleep disorders due to over exposure to intermittent hypoxia. The effects of sleep restriction through NSW and OSAHS require a particular interest in future research. For example, Klawe et al.[10], found no differences in cardio-respiratory PSG parameters in police officers with NSW. In our study, SA was the variable more highly altered among the group of police officers with NSW and OSAHS and patients with OSAHS only, than control subjects was the number of EEG activations. Difference in results between studies can be explained by difference in methodology and due to the fact that the other authors focused only in cardiorespiratory variables, in addition our study also searched for cortical EEG alterations. SA alteration revealed by awakenings, rose in our sample and it is thought to be related to brainstem nuclei activation and autonomic heart control during sleep modulation, and thalamic-cortical activation as was observed in the EEG of this study[28].

Cardio-respiratory variables showed the lowest scores in both group of patients, mainly in police officers on NSW and SAOHS. Intermittent episodes of hypoxia, resulted in a higher AHI, lower mean and minimum oxygen saturation. This observation is in agreement with other studies[11]. Recently, Reyes-Trigeros et al., showed the correlation between low oxygen saturation and scores of the Epworth sleepiness scale in patients with OSAHS[29], such as we observed in our study.

Today many people and police officers in several countries had overweight and obesity[25]. Both conditions are well known risk factors for OSAHS, arterial hypertension, diabetes, brain and myocardial infarctions, and other diseases. For this reason it is necessary to incorporate an integral treatment approach for obesity and its complications among different groups of workers. Our results and data from other authors suggest that police officers on NSW and OSAHS are at higher risk for cardiovascular diseases[30], metabolic alterations[31], and cognitive impairment[32], than other groups.

Our research had some limitations. This study had a cross-sectional design, further studies should evaluate a prospective follow-up that may weight each variable and its final outcome. The size of the sample was short, following studies should include a larger sample. Although, there is some BMI bias in controls, the groups are representative, and thus our results are significant. We did not study the effects of integral treatment for overweight and obesity in police officers, or the use of Continuous positive airway pressure (CPAP) treatment for OSAHS; these ideas could be address in future research with multivariate statistically analysis.

CONCLUSION

SA and SQ was more disrupted in patients on NSW and OSAHS police officers than in patients with OSAHS only and control group as an additive effect of both alterations. BMI mainly, and age had some partaking in these alterations and should attract more attention in future research.

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