ORIGINAL ARTICLE

The influence of Ramadan fasting and Equivalent Noise Exposure on Salivary Cortisol levels

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ABSTRACT

Background: One of non-auditory effects of noise exposure is fluctuation of body hormones' secretion. Also, disturbing the normal nutrition schedule can cause similar outcomes.
Aim: To investigate the combined effects of noise exposure and fasting in Ramadan month on salivary cortisol levels in nurses.
Methods: 75 nurses (39 male and 36 female nurses were exposed to noise in two hospitals) enrolled in the study. The equivalent noise level was measured in workstations and salivary cortisol was measured at the beginning (6 am) and also at the end of work shift (4 pm) before and during Ramadan month. The amount of change in the average of the values of groups were compared with each other. The paired sample t-test and liner regression were performed for statistical analysis.
Results: The equivalent noise exposure levels were below 76.5 dB-A in both hospitals. The mean salivary cortisol levels in morning and evening samples in normal feeding with noise exposure showed a significant difference between groups. But in fasting (Ramadan) and noise exposure a significant difference was not observed.
Conclusion: This study showed that exposure to low and moderate levels of noise (≤76 dB) when combined with fasting can cause more stress in the body. It has a major effect on salivary cortisol levels. According to the results noise exposure in Ramadan month (fasting period) should be seriously controlled and reduced to safe levels in order to insure controlling cumulative side effects of noise and hunger on workers' bodies.
Keywords: Fasting, Noise, Ramadan, Salivary cortisol

INTRODUCTION

Noise is the unwanted sound that has been identified as the most common source of environmental stress[1]. According to the World Health Organization, noise is considered as the third most dangerous contamination of environment[2]. Noise can cause various hearing and non-hearing effects on human health. Occupational exposure to high levels of noise can cause adverse effects including high blood pressure, decreased work performance, sleep problems, restlessness, stress, and ultimately hearing loss[3-7]. Hospitals are important service centers whose nature of activity and services provided, patients' needs, and staffing needs require a calm and quiet environment. Noise pollution in hospitals can adversely affect patients and their staff[8]. The internal resources of noise in the hospitals include mechanical equipment, ventilation systems, patient conversations, and clients who require medical care and services. Urban traffic has also been cited as the most important external source of noise in hospitals[8,9]. Adverse effects of noise on patient and client service as well as performance of medical care staff (including nurses, physicians, nursing assistants) are quite high[9,10]. According to the World Health Organization guidelines, daily noise levels in hospital settings should be set to 35-40 dB and 30-40 dB-A at night[11]. Cortisol is also considered as a stress hormone[12]. Some studies have reported that there is no association between exposure to noise and cortisol changes in the affected individuals[13,14], while other studies have shown a significant association between noise exposure and cortisol changes[15-18]. Specifically, disorders of the nutritional process indicate adverse effects on the body's metabolic process[19–21]. These conditions act as stressors and affect the secretion of the body's stressors, including corticotrophin-releasing hormone, catecholamines, norepinephrine and epinephrine and cortisol, through which the destructive effects are exerted on the body[22]. On the other hand, hunger increases the level of cortisol in the body[19]. As fasting during Ramadan is essential in Muslim societies, a wide range of the population in these countries is also exposed to noise levels (low, medium and high). Therefore, this study aimed to investigate the combined effects of noise exposure and starvation on salivary cortisol levels in hospital staff.

MATERIALS AND METHODS

The present study was a descriptive-analytical one, in Ahvaz city of Iran, between May and June of 2018, in which 75 nurses from two hospitals voluntarily cooperated. Exclusion criteria included hearing impairment, headache, head surgery, psychiatric shock (in the last 6 months), cardiovascular disease, metabolic disorders, diabetes, and job experience less than one year in the hospital. Inclusion criteria included voluntary fasting during the study period (coinciding with Ramadan). The purpose of the study was also explained to the participants and they were free to refrain from collaborating with the study at any time.
Noise monitoring: The CEL-231 sound level meter (made in UK) and its calibrator (CEL-110/2) were used to measure and monitor the noise. In this study, a preliminary visit to different parts of selected hospitals was carried out to determine the sources of noise and stationary method was used to measure workplace noise. Environmental noise in

hospitals had a continuous diffusion pattern. The following equation was used to evaluate staff exposure to noise[23].

$$Leq = 10 \log10\ 1/T^{*}\Sigma t_i{*}10\ LP_i/10$$

Where, T: total time of exposure to noise; LP_i: the noise level of any ith sample; ti: time duration of ith sample, expressed as fraction of total sample time.

Saliva sample Collection: Salivary samples were collected on two occasions: 1- exposure to ambient noise and normal feeding and one week before the start of Ramadan month (May) 2- Exposure to ambient noise and fasting, which these samples were collected in the third week of Ramadan month (June). Participants were asked to place 2 ml of their saliva sample into the 5 ml vial that give them, after waking up between 6 am and 7 am (beginning of shift) and 4 pm (end of working time). Also, in the morning brushing, eating, drinking and/or smoking was forbidden before taking the saliva sample. A total of 4 saliva samples (2 salivary samples at normal feeding time and 2 samples in fasting time) were obtained from each participant. The collected samples were then transferred to the laboratory and stored at -18 °C until analysis. Cobas-e radioimmunoassay kit with electro-chemiluminescence ECL method was used to determine cortisol in salivary samples.

Statistical analysis: Descriptive statistics, Kolmogorov-Smirnov test (to determine data normality), t-test and regression analysis were used for data analysis. Significance level was set at 0.05.

Ethical considerations: This study is based on a research project approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (Research Ethics code: IR.AJUMS.REC.1394.100).

RESULTS

In this study 75 staff from 2 hospitals participated. Table 1 presents demographic information. According to the Kolmogorov-Smirnov test, the data had normal distribution. There was no significant difference between males and females by comparing mean age and job experience. There was also no statistical difference between noise exposure levels between the two hospitals. But the noise level in both hospitals exceeds the recommended standard level for hospital environments. Table 2 presents salivary cortisol levels in morning and evening samples in normal feeding with equivalent noise exposure levels below 76.5 dB-A in two hospitals. Comparison of mean salivary cortisol levels between morning and evening showed significant difference between groups ($p < 0.05$). However, the mean salivary cortisol of participants showed no statistical difference ($p = 0.0571$). Table 3 presents salivary cortisol levels during fasting (Ramadan) in the morning and evening with noise exposure levels below 76.5 dB-A in two hospitals. Comparison of mean salivary cortisol levels between morning and evening samples showed no significant difference. Also, the mean salivary cortisol of participants showed no statistical difference ($p = 0.198$). Table 4 shows the linear regression of the relationship between normal feeding status and fasting during work day and noise exposure. There was a significant relationship between fasting status and exposure to ambient noise ($p < 0.01$). Also, no significant difference was observed between mean salivary cortisol concentrations in the working day with normal feeding and in the working day with fasting. However, the comparison between mean salivary cortisol concentrations in the working day with normal feeding and the working day with fasting a significant difference was observed ($p < 0.037$).

Table 1: Demographic information of participants'

Station		Age (year) mean±SD	Job experience (year) mean±SD	Noise levels dB-A		
				Min	Max	Leq-8h
Hospital 1	Male (n=20)	36.3±8.8	9.5±5	55.3	78.4	76.5
	Female (n=18)	35.5±7.6	9.3±5.8			
Hospital 2	Male (n=19)	37.2±9.1	10±6.2	54.7	78.3	75.9
	Female (n=18)	37.7±6.2	8.2±6.1			

Table 2: comparison between salivary cortisol levels with noise exposure and feeding (before Ramadan) in work day

Station		Salivary cortisol levels in normal feeding (µg/dL)				P*
		morning		evening		
		mean	95%CI	mean	95%CI	
Hospital 1	Male (n=20)	1.41	0.12-2.02	0.86	0.11-1.00	0.03
	Female (n=18)	1.54	0.32-2.31	0.94	0.1-1.02	0.034
Hospital 2	Male (n=19)	1.16	0.81-2.43	0.75	0.11-0.91	0.02
	Female (n=18)	1.54	0.32-2.31	0.83	0.1-0.98	0.04
P**		>0.05		>0.05		

*P-value: dependent t-test, compared between each group ** P-value: independent t-test, compared between groups

Table 3: comparison between salivary cortisol levels with noise exposure and fasting (Ramadan) in work day

station		Salivary cortisol levels in fasting (µg/dL)				P*
		morning		evening		
		mean	95%CI	mean	95%CI	
Hospital 1	Male (n=20)	1.61	0.52-2.62	1.28	0.43-1.09	0.101
	Female (n=18)	1.78	0.62-2.91	1.04	0.35-1.42	0.093
Hospital 2	Male (n=19)	1.55	0.83-2.46	1.11	0.71-1.77	0.124
	Female (n=18)	1.64	0.44-2.53	1.53	0.88-2.18	0.32
P**		>0.05		>0.05		

*P-value: dependent t-test, compared between each group ** P-value: independent t-test, compared between groups

Table 4: liner regression relationship between normal feeding (before Ramadan) and fasting (Ramadan) in evening salivary cortisol with noise exposure in work days

Nutrition condition	Evening salivary cortisol concentration		
	n	Coefficient (95%CI)	P
Feeding	75	0.81(-0.1-1.13)	0.095
Fasting	75	1.32(0.29-2.32)	0.014

DISCUSSION

According to the results, salivary cortisol levels in the morning and evening samples of work day in normal nutritional status (before Ramadan) and noise exposure were significantly different inside all groups. This discrepancy between morning and evening cortisol levels has also been reported in other studies[16,17,18,24,25]. In a study by Yaghoubi et al., the effect of industrial noise on blood pressure and salivary cortisol in car assembly workers was investigated. According to their results, the group who was exposed to moderate noise levels showed no impairment disruption in cortisol secretion. Whereas in groups exposed to high levels of noise, a significant increase in cortisol levels was observed[26]. Also, Darwish et al., studied psychosomatic responses to moderate levels of industrial noise. Their results showed a greater increase in mean cortisol levels during exposure to noise levels of 60-70 than to noise levels of 70-80 dB[27]. In other studies, examining the effect of noise exposure on cortisol, the results showed that exposure to low levels of noise did not affect cortisol level changes[24,28]. On the other hand, the results of the present study showed that the levels of saliva cortisol in morning and evening work shift in fasting (Ramadan) and noise exposure were not significantly different. This indicates that the salivary cortisol secretion is disrupted and the salivary cortisol level did not change significantly at the end of the shift compared to the beginning of the morning shift. In other words, the secretory pattern of cortisol in the circadian cycle is impaired during Ramadan fasting and noise exposure. In other words, the cortisol level in the evening shows an increasing trend compared to when people were not fasting and exposed to noise. Changes in normal cortisol rhythm have been reported in patients with chronic stress[29,30], chronic anxiety disorder[31,32], metabolic disorder[33], and nocturnal shifts[34,35]. According to the results of in the present study, however, these confounding factors were controlled by the participation of healthy individuals. Therefore, this change in the secretory process of cortisol can be attributed to a combination of the two factors of fasting and exposure to noise. In a study by Bahijri et al., on 23 healthy volunteers before and during Ramadan, it was found that cortisol levels significantly decreased in the morning fasting compared to normal nutrition [19]. While there was no difference in the present study, this may be related to exposure to noise in the present study. Exposure to noise at levels below 77 dB also affected the relative increase in cortisol levels. The results showed that the mean level of salivary cortisol in the working day (fasting and noise exposure) was higher than that of normal feeding (noise and exposure to noise) and this difference was statistically significant. Other studies have also shown increased levels of cortisol in the evening during fasting[36,37].

CONCLUSION

According to the results of this study, it was found that exposure to moderate levels of airborne noise can cause stress in individuals, but its level is not sufficient to make a significant difference in salivary cortisol concentration. Exposure to the same levels of noise (76 dB) when combined with another stressor (such as fasting) can cause more stress in the body. It has a significant effect on salivary cortisol secretory levels.

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