

THE STUDY OF NOISE AND VIBRATION EFFECTS ON WORKERS IN KERMAN MOTOR FACTORY

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ABSTRACT:

Introduction: Sleep restores the human's body. Some factors such as stress, noise and vibration can lead to sleep disorder and hormone imbalance. The purpose of this paper is to study the effect of exposure simultaneously to noise and vibration on sleep disorders of workers in Kerman Motor manufacturing industry.

Materials and methods: Analytical descriptive research was done on 200 workers by simple random sampling. The control group has been demographically matched up with the sample group. The standards for samples of this research were workers who are nonsmokers; nonusers of caffeine, soporific or tranquilizer; and do not have special diseases. Sampling was done by sound level meter, oscillator, demographical and sleep disorder information questionnaire.

Results: The exposure to noise and vibration is more than permitted amount. The control group and sample group, are all healthy people with no records of disease or tranquilizer medicine consumption.

Conclusions: The results have shown that the exposure to noise and vibration, affects the quality of workers' sleep. Therefore, solutions to decrease noise and vibration in factory should be considered.

INTRODUCTION

Sleep is one of the most important sources of building body cells; so any factor which causes sleep disorder, will expose human body to serious health problems in the long term [1]. Sleep disorder may be in form of having trouble in falling to sleep, in sleep continuity or both [2]. Improper sleep pattern might reduce efficiency and leads to absence of work or causes some accidents [3, 4].

Researchers have shown that the most common complaint about sleep is related to disorder in beginning and continuity of sleep [5, 6]. There are some factors that lead to sleep disorders such as chronic pains, headache, diabetes and cardiovascular diseases [7, 8]. Noise also is one of the factors that can cause sleep disorder. Peripheral Noise is a dangerous factor annoying people; therefore it can affect their quality of sleep [9].

There are objective and subjective evidences for the effect of noise on sleep disorder [10]. Reducing peripheral noises can cause the increase of rapid eye movement (REM) phase of sleep [11]. In a research on workers, the rate of their sleepiness in working hours has been measured 47 % [12]. One of the reasons can be disorder in quantity and quality of sleep. It also has been reported that 30 percent of people encountering noise in their workplace has undesirable quality of sleep [13]. Exposure to noise and vibration has destructive effects on people's cognitive function and mood. When 100 - 105 dB noise combines with vibration, it can increase the effects of each motivation even more [14]. According to International Organization for Standardization (ISO), noise is an acoustic phenomenon which is perceived unpleasant. The effects of noise are categorized in two group: auditory and non - auditory. Reported non - auditory effects of noise include increased stress, decrease cardiovascular function (hypertension, changes to blood pressure and / or heart rate), annoyance, and mental health, oral communications, sleeping problems which leads to neurological and physiological changes and results to depression and blood pressure [15, 16]. Nowadays with technological advancements, speed and power of machines have been increased which result in vibration [17]. The vibrations which human is facing, are more through equipment with electric or combustion engine [18]. Generally, vibration is categorized in: hand - arm and whole - body vibration. ISO has elaborated ISO2631 / 1997 standard for this vibration [19]. Some of vibration side effects are neurological disorders, digestive complications, mental fatigue, longer reaction time, negative effects on females' reproductive system, psychological problems and sleep disorder [20, 21]. On the other hand, noise and vibration are both mechanical waves and are interchangeably convertible. Sound wave diffu-

sion in the vicinity of the objects can cause vibration and in the same way vibrant object also can make noise. So they can exacerbate each other's effects [22]. One of the consequences of noise and vibration is sleep disorder which affects efficiency, comfort and security of workers [23]. According to a research in 2003, noise reduces sleep quality. Sleep is one the fundamental cycle of human's body which takes 1/3 of his life and during that time brain function is restored [24, 25]. Low quality sleep is a symptom of chronic sleeplessness. Sleeplessness in women is two times more compared to men [26]. Sleep disorder is classified in two categories: Severe and chronic. About 15 - 42 percent of world population suffers from sleep disorder [25]. Noise and vibration are two risky factors causing annoyance in individuals and in this way they can cause sleep disorder. A research has measured the sleepiness of workers subjected to noise, up to 47 % [27, 28].

Considering that the effect of exposure to noise and vibration simultaneously has been studied in previous researches, and the fact that there is a lot of workers in car manufacturing industry, this study focuses on noise and vibration effects on workers of Kerman motor factory.

MATERIALS AND METHODS

The proposed study has been done on Spring, 2017, and 200 workers of Kerman motor factory in Bam, Kerman were sampled. According to Cochran formula, we randomly chosed 100 workers as the sample group working in three different sections of factory: body making, coloring and decorating; which were exposed to noise and vibration. The other 100 workers were chosen as the control group and were sent to a place with noise exposure less than allowed amount (50 - 69 dB), no vibration, with the error level of 5 %. It is worth mentioning that the control

group and sample group were adjusted in terms of age, work experience, education, income level, marital status. The sample selection was simple random sampling and the standards of entrance to this research were workers who are nonsmokers, nonusers of caffeine, soporific, tranquilizer and liver and blood lipids medicine and do not have special diseases. The standard of quitting this research, was fatigue and non-cooperation in filling out the questionnaires. The equipment used to collect data included sound level meter (KIMO model, made in France), oscillator (Castle, made in England), demographical and sleep disorder information questionnaire. Noise was measured using sound level meter and without interrupting his work. Vibration also was measured by connecting the oscillator to each worker's hand. So the four parameters of acceleration, speed, movement and g (the acceleration due to gravity) were recorded while working with oscillating tools like LTV, LMS, and TWAIS. Then the questionnaires were filled out by workers. They included name, family, age, height, weight, marital status, job experience, number of working hour, worker's section, main / secondary job. The questionnaire of sleep disorder included 17 yes / no questions which were to evaluate sleep disorder in 3 parts: problems in beginning of sleep (5 questions), continuity of sleep (7 questions), waking of sleep

(5 questions). This questionnaire has been provided for Iranian society by Mohammadi et al. (quoted from Linch) in 2009. Its content validity is based on WAHZ and Boussel and equals 35 %. The test retest reliability also is $r = 0.86$. Data analysis was performed by Spss24 and with the help of Mann Whitney statistical tests such as T test and k2 and Spearman kolmogorov - smirnov.

RESULTS AND DISCUSSION

According to the obtained results, the average of age and job experience in both sample and control group is $23/30 \pm 57/6$, $1/5 \pm 64/4$ and $23/29 \pm 28/4$, $98/4 \pm 01/2$, respectively. The demographic characteristics of two groups were adjusted. Thus there are no significant differences. Other descriptive information about studied cases is shown in Table 1.

Noise and vibration of hand - arm in sample group were compared. The most and the least noise was for coloring section and decorating section ($43/94 \pm 4/7$ and $8/100 \pm 4/4$), respectively and the most and the least vibration was for decorating section and coloring section ($97/6 \pm 46/8$ and $28/4 \pm 3/4$), respectively. The results of noise and vibration encounter in different sections in sample group and noise and vibration encounter in both case and control group is represented in Tables 2 and 3.

Table 1. Demographic characteristics of exposure and control groups

Property		Exposed group	Control group	P _{value}
Age (year)		30.32 ± 6.57	29.23 ± 4.28	0.2
Job history (year)		5.1 ± 4.64	4.98 ± 4.28	0.43
Earnings (Rial)		12,600,000	13,500,000	0.9
Education*	Diploma	98	98	0.6
	Associate Degree	2	2	
Marital status**	Single	18	18	0.54
	married	82	83	

*average \pm standard deviation

**frequency

Table 2. Quality of exposure to noise and vibration in different manufactures halls (exposed group)

Manufacture's halls	Workers number	Exposure to noise (dB)	Exposure with vibration			
			Acceleration (m / s ²)	g (m / s ²)	Velocity (m / s)	Displacement (m)
Chassis manufacture	39	95.5 ± 6.7	4.5 ± 3.9	0.32 ± 0.28	2.5 ± 1.5	1.1 ± 0.49
Painting	5	100.8 ± 4.4	4.3 ± 4.3	0.44 ± 0.37	3.9 ± 1.9	1.2 ± 0.54
decoration	56	94.4 ± 7.4	6.9 ± 8.5	0.71 ± 0.74	4.2 ± 4.1	0.97 ± 0.38

Table 3. Exposure to noise and vibration in exposed group and control group

Exposure		Exposed group	Control group	P _{value}
Noise		95.2 ± 7.2	55.1 ± 3.4	0.0001
Vibration	Acceleration(m/s ²)	5.9 ± 7.0	-	
	G (m / s ²)	0.5 ± 0.61	-	
	Velocity (m / s)	3.5 ± 3.3	-	
	Displacement (m)	1.02 ± 0.34	-	

Table 4. Mean and standard deviation of sleep disorder score in exposed and control group

	Sleep disorder score	Sleep continuity disorder score	Disorder in wake up score
Exposed group	3.2 ± 2.1	5.8 ± 3.3	3.2 ± 2.9
Control group	2.8 ± 1.9	4.2 ± 3.2	2 ± 2.3
P _{value}	0.076	0.0001	0.004

Table 5. Correlation between sleep disorder, noise and vibration exposure in exposed group

Sleep disorder	Exposure to noise	Exposure to vibration			
		Acceleration (m / s ²)	G (m / s ²)	Velocity (m / s)	Displacement (m)
Disorder in sleep beginning	0.006	0.9	0.77	0.5	0.23
Disorder in sleep Continuity	0.171	0.43	0.9	0.42	0.7
Disorder in wake up	0.490	0.97	0.18	0.15	0.52

The study of results using statistical T test shows that there is a significant difference in noise and vibration encounter in sample and control group ($P_{\text{value}} < 0.0001$). So that the average for sample group is 95.17 and for control group is 45.54.

As shown in Table 4, there is a significant difference related to disruption of sleep ($P_{\text{value}} < 0.0001$) and problems in waking from sleep ($P_{\text{value}} = 0.004$). The average measurements in all three types of disorder, were bigger in sample group

compared to control group. The correlation between sleep disorder and noise and vibration parameters in sample group is represented in Table 5. The sample group was selected from people exposed simultaneously to noise and vibration. According to Table 5, the only correlation was related to the part of problems in beginning of sleep; thus the simultaneous effects of noise and vibration was disorder in beginning of sleep in sample group as can be seen in Table 6.

Table 6. Correlation between noise and vibration synchronic effect on disorder in sleep beginning in exposed group

	Noise and acceleration effect	Noise and g effect	Noise and Velocity effect	Noise and displacement effect
Disorder in sleep beginning	0.039	0.07	0.012	0.008

Various studies have been done on the effects of noise in sleep and there is a lot of evidences of destructive effects of noise on physical and cognitive activities of human. Today, it has been accepted that traffic noise has effect on sleep disorder. On the other hand according to a research, a 45 dB noise and higher than that, can postpone the time of falling to sleep for about 20 min [13]. In a study on workers exposed to noise higher than 75 dB for 8 h / day, compared to unexposed workers, it has been shown the noise effects on sleep structure in form of less efficiency [6]. According to a research in Manjil wind powerhouse, sleep disorder in different occupational group has significant differences. So that, administrative staff have the least sleep disorder, and repairmen have the most, so that this can be caused by noise exposure.

CONCLUSIONS

The presented study is compatible with all the mentioned researches. According to findings and comparing them to job standards, the noise and vibration are above the allowed measure. There has been a significant difference in sleep continuity and waking up from sleep, for the sample group exposed to noise and vibration and the control unexposed group. The average number for the former group was higher in three types of disorder (problems in beginning of sleep, continuity of sleep and waking from sleep). Regarding to the fact that samples in both sample and control group were adjusted in all demographical and health aspects, it can be concluded that exposure

to noise and vibration simultaneously, can affect the quality of sleep. As the sample group was selected from the workers exposed to noise and vibration simultaneously, without control group consideration, out of three types of sleep disorder, the correlation only happened for the problems in the beginning of sleep. Therefore, to evaluate the effects of two variables, noise and vibration variables were combined. Eventually, it has been proven that the effect of noise and vibration acceleration, effect of noise and vibration speed and the effect of noise and vibration movement, affect beginning of sleep in workers. Therefore, it is recommended to find a solution to reduce the noise and vibration in factory with high priority.

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COMPETING INTERESTS

The authors declared no conflicts of interest with respect to the authorship and / or publication of this article

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ETHICAL CONSIDERATIONS

All of the ethical issues have been completely observed by the authors.

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