



Blood Pressure of Jordanian Workers Chronically Exposed to Noise in Industrial Plants

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Abstract

Background: Occupational studies investigating the association between blood pressure and noise exposure are almost lacking in the Eastern Mediterranean Region countries.

Objective: To determine the association between occupational exposure to high level of noise and blood pressure among a group of workers in Jordan.

Methods: All workers who had been exposing to noise for at least 3 years in 3 plants in Madaba governorate in Jordan were included in this cross-sectional study. A structured questionnaire was used to collect data. The occupational noise level was measured with a portable calibrated sound meter.

Results: We studied 191 male workers, of whom 145 (75.9%) were exposed to a noise level higher than the permissible limit of 85 dBA. The mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) and the prevalence of hypertension were significantly higher among those exposed to higher noise level. In multivariate analysis, workers exposed to high level of noise had a significantly higher odds of hypertension compared to those exposed to noise level lower than the permissible limit (OR 4.7, 95% CI 1.6 to 13.8). The odds of hypertension increased by 17% (95% CI 10% to 30%) for each dB increase in noise intensity.

Conclusion: Exposure to high level of noise is associated with elevated blood pressure.

Keywords: Hearing loss, noise-induced; Occupational exposure; Hypertension; Manufacturing and industrial facilities; Jordan

Introduction

Affecting the auditory system, noise is a common hazard that may cause hearing loss after both short and long exposure.¹ Exposure to noise might lead to psychosocial, physiological, and biochemical changes in the body.²⁻⁴ One of the physiological responses to noise is the circulatory response including vasoconstriction of the peripheral blood vessels and elevated blood pressure.⁵

Chronic noise exposure has been shown to be associated with cardiovascular diseases, including ischemic heart disease and high blood pressure.⁶⁻¹⁵ However, the findings of the previous studies were contradictory and inconsistent.⁶⁻¹⁷ The variance observed in the findings of previous studies may be attributed to the use of different study designs, differences in exposure measurements and the use of different cutoff values to define noise exposure; difference in the adjustment for

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Received: Jul 31, 2017
Accepted: Sep 12, 2017

Cite this article as: Nserat S, Al-Musa A, Khader YS, et al. Blood pressure of Jordanian workers chronically exposed to noise in industrial plants. *Int J Occup Environ Med* 2017;8:217-223. doi: 10.15171/ijoem.2017.1134

For more information on risk factors of hypertension among bank employees see <http://www.theijoem.com/ijoem/index.php/ijoem/article/view/344>



possible confounding factors in the multivariate analysis would be another cause. A recent meta-analysis¹⁶ showed a significant, though small, association between exposure to either traffic or occupational noise and high blood pressure. Moreover, a review study¹⁷ demonstrated increased risk of hypertension and increased systolic blood pressure (SBP) and diastolic blood pressure (DBP) in workers who were exposed to noise levels higher than 85 dBA. However, both reviews^{16,17} revealed limited epidemiological evidence.

Occupational studies investigating the association between blood pressure and noise exposure are almost lacking in the Eastern Mediterranean Region countries. We conducted this study to determine the association between occupational exposure to high level of noise and blood pressure among a group of workers in Jordan.

Materials and Methods

A cross-sectional study was conducted in three industrial plants in Madaba governorate in Jordan. There were nine industrial plants in Madaba. They were divided into three groups based on their number of workers—two large plants with >100 workers, three medium plants with 50–100 workers, and four small plants with <50 workers. One plant from each group was randomly selected. The first one was a bottling plant with 138 workers. It con-

sists of different sections including plastic line section, syrup treatment section, can bottled line section, glass bottled line, warehouse section, lab section, and maintenance section. The second plant was a chemical plant with 98 workers. It consists of a mixing and compressor section, isolation material line (PVC) section, warehouse section, maintenance section, and lab section. The third plant was a steel work plant with iron scissor section, iron drill section, and blacksmith section.

Studied plants were visited between January and April 2017 after obtaining the official approvals. The total number of all workers from three studied plants was 274. Exposure to high level of noise was defined as exposure to a noise level higher than the permissible limit of 85 dB for at least three years. Those workers who had been exposing to noise at least three years in these plants were invited to participate in the current study. Those who were diagnosed with hypertension before starting work at the studied plants, as confirmed by their records in the plants, were excluded from the study.

Eighty-three workers were excluded from the study (63 had work experience less than three years and 20 were diagnosed with hypertension before starting their job) leaving a total of 191 workers to be included in the study.

All workers had fixed daytime shift (8:00 to 16:00) and were working six days a week with 30 minutes break a day.

Ethical approval was obtained from the Ethics Committee, Jordan Ministry of Health. A consent form was obtained from all workers. A structured questionnaire was used to collect data on socio-demographic characteristics of studied workers, family history of hypertension, tobacco use, years exposed to noise, and use of protection equipment. Data were collected using face-to-face interview. One researcher collected the data between January and March 2017.

TAKE-HOME MESSAGE

- About one quarter of Jordanian industrial workers were exposed to a noise level lower than the permissible limit of ≤85 dBA.
- The prevalence of hypertension among workers who were exposed to a noise level higher than the permissible limit was significantly higher than that among workers who were exposed to lower noise levels.

The noise level was measured with a portable calibrated sound meter (Casella sound level meter CEL-450A series instrument, UK) by a well-trained technician from the Occupational Health Directorate of Jordan. The intensity of noise emitted by machines and other instruments was recorded near the machines and at various sites in the workplace. The average noise level in dB was recorded for analyses.

Blood pressure of each participant was measured at workplace in a quiet room by a calibrated KaWe Mastermed A2 Aneroid BP Monitor. The measurement was repeated twice for all participants before the work shift. Blood pressure was measured after 10 minutes of rest while the worker sat down on a chair. Hypertension was defined according to the WHO criteria—a SBP ≥ 140 or a DBP ≥ 90 mm Hg. Mean blood pressure was calculated as $(SBP + 2 \times DBP) / 3$.

Height and Weight Measurement

Body weight and height were recorded for all participants. Weight was measured with a Tanita WB-150MA scale. Height was measured with an HR 001 Tanita Leicester Portable Height Measure. Body mass index (BMI) was then calculated. Workers who had a BMI between 25.0 and 29.9 kg/m² were considered “overweight.” Obesity was defined as a BMI ≥ 30.0 kg/m²

Statistical Analysis

Data were analyzed with IBM SPSS® ver 20. Differences between proportions were tested with χ^2 test. *Student's t* test for independent samples was used to assess the difference between the means of two groups of normally distributed variables. Logistic regression analysis was used to determine the association between noise and hypertension after adjusting for other variables. A p value < 0.05 was considered statistically significant.

Table 1: The socio-demographic characteristics of the workers

Variable	n (%)
Age (yrs)	
<30	46 (24.1)
31–40	97 (50.8)
>40	48 (25.1)
Body mass index	
Normal	89 (46.6)
Overweight	79 (41.4)
Obesity	23 (12.0)
Years of noise exposure	
<10	97 (50.8)
≥ 10	94 (49.2)
Marital status	
Not married	17 (8.9)
Married	174 (91.1)
Use of personal protective devices	
Sometimes	36 (18.8)
Always	23 (12.0)
No	132 (69.1)
Family history of hypertension	86 (45.0)
Smoking	91 (47.6)
History of work injuries	11 (5.8)

Results

Basic Characteristics

This study included 191 male workers with a mean age of 36.2 (SD 6.8, range 22 to 55) years. The mean noise exposure time in the same plant was 10.1 (SD 5.7, range 3 to 23) years. Socio-demographic and relevant characteristics of participants are shown in Table 1.

The mean noise level was 87.4 (SD 6.6,

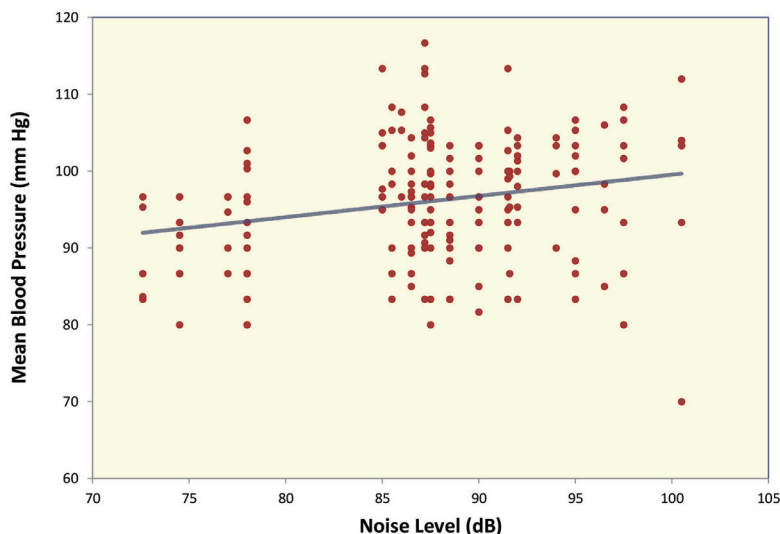


Figure 1: The correlation between noise level and mean blood pressure

range 72.6 to 100.5) dBA. Forty-six (24.1%) workers were exposed to noise levels lower than the permissible limit of 85 dBA; 145 (75.9%) were exposed to higher levels. The two groups of workers did not differ significantly in terms of their age, years of noise exposure, BMI, use of protective devices, and other studied characteristics.

Noise Level and Blood Pressure

The mean blood pressure increased with elevated noise level (Fig 1). The mean SBP was significantly ($p=0.023$) higher in the group with high noise level exposure (129 mm Hg) compared with the group with low noise exposure (124 mm Hg). Similarly, the mean DBP was significantly ($p=0.029$) higher in the exposed group compared with non-exposed group (80 vs 78 mm Hg).

The prevalence of hypertension among workers in the studied three plants was 31.9% (95% CI 25.3% to 38.6%). The prevalence of hypertension among workers exposed to noise levels higher than the permissible limit was significantly ($p<0.001$) much higher than that among workers exposed to lower noise levels (37.9% vs

13.0%) (Table 2). The prevalence was significantly higher among 36–55-year-old workers compared with 22–35-year-old married overweight workers. The prevalence of hypertension was increased significantly with increased years of noise exposure.

In multivariate analysis, hypertension was significantly associated with exposure to noise, age, and obesity (Table 3). After adjusting for other variables, workers exposed to noise higher than the permissible limit had a significantly higher odds of hypertension compared with those exposed to lower levels (OR 4.7, 95% CI 1.6 to 13.8). The odds of hypertension increased by 17% (95% CI 10% to 30%) for each dB increase in noise intensity.

Discussion

We found that about three quarters of workers were exposed to noise levels higher than the permissible limit. The mean blood pressure and the prevalence of hypertension were significantly higher among workers exposed to high noise level compared with those exposed to low levels. Multivariate analysis showed a significant association between exposure to high noise level and presence of hypertension after adjustment for potential confounders.

Previous studies showed conflicting findings in relation to the association between occupational exposure to noise and development of hypertension.⁷⁻¹⁷ The association between noise exposure and high blood pressure was demonstrated in many studies of various designs including cross-sectional and cohort studies. Moreover, the association was confirmed in various industry settings including textile workers,¹⁸ metal industry workers,¹⁹ airport workers,²⁰ automotive workers,²¹ and weaving workers.²² However, some studies did not support the association between noise ex-

posure and high blood pressure.^{9,10,23}

Some studies including few longitudinal studies demonstrated a dose-response relationship between the risk of hypertension and different noise parameters including the noise intensity, duration of noise exposure, and cumulative exposure.^{24,25} A meta-analysis²⁵ of studies published before 2008 showed a statistically significant increase of SBP and DBP among those with exposure to high level of noise compared with those exposed to lower levels. Similarly, another meta-analysis of 12 prospective studies published after 1999 showed that exposure to noise at work is associated with higher risk of hypertension.²⁶ Moreover, a review by Passchier-Vermeer¹⁷ showed increases in the means of SBP and DBP of 3.9 and 1.7 mm Hg, respectively, for workers exposed to high levels of noise compared with non-exposed workers.^{17,18} On the other hand, a meta-analysis of 43 studies published before 1999 showed that the risk of hypertension is increased a little (RR 1.14, 95% CI 1.01 to 1.29) with a 5-dBA increase in noise intensity.¹⁶ The study highlighted many limitations in exposure characterization, control for possible confounders, and the possibility of publication bias in the included studies.

The association between exposure to high level noise and risk of high blood pressure could be mediated by stress and its associated biochemical changes. Exposure to high levels of noise might cause stress. In response to stress, the secretion of a number of hormones and chemical substances such as cortisol, adrenaline and noradrenaline are enhanced. The increase in concentration of these chemicals was shown to result in peripheral vasoconstriction and increased arterial blood pressure.^{7,27} Other situations in the workplace may also increase the risk of hypertension in these places.⁵

In this study, increased age and obesity were significantly associated with hy-

Table 2: Prevalence of hypertension according to the studied characteristics. Figures are n (%).

Parameter	Normotensive	Hypertensive	p value
Noise level			
≤85 dBA	40 (87)	6 (13)	0.001
>85 dBA	90 (62.1)	55 (38)	
Age (yrs)			
<30	42 (91)	4 (9)	<0.001
31–40	66 (68)	31 (32)	
>40	22 (46)	26 (54)	
Body mass index			
Normal	64 (72)	25 (28)	0.040
Overweight	56 (71)	23 (29)	
Obesity	10 (44)	13 (57)	
Years of noise exposure			
3–5	50 (89)	6 (11)	<0.001
6–10	35 (85)	6 (15)	
11–15	29 (66)	15 (34)	
>15	17 (34)	33 (66)	
Marital status			
Not married	16 (94)	1 (6)	0.010
Married	114 (65.5)	60 (34.6)	
Family history of hypertension			
No	71 (67.6)	34 (32.4)	0.505
Yes	59 (69)	27 (31)	
Use of personal protective devices			
Sometimes	18 (50)	18 (50)	0.026
Always	15 (65)	8 (35)	
No	97 (73.5)	35 (26.5)	
Smoking			
No	66 (66)	34 (34)	0.420
Yes	65 (71)	26 (29)	

Table 3: Results of the logistic regression analysis assuming hypertension as the dependent variable

Predictors	Adjusted OR (95% CI)
Noise level	
≤85 dBA	1.0
>85 dBA	4.7 (1.6 to 13.8)
Age (yrs)	
≤30	1
31–40	2.6 (0.6 to 8.7)
>40	5.0 (1.3 to 19.4)
Body mass index	
Normal	1.0
Overweight	0.9 (0.4 to 2.0)
Obesity	4.5 (1.3 to 12.7)
Years of exposure	
<10 years	1
≥10 years	5.5 (2.3 to 13.2)

hypertension. This finding has already been demonstrated in several studies conducted on Jordan population.^{29,30}

One of the limitations of the current study was that it included only male workers. One would expect that females have higher susceptibility to noise exposure than males.^{25,31} Therefore, the findings of this study might only be valid for male workers. Other factors that should have been considered were the possibility of selection bias and lack of information on stress hormones. The fact that we assumed persons with exposure to noise levels >85 dB were exposed to same intensity in their entire service should also be considered in the interpretations of the study findings.

In conclusion, this study showed that exposure to high noise level was associated with increased blood pressure and higher prevalence of hypertension. Evidence-

based effective interventions at workplace need to be adopted to reduce the noise level in industrial plants.

Acknowledgments

Authors would like to acknowledge the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) and Jordan Field Epidemiology Training Program for their technical support.

Conflicts of Interest: None declared.

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