

# Noise exposure as a risk factor of cardiovascular diseases in workers

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## ABSTRACT

**Introduction:** Workers in different jobs are exposed to noise, which can affect hearing loss and sleep disturbance in the long term. Excessive noise exposure may lead to increased blood pressure, reduced efficiency, and increased absenteeism. **Materials and Methods:** In this case-control study, 80 workers were studied in terms of noise exposure and blood pressure. Noise exposure was measured by SEL 440 sound level meters according to ISO 1996 standard. Blood pressure of the case and control groups was measured in workplace, under standard circumstances, using ALPK2 mercury sphygmomanometer during physical examination. Data were analyzed by *t*-test and Pearson's correlation coefficient. **Results:** Mean level of noise was  $95.21 \pm 2.56$  db, which was significantly higher than permitted limit of 85 db (ACGIH 2009) ( $P < 0.01$ ). Diastolic blood pressure was normal in 28.8% and high in 50.1%, and between these in 21.1% of workers. Mean difference of systolic blood pressure in two studied groups ( $P < 0.01$ ) was meaningful. However, mean difference of diastolic blood pressure was not significant in two studied groups ( $P > 0.05$ ). There was a positive and weak relationship between noise and systolic blood pressure ( $r = 0.28$ ,  $P < 0.006$ ). **Conclusion:** Prolonged exposure to industrial noise is related with high blood pressure as a risk factor of cardiovascular diseases. Therefore, it is recommended that training programs be held for workers, preventive measures for noise exposure at workplace be taken, blood pressure of workers be attended to and special care be given to workers with a history of hypertension.

**Key words:** Cardiovascular diseases, hypertension, Isfahan industry, noise, occupational exposure, workers

## INTRODUCTION

Noise pollution has been imposed on human and has unwanted and unpleasant effects of human body and mind. Biologic

effects of noise are both auditory and nonauditory.<sup>[1]</sup> The most important effect of noise on human is hearing loss (noise induced hearing loss, NIHL), and its nonauditory effects are physical, mental and effects on performance.<sup>[2,3]</sup> Some harmful effects of noise on health have been proved and some like hypertension (HTN) and ischemic heart diseases are controversial among researchers. On the one hand, HTN is multifactorial and on the other hand, different races and societies have different levels of resistance against external factors like noise. Therefore, such a relationship has been reported controversially. Some studies have not reported a significant relationship between HTN and noise<sup>[4]</sup> while others found a significant relationship.<sup>[5,6]</sup> Therefore, noise is considered a risk factor for cardiovascular diseases (CVD).<sup>[7,8]</sup>

It seems that high levels of noise cause secretion of adrenalin, peripheral vasoconstriction and HTN as a result of increased

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stress. Furthermore, noise changes heart rate, reduces heart output, and increases respiration rate.<sup>[4,9,10]</sup>

A study on the effect of noise on HTN in textile workers exposed to noise of over 100 dBA found a significant relationship between noise and HTN because the prevalence of HTN was 1.34 times as much in the case group as in the control.<sup>[11]</sup> In another study on metal industry workers exposed to noise over 110 dBA, blood pressure before work (116 mmHg) and after work (128 mmHg) was significantly different. Mean blood pressure of workers increased with the increase in different parts of the factory, and a linear correlation was found between mean noise level and blood pressure changes in workers.<sup>[12,13]</sup> In a study on airport workers, a significant difference was found between ramp workers and office clerks. They concluded that chronic exposure to different levels of airplane noise (101 dBA on average) can be a risk factor for HTN.<sup>[14,15]</sup>

A study on workers exposed to noise showed mean diastolic blood pressure in workers exposed to noise during 8-hour day work of higher than 90 dBA was higher than that in workers exposed to noise lower than 90 dBA. Mean systolic and diastolic blood pressure during work was significantly higher than that in the control group.<sup>[16]</sup> A study on 24-hour blood pressure of automotive workers who were exposed to noise higher than 85 dBA for 16 hours on end showed that mean systolic blood pressure in the exposed workers was higher than that in workers exposed to noise lower than 59 dBA. Furthermore, the exposed workers showed 1 mmHg increase in blood pressure for 1 dBA increase in noise.<sup>[17]</sup> A study on weaving workers showed that increased intensity of noise (more than 80 dBA) increased systolic and diastolic blood pressure, and the increased blood pressure was significantly related with exposure time.<sup>[18]</sup>

A study on the effect of noise on physiologic parameters like heart rate, systolic and diastolic blood pressure showed that they increased with age and work experience. Heart rate did not change as a result of exposure to noise. Systolic blood pressure increased a little and diastolic blood pressure increased significantly at exposure to noise. Finally it was clear blood pressure can be an indicator of noise exposure while heart rate cannot.<sup>[19]</sup>

Studying the effects of noise and work shift on blood pressure of plastic workers showed that both noise and work shift impacted systolic and diastolic blood pressure but the effect of noise was more significant. Furthermore there was a correlation between noise and systolic and diastolic blood pressure.<sup>[4,17]</sup>

Several studies on the relationship between blood pressure and noise on weaving workers showed that systolic and diastolic blood pressure had a direct relationship with age and a reverse relationship with body mass index (BMI). Diastolic blood pressure was related only with sex. Moreover, after removing age, sex and BMI, there was a direct relationship between diastolic blood pressure and noise.<sup>[16,18,19]</sup>

Most of workers and employers do not take adverse effects of noise serious while noise is one of the disturbing factors for health. Cardiovascular diseases (CVD) are among the most important non-contagious diseases that cause a high mortality. Because of the effect of noise on HTN, and the importance of HTN as a risk factor for CVD, and the fact that noise can be prevented, conducting a study to complete previous studies was necessary.<sup>[20,21]</sup>

## MATERIALS AND METHODS

In this one-stage case-control study, samples were selected by convenient method. The case group was 80 workers of an industry in Isfahan, who had no history of HTN, CVD, or renal diseases. The control group was male office clerks of the same factory who did not have a history of HTN, CVD or renal diseases and were matched for age and BMI with the case group. Data were collected by physical examination, interview, and checking medical profiles of workers. In case of having a history of CVD, renal diseases or HTN, they were excluded from the study.

Workers of this industry were exposed to noises of different levels, which were measured according to ISO 1966 by SEL 440 sound level meter through channel A, and slow microphone response rate based on dBA. Permitted noise level was 85 dBA according to Iranian standard and ACGIH 2011.<sup>[21]</sup> During physical examination at work, blood pressure of the case and control groups was measured under standard circumstances during the middle hours of work shift (9-11 AM). In a general training session, workers were told not to have food, tea or coffee or smoke cigarette one hour before physical examination. Workers sat on a chair by the table to rest their right hand on for 5 minutes. After that worker's blood pressure was measured using an ALPK2 mercury sphygmomanometer twice with a 1 min interval and the mean was recorded. If systolic blood pressure was over 140 mmHg, and diastolic pressure was over 90 mmHg, they were considered hypertensive. The room temperature was normal.<sup>[24]</sup>

To analyze the data, independent *t*-test and Pearson's correlation test were used.

## RESULTS

The results of this study are results of physical examination and sound measurements. Workers' mean age was 26.6 ± 7.79 years and mean BMI was 23.39 ± 4.31. Their mean work experience was 3.58 ± 3.6 years. Mean sound level in the workshop was 95.21 dBA, which was significantly higher than permitted limit (85 dBA).<sup>[21]</sup>

Mean difference of systolic blood pressure between the case group and the control group was significant at  $P = 0.001$ . No significant difference was seen between the case and the control groups in terms of mean diastolic blood pressure. Pearson's correlation coefficient showed a direct relationship between systolic blood pressure and noise. ( $r = 0.28, P < 0.006$ ).

Mean sound level at workplace of the case group was  $95.21 \pm 2.56$  dBA.

Mean diastolic blood pressure of workers in the control and the case group was  $142.2 \pm 20.3$  and  $87.8 \pm 16.4$  mmHg. Those for systolic blood pressure were  $90.3 \pm 13.5$  and  $87.8 \pm 12.8$ , respectively.

## DISCUSSION

Measuring noise in the workshop showed that mean sound level ( $95.21 \pm 2.56$  dBA) was much higher than the international and Iranian standards (85 dBA). The High levels of noise can disturb, destroy the ability to hear, and harmful effects and may also put stress of other parts of the body, including the heart.<sup>[2,20]</sup>

Sections that produced noise higher than permitted limit (98 dBA) in the production section of the factory included scissors, liquid plastic cutter, air injection, injection unit, and unloading and demolding (Mold opening and closing). The noise in the grinding section was much higher (107 dBA) in a way that workers had to wear both ear-muffs and ear-plugs.

Regression test showed a linear relationship between systolic blood pressure (S), and noise (N):

$$S (\text{mmHg}) = 0.09 N (\text{dBA}) + 5.44.$$

According to this equation, in workplaces with noise higher than 85 dBA, an increase of 10 dBA in noise causes blood pressure to increase 9 mmHg. This relationship shows that higher levels of noise have harmful effects on blood pressure. This higher level of noise and the linear relationship can be the reason for mean difference of systolic blood pressure between the case and the control group ( $P = 0.001$ ), which is confirmed by most researches.<sup>[4-16]</sup>

Noise has a direct link with systolic blood pressure at the coefficient of 0.280 ( $P = 0.012$ ), but has no significant relationship with diastolic blood pressure because it is related to the minimum pressure at the time of cardiac rest. We did not find a significant relationship between mean diastolic blood pressure of the case and the control group, which contradicts some other researches.<sup>[4,6,8,11,12,16]</sup>

Pearson's correlation test showed that systolic blood pressure has a meaningful relationship with diastolic blood pressure ( $r = 0.67$ ,  $P = 0.006$ ). This relationship occurs naturally and cannot be considered a finding of this study.

Because the study population was young ( $26.6 \pm 7.79$  years), it is not expected they suffered from HTN, which is why we can study the correlation between age and blood pressure. Because the relationship between age and diastolic blood pressure is not meaningful, this expectation is met, but the direct relationship with systolic blood pressure ( $P = 0.04$ ) is against our expectation, and shows the effect of another

factor, which is in line with other studies.<sup>[4,12]</sup>

In order to study the effect of duration of noise exposure on blood pressure, work experience in that job was used. Correlation test showed its relationship with diastolic blood pressure at coefficient of 0.243 ( $P = 0.030$ ). Furthermore, it had a direct relationship with systolic blood pressure at the coefficient of 0.208 ( $P = 0.032$ ). This finding corresponds with other researchers' findings in this regard.<sup>[4,12,14]</sup>

The only control measure in this factory was protecting ears. Other methods are feasible but need designing. The first step is reducing noise at the source of noise, then on the way it spreads and finally for the recipient. Engineering methods like blocking the source, using noise absorbing walls, deviating sound waves and designing silent or low noise machinery are the best preventive measures, and Personal Protective Equipment (PPE) are the final solution.

If it is not possible to control noise in a short time, noise level must be measured, and in case it is higher than permitted limit, workers must be use of PPE to reduce their exposure to hazards and standards applicable to Occupational noise exposure and be informed and trained. They should use the right gears and be trained to use them correctly because if the gears are not used correctly, they will not be efficient. After implementing each controlling method, noise must be measured to control the sufficiency of the method and correct its weaknesses.<sup>[22]</sup>

This study showed that HTN is relatively common despite workers' young age. Since workers are the production force behind our economy, it is recommended that professional healthcare pay special attention to workers' health so they spend a happy life in spite of their hard work.

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