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EFFECTS OF OCCUPATIONAL NOISE EXPOSURE ON BLOOD PRESSURE AND OTHER ASPECTS OF HEALTH FOR WORKERS IN SELECTED INDUSTRIAL PLACES IN ZAKHO CITY, IRAQ

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ABSTRACT:
Industrial or Occupational noise play a vital role in life of workers. This source of pollution, disrupts and annoys the daily activities of workers. Occupational Noise pollution is increasingly being recognized as a physical factor in the environment that is injurious to many aspects of health. This study focuses on the industrial noise and its effects on workers. The aim of the study is to find out the possible relation between the occupational noise exposure and arterial blood pressure, pulse rate, and hearing thresholds for workers at several industrial areas in Zakho City, Kurdistan region of Iraq. The study group included 113 workers employed in twenty one different factories (chosen randomly). All the individuals under study were men. Their ages were between 15 to 60 years. The noise level was between (76.5-98) decibels (dB(A)). In order to observe the harmful effects of the noise, a questionnaire was made for all the workers. The systolic blood pressure mean for the samples is increased by 6.07 mmHg, while the diastolic blood pressure mean is increased by 2.63 mmHg; the pulse rate mean is increased by 5.56 beats/minute. The hearing threshold levels also shows a decrease in their values.

KEYWORDS: Industrial noise, Systolic Blood Pressure (B.P.), Diastolic B.P., Pulse Rate, Hearing Threshold Level, Audiometer.

1. INTRODUCTION

We live in a time where technology gives us a lot, but also adversely affects us. One major issue due to this technology is a noise pollution (NP). NP is one of the physical factors in industries, and, today, more attention is being paid to its harmful effects (Zamanian, *et al* 2013). NP is becoming increasingly more severe in industrial cities. In future years is expected to be insurmountable.

The term noise is commonly used to describe 'unwanted sound', or sounds that are disagreeable or unpleasant and can disturb the human being physically and physiologically (Hayta, 2007). The noise effects have a profound impact on the ecology and inhabitants. Excessive occupational noise (O.N.) lead to many adverse effects, such as elevated blood pressure (BP), annoyance, reduced performance, sleeping difficulties, tinnitus, stress, noise-induced hearing loss (NIHL) and temporary threshold shift (Nelson et al 2005). Evidence over the past several decades increasingly shows negative health effects from exposure to noise, especially with chronic exposure. Long-term impacts of noise may include many effects, such as, ischemic heart disease (coronary artery disease), and an increased risk of heart attack. This is a particularly significant health correlation, as cardiovascular diseases are a leading cause of death worldwide (Forsyth and Smead 2014). Industrial plants and factories are considered as one of noise sources, because these plants have a plenty of machines and devices.

The effects of noise on human health and comfort can be divided into four categories depending on its duration and volume. They are; (i) physical effects such as hearing defects; (ii) physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers of stomach; (iii) psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and (iv) effects on work performance, such as reduction of productivity and misunderstanding what is hear (Jakovljevic et al., 2006).

The physiological effects include auditory effects; hearing loss, hearing impairments, and non-auditory effects (WHO, 1999. Non-auditory physical health effects that are biologically plausible in relation to noise exposure and annoyance from noise exposure include changes in BP, heart rate, and levels of stress hormones Babisch et al., 2006).

Study of NP and its effects on human being is an increasingly expanding topic in the world. Many noise studies were conducted to investigate the magnitude of the problem in various cities throughout the world. NP is today accepted as a significant part of the larger problem of environmental pollution, and is considered an area of concern with respect to community health.

Many studies have been done worldwide to find out the negative effects of noise. A study performed on workers at automobile factory in China, by Chang, et al, (2003). They found a significant difference of 16 mmHg in sleep-time systolic blood pressure (SBP) existed between two exposure groups, and a marginal increase of SBP as a result of increase in occupational noise exposure. Kerketta et al. (2011) report the systematic noise monitoring inside the work zone area of a chromite mining complex in India. Hanini, (2002) found that there is a strong correlation between Occupational noise (for workers in Palestine) and arterial blood pressure (systolic & diastolic), pulse rate, and hearing threshold levels at different frequencies. Another study to determine the possible effects of Occupational noise on workers were done 18, workers exposed to noise more than 90 dB have a significant shift of the mean measured values (blood oxygen saturation, pulse rate, BP and hearing threshold

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levels), more than workers exposed to noise less than 90 dB (Alsheikh, and Nabeel, 2012).

In Germany and other developed countries as many as 4 to 5 million that is 12-15% of all employed people, are exposed to noise levels of 85 dB(A) or more. That results in 20% or more of employers suffer from hearing impairment (WHO, 2001). However, some of the research scientists observed negative (decreased or non-significantly increased) association between blood pressure and noise (Green et al, 1991). Yousif and Mahdi. (2013), in their study, assess the risk of arterial blood pressure of workers in selected industrial places in Duhok city, Kurdistan region of Iraq , when exposed to occupational noise.

Due to the increasing sources of noise in Iraq, the impact of NP on human health is getting more crucial. There is a lack of available information in Iraq (including Zakho city) regarding the NP issues, such as the level of sound at different places. As well as the relation between the occupational noise exposure and cardiovascular system (e.g. arterial blood pressure, and pulse rate).

Hence, more work must be done to understand and acquire Noise Pollution issue in Iraq. The lack of studies in this field was the motivator to measure the noise levels and their health effects on humans. This study is focused on studying the health impact of noise on workers in 21 factories in Zakho city in Kurdistan region, Iraq.

2. METHODOLOGY

2.1 Study Sample

The sample of this study consists of 113 male workers. The workers are selected in different factories. Their ages were between 15 to 60 years (with mean value of 28. 4 year). The samples were chosen randomly from several sections in twenty one different factories distributed in several locations in Zakho city: (including: metals, plastic, stone-cutter, concrete production and carpentry wood). The duration of the data collection was 6 months. The statistics were performed for workers satisfying some conditions, and more details are given by Ali, (2014).

2.2 Stage of Study

The first stage in implementing the study is to visit the selected factories in many locations in Zakho city, Iraq, to inform them about the study and take the permission for doing the measurements. After taking the agreement, the next step was to gathering information about the workers. In order to observe the harmful effects of the noise caused by the Occupational Noise (O.N.) from the different machines), a questionnaire was made for all the workers (113 persons) included in this study. In order to fulfil the objectives of this study, regular visits were taking place to measure the sound, using sound level meter. The sound level meter was placed in the centre of the plant, where the workers spent most of their time. Most of the Workers and their supervisors were collaborating (cooperative) and simplify the effort done to do the study. The measurements for the workers were taken twice a day. First in the morning before the workers begin working, and the second after 4.5 hours after the beginning of work and each measurement was repeated twice then the mean was calculated. The study was conducted during six months (Nov. 2013-May 2014).

For each worker the blood pressure (systolic and diastolic), and pulse rate, were measured and recorded. Also Mean Arterial Pressure (MAP) and Pulse Pressure (PP) was calculated from the above data. The threshold of hearing of the workers levels are measured at different frequencies (0.25-8 kHz), for both right and left ears using the Audiometer (Ali, 2014). Table (1) presents the details of noise monitoring places, i.e. it shows the factories Name, factories Type, The sound pressure levels –Leq [dB(A) (Mean Value)], and Number of examined workers in these factories.

2.3 Apparatus (Instrumentations)

Digital sound level meter, (Phonometer), of type (SMART SENSOR)- Model SL-200 (VOLTCRAFT). Model: AR 824, was used to measure the noise. Audiometer of type (IEC60645, ANSIS3.6:2004, Amplivox, England, Model 240) was used to measure the hearing threshold (HT) level. To measure the (systolic, diastolic) blood pressure and heart pulse rate, Automatic Digital Electronic Wrist Blood Pressure Monitor was used. Digital Electronic Wrist Blood Pressure Monitor is of type (Boso, BOSCH+SOHN Co, Germany Model WS-300). Mercury sphygmomanometer was used to calibrate the automatic digital electronic.

Table 1. Description of the studied areas

#	Factory Name	Factory Type	Number Of examined workers	Leq in(dB(A) (Mean Value)
1	F1 -Shevan factory	Plastic	4	88
2	F2 -Qadi company	Plastic	13	89.5
3	F3 –Bawari factory	Plastic	9	84
4	F4 –Sofey factory	Plastic	10	95
5	F5-golley factory	Plastic	8	97
6	F6-Jodi factory	Plastic	5	91.13
7	F7-Newroz factory	Plastic	5	81.3
8	F8-Darya factory	Stone cutter	5	96
9	F9-Dalal factory	Plastic	4	76.5
10	F10-Dalal company	Concrete production	8	78
11	F11-karwan factory	Metal	5	88
12	F12-Nezar factory	Plastic	6	87
13	F13-Dejla -Furat factory	Plastic	3	98
14	F14 -Adel factory	Plastic	3	94
15	F15 -Hushyar factory	Plastic	4	82.8
16	F16 -Waleed factory	Plastic	5	82.9
17	F17 –Furat factory	Plastic	6	87.26
18	F18-Brayati factory	Wood	3	95
19	F19-Nehmat factory	Wood	3	88.8
20	F20-ALAkhwayn factory	Wood	2	85
21	F21-Ashti factory	Wood	3	77

2.4 Statistical Analysis

Data are analysed statistically by using the Statistical Package for the Social Sciences (SPSS) Statistics version 15.0, and Microsoft excel program to find the association between noise level and dependent variables: heart pulse rate, the systolic and diastolic blood pressure, and threshold of hearing level. This data analysed by using Paired Sample T-test and ANOVA test to calculate the probability value (p-value) and the Pearson's correlation coefficient (R) for all sample workers in all studied factories.

3. RESULTS

3.1 Arterial Blood Pressure and Pulse Rate

Arterial blood pressure (B.P.) (systolic and diastolic), and pulse rate (P.R.), before and after exposure, according to occupational noise (O.N.) level are show in Figures (1-3) respectively.

3.2 Hearing Threshold Levels for Workers in Different Factories

The hearing threshold levels (HTL) at different frequencies, were investigated, for only the left and only the right ears for all studied workers in each factory before and after exposure to (O.N.). Table (2) shows net change of hearing threshold levels (as a function of frequency) for both together (the right and left ears) before and after exposure. Average values for HTL for both the right & left ears (RL) for all studied workers in all factories according to O.N. level before (b) and after (a) exposure were investigated and plotted as a function of frequencies. Figure (4) shows an examples for factory (F12-Nezar Factory), where the Mean values of HTL of the right and the left ears before (b) and after (a) exposure to O.N. at different frequencies.

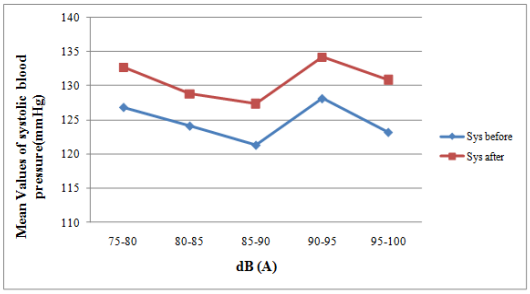

Figure 1. Values of average of systolic blood pressure according to noise pollution level (before & after) exposure.

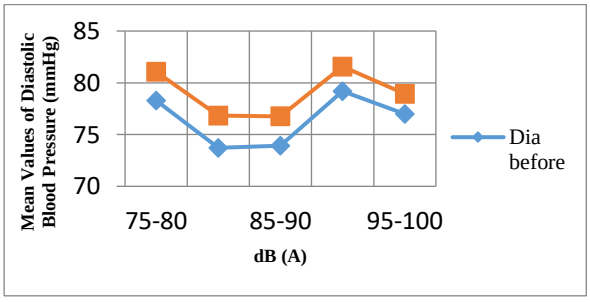

Figure 2. Values of average of diastolic blood pressure according to noise pollution level (before & after) exposure.

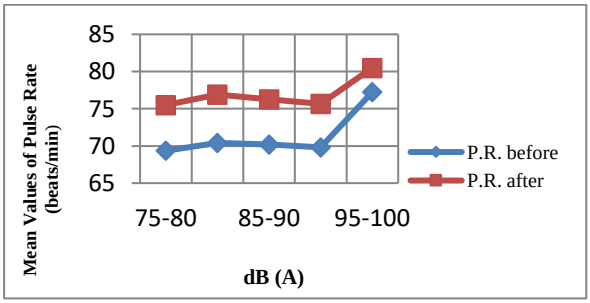

Figure 3. Values of average mean pulse rate (beats/min.) relative to different values of sound pressure levels dB (A), (before & after) exposure.

Values of average of both ears (RL) responses for different frequencies (before-b& after-a exposure) according to noise pollution level {80-85 dB (A)} is shown in figure (5). The results of the mean values of arterial B.P. (systolic and diastolic), and P.R. before and after exposure to O.N., were investigated and plotted as a function of the ages of the workers (Age groups: A1:14-25 yr., A2: 26-37 yr., A3: 38-49 yr., A4: more than 49 yr.). It was observed that there was a significant increase in mean values of arterial B.P. (systolic, and diastolic in Age groups A3), and P.R. A comparison of the different age groups, showed that the change in (SBP) was higher among the oldest workers (A4) in which (DBP) decreased. While the (P.R), and the change of P.R was higher among the youngest workers. Figures (6) and (7) show mean values of HTL of both ears (b & a) exposure to noise of workers at different frequencies according to age groups respectively.

3.3 Statistical Analysis

Results from the audiometric tests, for 7 frequency bands, on the case and control groups, together with the T- test results, and other statistics analysing for each employment group will be published soon.

4. DISCUSSIONS

Table 1 indicates that the noise levels vary with respect to different types of plants / or factories in Zakho city. The results show that the measured values of systolic B.P. are increased after exposure to noise and there is a significance change of systolic with the occupational noise (O.N.). It can be seen that the change of the values depends on the noise levels. The systolic B.P increased by 6.07 mmHg, while the diastolic B.P increased by 2.625 mmHg. Figure (3) shows a clear increase in heart pulse rate (PR) that occurs when they were examined after exposure to O.N. in the factories. PR increased by the value of 5.56 beats/minute. The correlation coefficients for the dependent variables are strong.

The results of this study are rather similar to other studies, and are comparable with most other studies in other countries, which give it high credibility, e.g.; Talbott, et al., (1999) showed that for noise difference of 83 dB(A) to 89 dB(A), there is a mean increase of 2.5 mmHg for systolic blood pressure, and a 2.5 mm Hg mean increase of diastolic blood pressure. Also, Fogari Roberto et al. (2001), found that there is an increase in heart rate by 4.7 beats/minute for the workers whom works in noisy factories. Also it occurred an increase of systolic blood pressure by a mean of 6 mmHg and an increase of diastolic blood pressure by a mean of 3 mmHg. However, some of the scientists/ researchers observed a rise only in systolic BP (Evans et al., 2001), while many others found a significant increase in both systolic and diastolic B.P. in response to noise (Alsheikh and Nabeel. 2012). The actual mechanism responsible for increase in B.P. and P.R. is not yet completely understood so far, but a few facts are known to explain this increase, e.g. due to the increase of the ages of workers. Harris, (1979) reported that noise will cause a further increase in the stress reaction which will elevates B.P., this will increase cardiac oxygen demand which will in turn increase in the pulse rate.

Table 2 indicates that the noise levels vary with respect to different values of HTL. From table (2), which shows net change of HTL as a function of frequency, we can see that the maximum net differences occurred when the frequency equals 500 Hz. It is clear from the details of figures (5-7) that there are significant changes in response or the hearing threshold shifts in the right and left ears of workers, before exposure to occupational noise (pre-exposure) and after six months from exposure to noise. The results of this study are rather similar to other studies, and are comparable with most other studies (e.g. Ref. Hanini, (2002), Alsheikh and Nabeel. (2012). The effects of noise on the workers in Zakho region, Iraq, are very complex, because they will face another sources of noise (during driving or using old cars, or using huge numbers of generators for electricity production in Iraq) (Yousif, 2010, Yousif and Mahdi, 2013), i.e. during other nonworking hours. However, O.N. in industries has been pointed out as a stressor that could potentially induce hypertension. (Ardeshir Kalantari, 2006).

According to analysing results of the questionnaire applied to the all workers in all factories included in this study, most of the workers are of little education therefore they are not fully aware of the hazardous effects of noise. Almost all the workers are

highly exposed to high noise levels compared to (OSHA) limits without Personal protection equipment (PPE), such as ear plugs, muffles, or any proper ear protection. However, results of the questionnaire show that, majority of workers in the industries are annoyance from the noise in their workplaces.

Table 2. Net change of hearing threshold levels for both together (the right and left ear) before and after exposure.

Hearing Threshold Levels	Mean before exposure	Mean after exposure	Net difference
0.25kHz	25.9	29.4	3.5
0.5kHz	26.05	29.9	3.85
1kHz	22.08	25.77	3.69
2kHz	15.3	16.8	1.5
4kHz	18.8	22.4	3.6
6kHz	18.9	19.8	0.9
8kHz	20.4	22.7	2.3

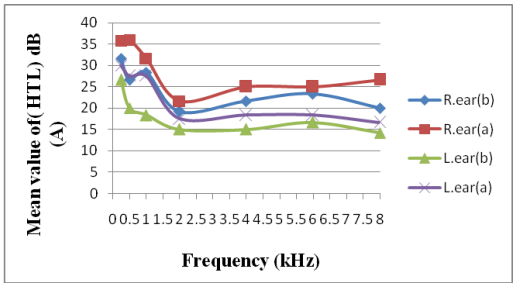

Figure 4. Mean values of hearing threshold levels (HTL) of the right and the left ears before (b) and after (a) exposure to occupational noise in (F12) Nezar Factory at different frequencies.

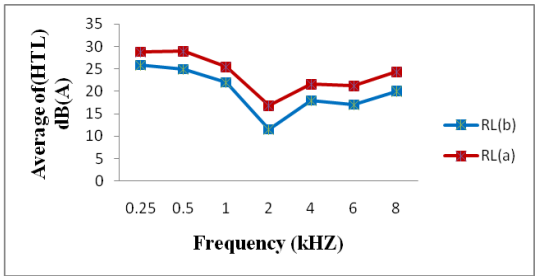

Figure 5. Values of average of HTL for both ears (RL) responses for different frequencies (before& after exposure) according to noise pollution level {80-85 dB (A)}.

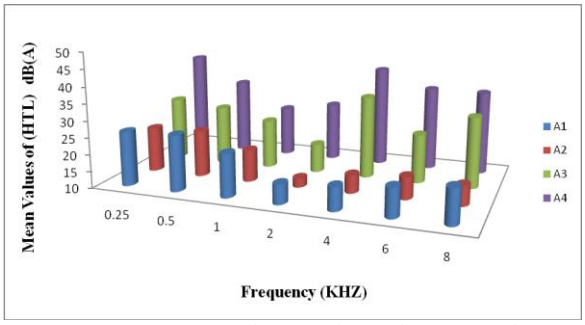

Figure 6. Mean values of (HTL) of ears of workers (before exposure) according to different frequencies by different age groups.

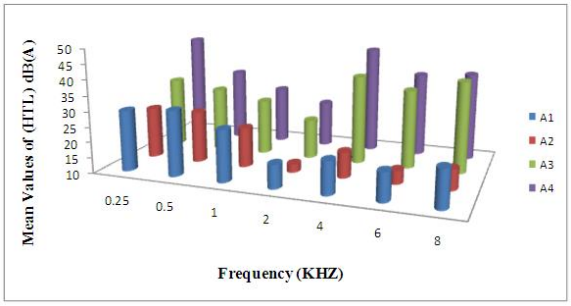

Figure 7. Mean values of (HTL) of ears of workers (after exposure) according to different frequencies by different age groups.

5. CONCLUSIONS AND RECOMMENDATIONS

The following are main conclusions from this study:

1- High levels of occupational noise affected adversely the blood pressure (systolic and diastolic). Majority of workers in industrial factories (21 factories in Zakho region, Iraq), are annoyance from the noise in their workplaces. The hearing threshold levels and pulse rate of the most of the workers are not normal.

2- The noise pollution in industrial factories in Zakho region, Iraq, is very extensive, e.g. factories have noise pollution above The noise level was between (76.5-98) decibels dB.

3- The hearing threshold levels shows a decrease in their values. The other results show that the measured values are increased after exposure to noise. The change of the values is depending on the noise levels.

4- The results show that the measured values of systolic blood pressure, diastolic blood pressure and pulse rate, for the workers are increased after exposure to noise. The average systolic and diastolic blood pressure was increased by about 8.70 mmHg, while the pulse rate is increased by about 5.56 beats/minute.

5- Although the Regulations are present in Iraq, (The Environmental Law). But the activation for the legislations is absent or neglected or simply unknown. Therefore, there are no safety procedures, or shields to protect workers from the noisy machines and devices.

There are many recommendations and actions, mainly from The Occupational Safety and Health Administration (OSHA, 2014), and World Health Organization (WHO, 1999), which can be carried on to reduce or prevent the occupational noise in order to conserve workers health, such as: Provide workers with noise protective equipment like ear protection (EP), factory's designer has to come up with designs that increase the factory's area, and allowing enough spaces between machines, periodic tests for the workers in order to determine the health effects of noise early, etc.

Therefore, Technical control of the problem of noise along with administrative control and awareness for the workers has to be developed in an integrated health prevention and control program.

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كارتێكرنا ژاوەژاو لسەرفشارا خوينێ ودلی وكوهلێبونێ بۆ وان كاركەرێن ل كارگەهێن زاخو

كورتيا لێكولينێ:

ژاوەژاو ئێكە ژسيمايێن هەرە گرنگ دڤی چەرخی دا وبشێوەيەكێ مەزن دهێتە بەرچاڤكرن وەكو فاكتەرەكی فيزيكی دژينگەهێ دا و دبيتە ئێك ژ فاكتەرێن سروشتی يێ كاريگەر ژ بۆ پيسبونا ژينگەهێ و كارتێكرنێ لسەرتێكدانا تەندروستيا هەمـــی زينـدەوەران دا وچەندين ئاريشەيێن ساخلەميێ پەيدا دكەت .مەرم ژ ئەڤێ ڤەكۆلينـێ ئـەوە ژبـۆ تاقيكرن وچاوانيا كارتێكـرنا ژاوەژاو لسەر سيستەمێ (cardiovascular system) بو نموونە : فشارا خوينێ , لێدانا دلی و پيڤـەرا گوە لێبونێ لدەف كاركـەرێن تـوشی پرەدەنگی يـێ يا پێشەشازی بوين ل كارگەهێن باژێـرێ زاخو-كوردستانا عيراقێ.گـروپێ ڤـەكولينێ پێكهاتبوو پتر ژ113 كاركەر ل (21) كارگەهێن پێشەسازی لدەڤەرا زاخو وكارگەە جورا وجور بوون و ژيێ كاركەرا د ناڤبەرا 15-60 سالا وكاركـەر توشـی ريژەيا پرەدەنگی دناڤبەرا (76.5-98) دسيبل بوينە ژ بۆ تاقيـكرنا كارتێكرنا نەرێنـی يا پرەدەنگـی ئەوا هاتيە ئەنجامـدان و راپرسينەك هاتە ئەنجامـدان بۆ هەر كاركـەرەكی. ئەنجامان ديار كر كو جێوازيێن بەرچاڤ هەبوون د فشارا خوينـێ دا يا (بلند ونزم) ولێدانا دلی وپيڤەرا گوە لێبونێ. بشێوەيـەكـێ گشتـی بۆمـە ديار دبيت كو پرەدەنگی دبيتە فاكتەرەكێ كاريگەر لسەر ساخلەميێ , و دپەرە سەندنا فشارا خوينێ ولێدانا دلی وگوە لێبونێ دا. هەر وەسا ديار بوو كو ئەو كاركەرێن تۆشی پرەدەنگيا بلند دبن كارتێكرنا فشارا خوينێ ولێدانا دلی و پيڤەرا گوە لێبونێ مەزنترە ژ وان كاركەرێن لژێر پرەدەنگی يا نزم دبن.

تأثير الضجيج المهني على ضغط الدم وعتبة السمع عند العمال في مصانع زاخو

خلاصة البحث:

الضوضاء المهنية الناتجة عن الاعمال الصناعية تلعب دورا رئيسيا في حياة العمال ويؤثر بشكل سلبي على السمع وضغط الدم. في هذا البحث, تمت دراسة أثر التعرض للضجيج الصناعي على معدلات ضغط الدم (الانقباضي والانبساطي) , ونبض القلب , وحالة (درجة) السمع عند مجموعة من العمال في احدى وعشرون مصنعا في مدينة زاخو-اقليم كوردستان العراق. ضم مجتمع الدراسة 113 من العمال الذكور ممن تتطبق عليهم شروط الدراسة تتراوح اعمارهم بين 15-60 سنة و مدة مكوثهم (بقائهم) في العمل الحالي سنتين على الاقل , وتراوحت مستويات الضجيج في الوحدات الصناعية { 76.5 دسيبل الى 98 دسيبل } (dB(A. أظهرت هذه القراءات أن العمال في معظم الوحدات الصناعية المدروسة يتعرضون يوميا لمستويات من الضجيج الصناعي تفوق المعايير الموصى بها عالميا. كذلك أظهرت الدراسة أن هناك علاقة بين مستوى الضوضاء (الضجيج) المهنية و كل من ضغط الدم (الانقباضي والانبساطي) , نبض القلب , و درجة السمع على ذبذبات مختلفة عند عمال المصانع. أظهرت النتائج ازدياد معدل ضغط الدم الانقباضي بمقدار 6.004 مليمتر زئبقي نتيجة التعرض للضوضاء عند ترددات مختلفة . كذلك ازداد معدل ضغط الدم الانقباضي للعمال بمقدار 6.004 مليمتر زئبقي, و ازداد معدل ضغط الدم الانبساطي بمقدار 2.4 مليمتر زئبقي, و ازداد معدل النبض بمقدار 5.6 نبضة/الدقيقة. كما قلت درجات السمع للعمال بمعدل يتراوح (0.9 الى 3.85) دسيبل عند ترددات مختلفة .