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Evaluation of noise pollution and its effects on the blood pressure of female workers in the clothing industry in Al-Najaf city, Iraq

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ABSTRACT

This study aimed to evaluate the effect of noise pollution on blood pressure in female workers in the men's clothing industry in Najaf, Iraq. Sound level measurements were conducted using a sound level meter in three factories in the men's clothing industry. Additionally, the study also included measuring the blood pressure of 60 female workers in three factories in the men's clothing industry. The results indicated that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning hours belonged to the sewing department, while the ironing department had the lowest mean L_{Aeq} and minimum sound level (L_{min}) in the men's suit production factory. Additionally, the study revealed that the mean equivalent noise levels in the men's suit production factory across all departments during morning hours exceeded those in the administration department. In addition, the study recorded a significant elevation ($p< 0.05$) in blood pressure (systolic and diastolic) and heart pulse rate among female workers in the sewing department compared to other departments in the health and general products lab factory. The results showed a significant ($p< 0.05$) increase in the average values of blood pressure (systolic and diastolic) and heart pulse rate of female workers in all apartments of the health and general products lab factory compared with the control.

Keywords: Noise pollution, Blood pressure, Clothing industry, Female workers.

Introduction

In general, noise is defined as the intensity of sound whose presence is undesirable and can pose a health and safety risk to workers in various workplaces (Denisov,2018). Noise is a disturbance to the human environment that is escalating at such a high rate that it will become a significant threat to the quality of human lives (Jariwala, 2017).

Additionally, noise is classified into two categories: occupational noise (i.e., noise in the workplace) and environmental noise, which encompasses noise in all other settings, including community, residential, and domestic areas (e.g., traffic, playgrounds, sports, music). Moreover, Chamkori et al. (2016) revealed that noise is one of the harmful environmental factors and an inevitable phenomenon in the home and workplace. In recent years, numerous researchers have investigated the health effects of noise pollution. Vertigo, agitation, weariness, hypertension, gastrointestinal system problems (including gastric and duodenal ulcer), cardiac arrhythmia, nervous and psychic disorders have been studied by several researchers (Ising and Kruppa, 2004). An additional study has found that noise can stimulate the body's stress response, and loud noise causes stress and annoyance (Rylander, 2004), as well as fluctuations in blood pressure (Iyawe et al., 2000). In addition, noise has also been found to affect the quality of the environment for patients, creating an unhealthy environment. Noise may increase blood

pressure, increase heart rate, stimulate the release of epinephrine (also known as adrenaline), induce high levels of pain, and alter the quality of sleep (Stansfeld & Matheson, 2003). Long-term noise-induced stress may lead to disturbances in blood pressure regulation through the rise of circulatory stress hormones, including adrenaline and noradrenaline. On the other hand, an increase in blood pressure may also increase the prevalence and mortality of cardiovascular disease (Ettehad et al., 2016). Industrial factories generating noise intensity exceeding 85 dB include textile factories (93 dB), furniture factories (93 dB), paper factories (92 dB), and wood processing factories (106 dB) (Gongi, 2018). This research aims to investigate the impact of workplace noise exposure on the blood pressure of female workers in the men's clothing industry in Najaf, Iraq.

Materials and Methods

Study population: The study consisted of 60 female workers in in men's clothing industry include the three factories: men's suit production factory, military production factory and health and general products lab factory in Al-Najaf AL-Ashraf city and 60 unexposed healthy female subjects of the same age, height, and weight group served as control table (1). All workers in these three exposure groups and the control group had no history of respiratory or allergy disease. Additionally, those female workers worked for at least 8–10 hours a day, 6 days a week (Table 1).

Noise level evaluation: Noise level assessments were conducted during morning hours (9:00 am–12:00 pm).In this study, three sound level parameters were recorded in every measurement in decibels (dB): the A-weighted equivalent continuous level (LAeq), the maximum sound level (Lmax), and the minimum sound level (L_{min}).

Sound level measurements: Sound level measurements were recorded using a sound level meter (SLM), model UNI-T UT352, China, with a range of 30 dB to 130 dB. The equipment was positioned approximately 1.5 m above the ground surface. The sound level meters were set to A-weighting and slow time to verify the fluctuating mean sound level. Nighttime. Measurements were done in all quarters. The time between every two readings (within the same period or interval) was one and a half hours, and the time spent reading at each location was nearly five minutes. All readings included measurements of the A-weighted equivalent sound level (LAeq), as well as maximum and minimum sound levels in every location of the electrical power generators. This measuring device was calibrated every time before use. The sound measurements were performed in the morning and evening.

Blood pressure and heart pulse rate measurements: The systolic and diastolic blood pressures and heart pulse rates of the employees were measured using an automatic digital wrist cuff blood pressure monitor with heart rate detection capability (model number 3.2). Additionally, some blood pressure measurements were taken using a mercury sphygmomanometer. Blood pressure and heart rate were measured twice a day, before and after work, recording the average of the two readings at each instance

BMI (Body Mass Index): The weights and heights of the workers and controls were measured using a well-calibrated scale. The weight was recorded in kilograms (Kg) and the height in centimeters. The body mass index (BMI) was calculated according to the following equation (Eknoyan, 2008).

$BMI\ (Kg/m^2) = Weight\ (Kg)/\ (Height\ (m))^2$

Statistical analysis: The data were statistically analyzed using SPSS (Statistical Package for the Social Sciences). The independent sample t-test. All values were expressed as mean ± Standard Error of Mean. P-values less than 0.05 and 0.01 were considered statistically significant.

Results and Discussion

The results showed that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning time belonged to the Sewing department, while the lowest mean LAeq and minimum sound level (Lmin) were recorded in the ironing department of the men's suit production factory (Table 2). In the present study, the mean equivalent noise levels observed in all departments of a men's suit production factory during morning time exceeded those in the administration department.

The results showed that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning hours were observed in the ironing department, while the lowest mean LAeq and minimum sound level (Lmin) were observed in the design department of the military production factory (Table 3). In the present study, the mean equivalent noise levels observed in all departments of a men's suit production factory during morning time exceeded those in the administration department.

Table (1): The number, duration of work, age, and some anthropometric characteristics of female workers of three factories in the clothing industry, Najaf, and the control.

Groups / Parameters	Control subjects	Men's suit production factory female workers	Military Production factory female workers	Health and general products lab factory female workers	Sign. level .
Number	60	20	20	20	
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
Age (years)	45.8±8.13	46.12±9.79	45.52±8.17	45.33±6.8	NS
Duration of employment (years)	-	10.04±4.76	14.33±2.77	15.16±3.83	-
Height (m)	1.692±0.051	1.7±0.02	1.7±0.02	1.67±0.12	NS
Weight (kg)	64.21±9.76	64.36±10.74	64.44±11.43	64.76±11.43	NS
BMI ($Kg/m^{2)}$	22.36±3.34	22.03±3.46	22.05±3.68	23.07±3.34	NS

Notes: SD = Standard deviation. NS: No Significant.

Table (2) Average (L_{Aeq}), minimum (L_{min}), and maximum (L_{max}) sound levels in (dB) at different departments during morning time in the men's suit production factory.

Departments	Sound levels (dB)		
	L_{Aeq}	L_{min}	L_{max}
	Mean ± SD	Mean ± SD	Mean ± SD
Design department	70.96 ± 2.22	72.99 ± 2.59	77.66 ± 1.73
Sewing department	80.41 ± 0.65	61.91 ± 1.34	83.98 ± 0.79
Ironing department	60.03 ± 1.29	59.66 ± 1.58	73.44 ± 1.34
Administration	50.03 ± 1.20	40.66 ± 1.50	55.44 ± 1.30

Note: Morning readings are between 9:00 am and 12:00 pm.

Table (3) Average (L_{Aeq}), minimum (L_{min}), and maximum (L_{max}) sound levels in (dB) at different departments during morning time in the military production factory.

Departments	Sound levels (dB)		
	L_{Aeq}	L_{min}	L_{max}
	Mean ± SD	Mean ± SD	Mean ± SD
Design department	74.56 ± 1.19	70.09 ± 0.87	83 ± 2.05
Sewing department	79.09 ± 1.65	68.65 ± 1.48	85.09 ± 1.88
Ironing department	90.36 ± 0.29	88.03 ± 0.4	91.36 ± 0.29
Administration	50.03 ± 1.20	40.66 ± 1.50	55.44 ± 1.30

Note: Morning time, the readings are between (09.00- and 12.00-hours a.m).

The results showed that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning hours belonged to the sewing department, and the lowest mean LAeq and minimum sound level (Lmin) were in the design department of the health and general products lab factory (Table 4). In the present study, the mean equivalent noise levels observed in all departments of a men's suit production factory during morning time exceeded those in the administration department. In addition, comparison of mean A-weighted equivalent continuous sound levels (L_{Aeq}) in (dB) among three factories in the men's clothing industry / Najaf in Al-Najaf city, the results showed that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) during morning time belonged to the sewing department in the health and general products lab factory, and the lowest mean L_{Aeq} in the design department in the Military production factory (Table 5). In the present study, the mean equivalent noise levels observed in all departments of the men's suit production factory during morning time exceeded those in the administration department.

The results showed that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning time belonged to the military production factory and the lowest mean L_{Aeq} and minimum sound level (L_{min}) in the health and general products lab factory in the health and general products lab factory (Table 6). In the present study, the mean equivalent noise levels observed in all the factories during the morning time exceeded the administration department's limit.

The results indicated a significant elevation ($p < 0.05$) in blood pressure (systolic and diastolic) and heart rate of female workers in the sewing department compared to other departments in the men's suit production factory (Table 7). The results showed a significant ($p < 0.05$) increase in the average values of blood pressure (systolic and diastolic) and heart pulse rate of female workers in all apartments of the men's suit production factory compared to the control (Table 7).

The results indicated a significant elevation ($p < 0.05$) in blood pressure (systolic and diastolic) and heart rate of female workers in the sewing department compared to other departments in the military production factory (Table 8). The results showed a significant ($p < 0.05$) increase in the average values of blood pressure (systolic and diastolic) and heart pulse rate of female workers in all apartments of the military production factory compared to the control (Table 8).

The results indicated a significant elevation ($p < 0.05$) in blood pressure (systolic and diastolic) and heart rate of female workers in the sewing department compared to other departments in the health and general products lab factory (Table 9). The results showed a significant difference ($p < 0.05$) in the average values of blood pressure (systolic and diastolic) and heart pulse rate of female workers in all apartments of the health and general products lab facility compared to the control (Table 9).

The findings of the present study reported that the highest mean A-weighted equivalent continuous sound level (L_{Aeq}) and maximum sound level (L_{max}) during morning time belonged to the Sewing department, and the lowest mean L_{Aeq} and minimum sound level (L_{min}) in the ironing department in the men's suit production factory (Table 1). Similar findings were recorded. Talukdar (2001) reported that the noise level in the textile industry ranges from 80 dBA to 99 dBA, with the lowest levels observed in the blow room and the highest levels in the loom shed. Yhdege (1991) investigated the occupational noise exposure of workers in textile industries in Tanzania. The results of the investigation indicate that these industries have gross occupational exposure to noise, with more than 30% of workers exposed to noise levels exceeding 90 dB(A).

These results may be attributed to the fact that the process of textile production cannot be separated from the potential dangers inherent in the work environment. One of these is the noise from production machines, so efforts are needed to prevent occupational diseases and increase work productivity. In general, noise is defined as the intensity of sound whose presence is undesirable and can pose a health and safety risk to workers in various workplaces. In the present study, the mean equivalent noise levels observed in all departments of the men's suit production factory during morning time exceeded those in the administration department. According to the Occupational Safety and Health Administration (OSHA), the existence of occupational noise exposure at or above 85 dB(A) has been identified as the threshold that necessitates the development of a hearing conservation program for workers.

The results showed a significant increase ($p < 0.05$) in blood pressure (systolic and diastolic) and heart rate of female workers in the sewing department compared to other departments in the men's suit production factory (Table 6). The results showed a significant increase in the average values of blood pressure (systolic and diastolic) and heart pulse rate of female workers in all apartments of the men's suit production compared with the control (Table 6). Similar results were obtained by Chen et al. (2017), who investigated the binding of noise exposure in an occupational setting and blood pressure. The study findings showed that noise-exposed subjects had significantly higher levels of systolic blood pressure (SBP) (125.1±13.9 mmHg) and diastolic blood pressure (DBP) (77.6±10.7 mmHg) than control subjects (SBP: 117.2±15.7 mmHg, DBP: 70.0±10.5 mmHg). Mirzaei et al. (2012) reported that high noise levels can increase the incidence of high blood pressure and elevate heart rates in subjects near the noise source. The results of their study showed that 62 % of subjects reported that noise pollution was painful.

Table (4) Average (L_{Aeq}), minimum (L_{min}), and maximum (L_{max}) sound levels in (dB) at different departments during morning time in the health and general products lab factory.

Departments	Sound levels (dB)		
	L_{Aeq}	L_{min}	L_{max}
	Mean ± SD	Mean ± SD	Mean ± SD
Design department	74.26 ± 1.69	72.89 ± 1.34	75.79 ± 2.25
Sewing department	77.48 ± 1.34	61.11 ± 1.03	80.21 ± 1.67
Ironing department	70.47 ± 0.85	67.04 ± 0.66	71.31 ± 1.21
Administration	50.03 ± 1.20	40.66 ± 1.50	55.44 ± 1.30

Note: Morning time, the readings are between (09.00-12.00 hours a.m.).

Table (5): Comparison of mean A-weighted equivalent continuous sound levels (L_{Aeq}) in (dB) among three factories based on departments.

Departments	Sound levels (dB) in factories		
	Men's suit production factory	Military production factory	Health and general products lab factory
	Mean ± SD	Mean ± SD	Mean ± SD
Design department	72.02 ± 1.46	71.66 ± 0.05	77.11 ± 1.43
Sewing department	78.69 ± 1.02	68.41 ± 2.27	82.98 ± 1.37
Ironing department	73.94 ± 1.26	71.21 ± 2.15	78 ± 0.7
Administration	50.03 ± 1.20	40.66 ± 1.50	55.44 ± 1.30

Note: Morning readings are between 9:00 am and 12:00 pm.

Table (6): Comparison of mean sound levels in dB among different factories.

Departments	Sound levels (dB)		
	L_{Aeq}	L_{min}	L_{max}
	Mean ± SD	Mean ± SD	Mean ± SD
Men's suit production factory.	73.29±0.99	63.34±1.1	77.7±1.24
Military production factory.	81.39±2.6	78.09±2.42	86.31±2.45
Health and general products lab factory.	73.06±3.48	66.68±3.72	75.33±4.01
Administration	50.03 ± 1.20	40.66 ± 1.50	55.44 ± 1.30

Note: Morning time, the readings are between (09.00-12.00 hours a.m.).

Table (7): Comparison of the mean blood pressure and heart pulse rate of female workers in the three departments of the men's suit production factory.

Parameters	Control	Men's suit production factory.		
		Ironing department	Sewing department	Design department
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Systolic blood pressure (SBP) (mmHg)	121.54±1.29	130.36±4.59a	150.26±4.59a	130.21±1.85a
Diastolic blood pressure (DBP) (mmHg)	80.45±0.98	86.52±2.08	88.52±2.08ab	80.28±1.38
Heart pulse rate HPR(beats/min)	80.01±3.27	83.98±6.54a	90.98±6.54ab	86.67±4.91a

Note: (a) = indicates statistically significant (p≤ 0.05) as compared with control. (b) = shows statistically significant difference as compared with the Ironing department (p≤ 0.05). (c) = indicates statistically significant difference as compared with the Sewing department (p≤ 0.05).

Table (8): Comparison of the mean blood pressure and heart pulse rate of female workers in the three departments of the military production factory.

Parameters	Control	Military production factory.		
		Ironing department	Sewing department	Design department
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Systolic blood pressure (SBP) (mmHg)	121.54±1.29	130.26±4.29a	137.26±4.29ab	120.61±4.85
Diastolic blood pressure (DBP) (mmHg)	80.45±0.98	80.52±2.08	90.52±2.08ab	83.28±1.38a
Heart pulse rate HPR(beats/min)	80.01±3.27	87.88±6.54a	87.98±6.54a	83.67±4.91a

Note: (a) = indicates statistically significant (p≤ 0.05) as compared with control. (b) = shows statistically significant difference as compared with the Ironing department (p≤ 0.05). (c) = indicates statistically significant difference as compared with the Sewing department (p≤ 0.05).

Table (9) Comparison of the mean blood pressure and heart pulse rate of female workers in three departments of the female workers in in health and general products lab factory.

Parameters	Control	Health and general products lab factory.		
		Ironing department	Sewing department	Design department
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Systolic blood pressure (SBP) (mmHg)	121.54±1.29	120.26±4.59	132.26±4.59ab	130.61±1.85a
Diastolic blood pressure (DBP) (mmHg)	80.45±0.98a	90.52±2.08a	90.52±2.08ab	80.28±1.38a
Heart pulse rate HPR (beats/min)	80.01±3.27	86.98±6.54a	87.98±6.54ab	87.67±4.91a

Note: (a) = indicates statistically significant (p≤ 0.05) as compared with control. (b) = shows statistically significant difference as compared with the Ironing department (p≤ 0.05). (c) = indicates statistically significant difference as compared with the Sewing department (p≤ 0.05).

Additionally, workers in the sewing department experience occupational stress due to excessive noise in the workplace. Numerous studies have reported that exposure to various physical and mental stressors can increase the secretion of stress hormones, including cortisol, corticosterone, adrenaline, and norepinephrine (also known as noradrenaline). Moreover, noise exposure activates the sympathetic and endocrine systems, thereby affecting metabolic states of human beings (Recio et al, 2016). Long-term noise-induced stress may lead to disturbances in blood pressure regulation through the rise of circulatory stress hormones, such as adrenaline and noradrenaline (Ghotbi et al., 2013).

In the present study, the mean equivalent noise levels observed in all the factories during morning time exceeded the administration department's limit. One of the impacts of noise is on the non-auditory system of the workers. Disturbances in blood pressure and pulse are characteristic of it. Some studies in Indonesia, particularly those in the textile industry of Surakarta, have shown that noise from weaving machines, with an intensity of 93-105 dBA, affects blood pressure and pulse rate. One of the largest textile companies in Surakarta has been unable to overcome the problem of noise intensity that exceeds the threshold value, which has the potential to cause work-related stress (Park et al., 2017). One of the impacts of noise is on the non-auditory system of the workers. Disturbances in blood pressure and pulse are characteristic of it. Some studies in Indonesia, particularly those in the textile industry of Surakarta, have shown that noise from weaving machines, with an intensity of 93-105 dBA, affects blood pressure and pulse rate. One of the largest textile companies in Surakarta has been unable to overcome the problem of noise intensity that exceeds the threshold value, which has the potential to cause work-related stress (Basner et al., 2014).

The results showed a significant ($p < 0.05$) increase in the average values of blood pressure (systolic and diastolic) and heart pulse rate among female workers in all apartments of the health and general products lab factory, compared to the control (Table 9). Staff in the clothing industry suffer from occupational stress due to excessive noise in the workplace. Numerous studies have reported that exposure to various physical and mental stressors can increase the secretion of stress hormones, including cortisol, corticosterone, adrenaline, and norepinephrine (also known as noradrenaline). Moreover, noise exposure activates the sympathetic and endocrine systems, thereby affecting the metabolic states of human beings (Azanaw, 2025).

Conclusion

The study found that the highest average noise levels were in the sewing department in the clothing industry in Al-Najaf city. The results found that exposure to occupational noise had adverse effects on blood pressure in clothing industry workers.

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