КАРДИОЛОГИЯ
CARDIOLOGY

THE INTERACTION OF OCCUPATIONAL NOISE EXPOSURE WITH THE CARDIOVASCULAR RISK FACTORS

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RESUME

Rational. *Occupational noise poses a significant occupational hazard, affecting a large portion of the global population. The correlation between cardiovascular risk factors and noise exposure has been examined, and conflicting findings have been found.*
The aim. *This study aimed to explored the association between occupational noise and cardiovascular risk factors among word related noise-exposed laborers.*
Methods. *A cross-sectional study was conducted among 495 workers at a home appliance manufacturing factory. Participants are divided in two groups including workers exposed to noise levels above 85 dB and below 85 dB at work. Demographic information, audiometric tests, blood pressure tests, and lipid profile testing collected from the occupational health files. To evaluate the association between noise exposure and cardiovascular risk factors, the multivariable logistic regression analyzes were used.*
Results. *Our finding revealed significant correlation between exposure to noise above the 85 db and elevated levels of fasting blood sugar (FBS), triglyceride (TG), low-density lipoprotein (LDL), physical activity and high diastolic blood pressure. Following logistic regression to remove the impact of confounding variables, relationship between FBS, LDL, TG and physical activity remained statistically significant.*
Conclusions. *The current investigation shows the correlation between exposure to noise above the permissible limit and the risk factors of cardiovascular diseases, especially FBS, LDL, and TG.*

Key words: *cardiovascular risk factors, hypertension, occupational noise, noise Induced hearing loss*

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ОЦЕНКА СВЯЗИ МЕЖДУ ВОЗДЕЙСТВИЕМ ПРОФЕССИОНАЛЬНОГО ШУМА И ФАКТОРАМИ РИСКА СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ

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РЕЗЮМЕ

Обоснование. *Профессиональный шум представляет собой значительную профессиональную опасность, затрагивающую большую часть населения мира. Была изучена корреляция между сердечно-сосудистыми факторами риска и воздействием шума, и были обнаружены противоречивые результаты.*
Цель. *Данное исследование нацелено на изучение связи между производственным шумом и факторами риска сердечно-сосудистых заболеваний среди рабочих, подвергающихся воздействию профессионального шума.*
Методы*. Кросс-секционное исследование было проведено среди 495 рабочих на заводе по производству бытовой техники. Участники были разделены на две группы, среди них работники, подвергавшиеся воздействию шума на уровне выше 85 дБ и ниже 85 дБ на работе. Демографическая информация, аудиометрические тесты, тесты артериального давления и липидный профиль были собраны из документов по охране труда. Для оценки связи между воздействием шума и факторами риска сердечно-сосудистых заболеваний были использованы многофакторные логистические регрессионные анализы.*
Результаты. *Наши результаты выявили значительную корреляцию между воздействием шума выше 85 дБ и повышенными уровнями сахара в крови натощак, триглицеридов (ТГ), липопротеинов низкой плотности (ЛПНП), физической активности и высоким диастолическим артериальным давлением. После логистической регрессии для устранения влияния сопутствующих переменных связь между повышенными уровнями сахара в крови натощак, ЛПНП, триглицеридов и физической активностью осталась статистически значимой.*
Выводы*. Текущее исследование показывает взаимосвязь между воздействием шума выше допустимого уровня и факторами риска сердечно-сосудистых заболеваний, особенно повышенными уровнями сахара в крови натощак, ЛПНП и ТГ.*

Ключевые слова: *факторы риска сердечно-сосудистых заболеваний, гипертония, профессиональный шум, потеря слуха, вызванная шумом*

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INTRODUCTION

Occupational noise poses a significant occupational hazard, affecting a large portion of the global population. The World Health Organization (WHO) states that over 5 % of people worldwide, comprising 432 million adults and 34 million children, may require rehabilitation to treat severe hearing loss. Furthermore, WHO anticipates that the number of individuals with noise-induced hearing loss (NIHL) could exceed 700 million by 2050 [1]. Hearing impairment is a popular condition among the elderly, affecting negatively on attention, cognition and also reduces their ability to communicate and social interactions [2]. Noise pollution not only affects adversely on hearing, but also causes cardiovascular diseases. The relationship between cardiovascular diseases and occupational noise is well-described in a 2004 WHO assessment [3]. Chang Ta-Yuan et al. have shown that male blood pressure levels, both systolic and diastolic, may rise with prolonged exposure to noise levels ≥ 85 dB [4]. Another study found that brief exposure to aircraft noise at night caused endothelial function to decline and adrenaline release to rise in healthy participants. Reactive oxygen species production may be elevated in this noise-induced condition. This shows that the current link between prolonged noise exposure and the onset of cardiovascular disease may be influenced by noise-induced endothelial dysfunction [5]. The correlation between high blood pressure, hyperlipidemia, and other cardiovascular risk factors and noise exposure has been examined, and conflicting findings have been found [6].

THE AIM

In this study, we aimed to investigate the relationship between occupational noise exposure and cardiovascular risk factors among workers, particularly focusing on how exposure to noise above the permissible limit may influence key health markers.

MATERIAL AND METHODS

The research was conducted as a cross-sectional study on eligible workers at a home appliance manufacturing facility between 2022 and 2023. Workers who expressed interest in participating were included in the study, following the guidelines of the Declaration of Helsinki. The study protocol was approved by the ethical committee (protocol no. IR.IUMS.FMD.REC.1401.178, approved date: June 22, 2022). Participants were required to have a minimum of one year of work experience, be between the ages of 18 and 70, and of both genders. Exclusion criteria included certain underlying health conditions such as dyslipidemia, mellitus diabetes, thyroid disorders, and cardiovascular disorders, history of ear issues, ear surgeries, prior exposure to ototoxic solvents, metals and drugs, history of acoustic trauma and unwillingness to participate. All participants provided informed consent. Workers were divided into two groups based on their exposure to noise.

Those who experienced noise above 85 decibels at work were included in the noise exposure group;

Those who were exposed to noise levels below 85 decibels were classified into the non-noise exposed group. Then compared the two groups regarding cardiovascular risk factors.

It should be noted that employee`s demographic and occupational information was completed using the occupational health file. Demographic information encompasses age, gender, height, marital status, smoking (pack / years), physical activity, use of personal protection equipment (PPE). More than one cigarette a day for the previous six months was considered smoking. Physical activity was described 150 minutes of activity per week or at least 5 days a week and at least half an hour. The duration that employees spent wearing personal protective equipment (PPE) at work and the kind of PPE—such as earmuffs or earplugs—were taken into account when calculating the usage of these devices. Data on biochemically measured levels of total cholesterol, triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and fasting blood sugar (FBS) in blood samples are recorded in the workers' occupational health file. A qualified physician took the employee's systolic and diastolic blood pressure in accordance with standard procedure, and the results were entered into the worker's occupational health record.

Hearing screening

According to the report and measurements of health, safety and environment unit, workers were exposed to noise of more than 85 decibels in their working hours, the air bone hearing threshold in both ears by an audiometric expert by performing audiometry in an acoustic chamber and at frequencies (500-1000-2000-3000-4000-6000-8000) was measured and recorded in their Occupational Health file. Prior to the test, employees who met the requirements for audiometry had to stay away from noisy areas for over 12 hours.

Statistical Analysis

The data collected was examined using IBM SPSS Version 23.0 for Windows, a statistical package for the social sciences (SPSS Inc. Illinois, USA (Chicago). Mean and standard deviation (mean ± SD) were used to express the results for quantitative variables, while frequency and percentage were used for qualitative variables. For the comparison of qualitative and quantitative variables, the chi-square test and the t-test were employed, respectively. Ultimately, the effect of confounding variables was adjusted using the Logistic Regression test, taking into account a *p*-value less than 0.05 and a confidence interval of 95 percent.

RESULTS

The survey was conducted among 495 workers at a home appliance manufacturing factory.413 (83.4 %) employees were male and 82 (16.6 %) were female.

The mean age of the subjects was 33.49 with a standard deviation of 6.20 (20–53). In this study, 362 employees (73.1 %) were married and 133 (26.9 %) were single. Each participant had, on average, 1.3 children (ranging from 1 to 4). 85.9 % of participants did not smoke. The mean consumption of cigarettes pack / year was 3.56 (0.03-20). The average height of workers was 173.58 cm (148–199) and mean weight 78.74 kg (47–148). The average body mass index (BMI) was recorded at 26.04 (16.36–44.68). In terms of physical activity, 205 (41.4 %) employees have replayed positive and 290 (58.6 %) negative. On average working experience was 10.41 years (1–30) with average 11.86 working hours (8–15). Notably none of the workers had shift work. Thirty-two workers, or twenty-eight percent, were exposed to noise levels above 85 dB, while 352 workers, or seventy-one percent, were exposed to louder noise. However, majority of them (72.1 %) did not use hearing protection devices. Among those using hearing protection devise 2.4 % have chosen earplugs and 25.5 % opted earmuffs. The results of the survey on cardiovascular risk factors showed that the average blood pressure was 110.53 mmHg (80–190) for the systolic and 78.51 mmHg (60–120) for the diastolic. The average FBS was 90.42 mg/dL (60–284). For lipid profile a mean TG level was recorded at 157.94 mg/dL (39–827) and cholesterol at 174.18 mg/dL (106–315). In addition, the average HDL was reported as 42.41 mg/dL (10–58) and LDL as 101.31 mg/dL (20–236).

Table 1 represents the comparison of cardiovascular risk factors between two noise-exposed groups. Individuals exposed to noise levels greater than 85 dB had higher means for both diastolic blood pressure and TG (p-value < 0.05).

We defined the cardiovascular risk factors as qualitative variables in order to assess the relationship between the level of noise exposure and cardiovascular risk factors. Chi–square analysis showed that occupational exposure to noise levels above 85 dB is correlated with TG above 150 mg/dl, LDL below 100 mg/dl, FBS below 126 mg/dl, and physical activity (more than 150 minutes per week) (p-value < 0.05). Table 2 presents the findings.

Following logistic regression to remove the impact of confounding variables, relationship between FBS, LDL, TG and physical activity remained statistically significant (table 3).

DISCUSSION

The survey was conducted among 495 workers at a home appliance manufacturing factory. The result demonstrated relationship between occupational noise and cardiovascular risk factor. It revealed significant correlation between exposure to noise above 85 db and elevated levels of TG, LDL, FBS and reduced physical activity. One of the most common workplace hazards, according to other studies, is noise pollution [7]. In a case-control study which was conducted in 2021 in a power plant industry, it was revealed that exposure to occupational noise

TABLE 1

CARDIOVASCULAR RISK FACTORS BETWEEN TWO NOISE-EXPOSED GROUPS – T TEST

	Occupational noise exposure level	Mean	Standard deviation	*p-value*
SBP*	< 85	109/8011	12/14655	NS
	> 85	112/3287	15/48592	
DBP †	< 85	78/0256	5/68719	0.002
	> 85	79/7203	4/73882	
FBS ‡	< 85	89/30	16/081	NS
	> 85	93/17	22/217	
TG §	< 85	147/94	83/518	0.001 >
	> 85	182/56	117/089	
Chol II	< 85	175/25	36/174	NS
	> 85	171/55	33/613	
HDL ¶	< 85	42/56	4/494	NS
	> 85	42/05	5/883	
LDL #	< 85	103/60	31/686	NS
	> 85	95/68	31/128	

Note. *Systolic Blood Pressure, † Diastolic Blood Pressure, ‡ Fasting Blood Sugar, § Triglyceride, II Cholesterol, ¶ High Density Lipoprotein, # Low Density Lipoprotein.

TABLE 2

CARDIOVASCULAR RISK FACTORS BETWEEN TWO NOISE-EXPOSED GROUPS – CHI–SQUARE

		SBP*≥140 mmHg	DBP†≥ 90 mmHg	chol‖≥200 mg/dl	TG§≥150 mg/dl	HDL¶<LLN	LDL#≥100 mg/dl	FBS‡≥126 mg/dl	Smoking	Physical Activity (<150 minute per week)	BMI≥ 25 kg/m²
Noise exposure	> 85 db	6 (4.2%)	9 (%6.3)	25 (17.5%)	74 (51.7%)	61 (42.7%)	63 (44.1%)	9 (6.3%)	22 (4/15%)	83 (0/58 %)	82 (3/57 %)
	< 85 db	9 (2.6%)	13 (3.7%)	70 (19.5%)	136 (38.6%)	152 (43.2%)	194 (55.1%)	6 (1.7%)	48 (6/13%)	122 (7/34 %)	209 (4/59 %)
	P value	0.33	0.20	0.53	0.007	0.91	0.02	0.007	0.67	0.001 >	0.67
	OR (CI)	1.6 (0.5 – 4.7)	1.75 (4.19-0.73)	0.85 (1.41-0.51)	1.70 (2.52-1.15)	0.97 (1.45-0.66)	0.64 (0.94-0.43)	3.87 (11.09-1.35)	15/1 (1.99 – 0.66)	0.38 (0.57 – 0.25)	0.92 (1.36 – 0.62)

Note. *Systolic Blood Pressure, † Diastolic Blood Pressure, ‡ Fasting Blood Sugar, § Triglyceride, ‖ Cholesterol, ¶ High Density Lipoprotein, HDL<40 for male and <50 for female, # Low Density Lipoprotein.

TABLE 3

LOGISTIC REGRESSION

		Beta	Standard error	Significance	Odds ratio	95% Confidence interval	
						Lower	Upper
Step 1[a]	TG§	.495	.209	.018	1.640	1.088	2.472
	LDL#	.514	.209	.014	1.672	1.109	2.519
	FBS‡	1.177	.562	.036	3.244	1.079	9.755
	Physical activity	.954	.208	.000	2.595	1.728	3.898
	DBP†	-.510	.488	.295	.600	.231	1.561
	Constant	-1.379	.507	.007	.252		

Note. † Diastolic Blood Pressure, ‡ Fasting Blood Sugar, § Triglyceride, # Low Density Lipoprotein.

above the permissible level, can affect the cardiovascular disease risk factors including mean FBS, triglyceride, liver enzyme, blood pressure, and BMI [8]. In a cross sectional study including 6,266 participants, exposure to occupational noise, particularly at higher intensities and longer durations, was associated with increased risk of cardiovascular diseases [9]. McNamee and et al. have indicated that long-term exposure to high-level sounds is not only associated with hearing loss, but also causes cardiovascular diseases which were in the line with our study [10]. Moreover, chronic occupational noise exposure has been linked to increased mortality and the incidence of cardiovascular disease, according to epidemiological studies [2, 11-13]. A psycho-social stressor, noise can raise blood pressure, blood fat, and blood glucose levels, which is the pathological foundation of cardiovascular diseases [6]. Apart from noise, other variables that can cause hearing impairments include age, gender, race, family history of ear infections, and metabolic conditions like diabetes and hypertriglyceridemia [14, 15]. The degree of hearing loss appeared to be correlated with elevated FBS, TG, and free thyroxine levels [16]. Moreover, other findings show that high level of dyslipidemia indicators, including cholesterol and triglycerides, through disruption of lipid microcirculation in the inner ear can also cause hearing loss [17]. Important factors that support the electromotor and cochlear functions include the lipid composition, fluidity, and stiffness of the outer hair cell membrane. Thus, any dyslipidemia disorder has the potential to affect how the outer hair cells function and result in inner ear microcirculatory problems [14]. Rashnuodi and colleagues revealed that guinea pig cochlea cell stiffness and consequent inner ear dysfunction can result from the absorption of water-soluble cholesterol in the external hair follicles [18]. Conversely, after controlling for confounding variables, years of noise exposure were associated with an increased blood cholesterol level in a non-linear dose-response manner with respect to Kun Zhang study [19]. Currently, plenty of evidences show that exposure to sound can enhance blood pressure and blood glucose [20, 21]. In addition, the vascular system is affected and capillary blood flow is reduced, which can lead to hearing loss due to reduced O2 transport and tissue hypoxia [22]. A blood brain barrier-like structure called the inner ear blood labyrinth barrier (BLB) divides inner ear fluids (endolymph and perilymph) from blood vessels in the brain. When the BLB of the cochlea becomes dysfunctional due to hypertension or vascular damage, endolymph ion homeostasis is disrupted, which may result in depolarization of hair cells and hearing loss [23]. Exposure to noise has been shown to inhibit pancreatic insulin secretion and decrease insulin sensitivity in the liver, skeletal muscle, and adipose tissue. It also plays a crucial role in the secretion of various stress hormones, including cortisol, which can cause hyperglycemia [24, 25]. Regarding how noise exposure affects cardiovascular risk factors, there is disagreement among the results. The average fasting blood sugar, triglycerides, blood pressure, and body mass index were significantly correlated in 2023 in a study carried out in a large Iranian power plant industry [26]. The findings of this study were nearly identical to those of our own, although we did not find a significant correlation between noise exposure and body mass index. This finding may have resulted from the different socioeconomic backgrounds and smaller sample sizes of our study's participants. According to MG Kim et al. research, occupational noise exposure results in both pre-hypertension and hypertension [27], Therefore their results are not completely consistent with our study, which may be due to the difference in the sample size, the gender of the participating workers (in the Korean study, all workers were male), Food and cultural habits. Chang et al. found that workers exposed to occupational noise exceeding 80 dB were notably more likely to experience elevated blood sugar levels, which is consistent with our findings [28]. Apart from LDL and FBS levels, a further study on 65 female textile industry workers in India who were subjected to high noise levels showed a significant relationship between the lipid profiles [29]. But in our study, there was substantial correlation between the sound of more than 85 db and the increase of triglycerides, the increase of LDL and the increase of diastolic blood pressure and FBS. Another inquiry showed that in the noise exposure group vs. the control group, the systolic and diastolic blood pressure were higher [30]. Weil the only significant relationship found in our study was between noise and elevated diastolic blood pressure. Masoud Naqab and colleagues conducted a study. Found that workers who experienced high levels of noise had hypertriglyceridemia, which aligned with our findings [31]. In addition, Ismaila and colleagues showed a significant correlation between occupational noise exposure and systolic blood pressure, but no correlation was found for diastolic blood pressure, which was inconsistent with our findings [32]. The variation in the sample size and the workers' gender may be the cause. However, in an investigation carried out by Lee et al. The mean systolic blood pressure of metal production workers in Korea in 2009 was 3 points 8 mmHg higher than that of office workers in the group exposed to noise levels exceeding 85 dB [33]. This study was not aligning with our results concerning the increase in diastolic blood pressure. Regarding Maria Foraster et al. [34] relationship between noise caused by vehicles and the amount of physical activity, showed that long-term noise disturbance leads to a decrease in average physical activity which either directly by reducing the desire to exercise or by disrupting sleep quality and increasing daytime sleepiness. Regarding physical activity, in our study, people who were exposed to noise over 85 db had more physical activity, which indicates that people with more physical strength work at higher noise level.

In fact, noise pollution in the workplace is known to occur to varying degrees depending on the workplace and the duties of individual workers. Due to the impossibility of getting exact noise exposure measurements for every employee, the average sound pressure level throughout the entire workspace was used to assess noise exposure instead of measuring noise exposure for each

worker. Even within this region, some workers may have higher exposure than others, and workers may also move from one region to another. These issues may lead to measurement bias in study's results. Furthermore, cross-sectional nature of the study does not show a causal relationship. In addition, unwillingness to participate in the study and failure to recall medical information (Recall Bias) were other limitation factors.

CONCLUSION

The findings of this study showed that cardiovascular disease risk factors, particularly TG, LDL, and FBS in workers, are impacted by noise exposure above the recommended threshold. Thus, the following advice is advised: using engineering control, management, and hearing protection equipment, among other principles of hearing protection, can lower the risk of cardiovascular diseases. Furthermore, it halted the development of cardiovascular complications by conducting timely diagnosis and periodic measurement and screening of cardiovascular diseases at shorter intervals and with greater accuracy in individuals exposed to occupational noise.

Conflict of Interest

No conflict of interest exists, according to the authors.

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REFERENCES

1. Toyama K, Mogi M. Hypertension and the development of hearing loss. *Hypertens Res*. 2022; 45(1): 172-174. doi: 10.1038/s41440-021-00789-w

2. Shukla A, Harper M, Pedersen E, Goman A, Suen JJ, Price C, et al. Hearing loss, loneliness, and social isolation: a systematic review. *Otolaryngology – Head and Neck Surgery*. 2020; 162(5): 622-33. doi: 10.1177/0194599820910377

3. Teixeira LR, Azevedo TM, Bortkiewicz A, Da Silva DTC, De Abreu W, De Almeida MS, et al. WHO/ILO work-related burden of disease and injury: Protocol for systematic reviews of exposure to occupational noise and of the effect of exposure to occupational noise on cardiovascular disease. *Environment international*. 2019; 125: 567-78. doi: 10.1016/j.envint.2018.09.040

4. Chang T-Y, Hwang B-F, Liu C-S, Chen R-Y, Wang V-S, Bao B-Y, et al. Occupational noise exposure and incident hypertension in men: a prospective cohort study. *Am J Epidemiol*. 2013; 177(8): 818-25. doi: 10.1093/aje/kws300

5. Schmidt FP, Basner M, Kröger G, Weck S, Schnorbus B, Muttray A, et al. Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults. *Eur Heart J*. 2013; 34(45): 3508-14a. doi: 10.1093/eurheartj/eht269

6. Hosseininejad M, Salehi F, Mirzamohammadi E, Mohsenizadeh SA, Mohammadi S. The relationship between occupational exposure to organic solvents and metabolic syndrome in petroleum refinery workers in Tehran, Iran. *Diabetes Metab Syndr*. 2021; 15(5): 102223. doi: 10.1016/j.dsx.2021.102223

7. Zhang L, Chen S, Chen Z, et al. Relationship between occupational noise exposure and hypertension: Cross-sectional evidence from real-world. *Front Public Health*. 2022; 10: 1037246. doi: 10.3389/fpubh.2022.1037246

8. Mohammad-Ghasemi M, Dehghani-Bidgoli S, Ahmadi T, Nikbakht N, Heidarifar S, Sadeghi-Yarandi M. Investigating the effect of workplace noise exposure on cardiovascular disease risk factors in a power plant industry: A case-control study. *Work*. 2023; 76(4): 1429-40. doi: 10.3233/WOR-220396

9. Guo X, Davies HW, Karim ME. The intensity and duration of occupational noise exposure and cardiovascular disease in the United States: a nationally representative study, 2015 to 2020. *Annals of Work Exposures and Health*. 2024; 68(1): 36-47. doi: 10.1093/annweh/wxad065

10. McNamee R, Burgess G, Dippnall WM, Cherry N. Occupational noise exposure and ischaemic heart disease mortality. *Occup Environ Med*. 2006; 63(12): 813-9. doi: 10.1136/oem.2005.026245

11. Li W, Shu S, Cheng L, Hao X, Wang L, Wu Y, et al. Fasting serum total bile acid level is associated with coronary artery disease, myocardial infarction and severity of coronary lesions. *Atherosclerosis*. 2020; 292: 193-200. doi: 10.1016/j.atherosclerosis.2019.11.026

12. Yang Y, Zhang E, Zhang J, Chen S, Yu G, Liu X, et al. Relationship between occupational noise exposure and the risk factors of cardiovascular disease in China: a meta-analysis. *Medicine*. 2018; 97(30): e11720. doi: 10.1097/MD.0000000000011720

13. Guo X, Davies HW, Karim ME. The intensity and duration of occupational noise exposure and cardiovascular disease in the United States: a nationally representative study, 2015 to 2020. *Annals of Work Exposures and Health*. 2024; 68(1): 36-47. doi: 10.1093/annweh/wxad065

14. Doosti A, Lotfi Y, Bakhshi E. Effects of Hyperlipidemia on Noise Induced Hearing Loss (NIHL). *Indian J Otolaryngol Head Neck Surg*. 2016; 68(2): 211-3. doi: 10.1007/s12070-015-0855-2

15. Han X, Wang Z, Wang J, Li Y, Hu H, Hu Y, et al. Metabolic syndrome is associated with hearing loss among a middle-aged and older Chinese population: a cross-sectional study. *Ann Med*. 2018; 50(7): 587-595. doi: 10.1080/07853890.2018.1469786

16. Abd EL-Gaffar ES, Abd El-Samad HM, Abd El-Salam GMS. The significance of routine laboratory parameters in patients with sudden sensorineural hearing loss. *Indian J Otolaryngol Head Neck Surg*. 2013; 65(Suppl 3): 553-6. doi: 10.1007/s12070-012-0480-2

17. Sutbas A, Yetiser S, Satar B, Akcam T, Karahatay S, Saglam K. Low-cholesterol diet and antilipid therapy in managing tinnitus and hearing loss in patients with noise-induced hearing loss and hyperlipidemia. *Int Tinnitus J*. 2007; 13(2): 143-9.

18. Rashnuodi P, Amiri A, Omidi M, Mohammadi A. The effects of dyslipidemia on noise-induced hearing loss in petrochemical workers in the southwest of Iran. *Work*. 2021; 70(3): 875-82. doi: 10.3233/WOR-213607

19. Zhang K, Jiang F, Luo H, Liu F. Occupational noise exposure and the prevalence of dyslipidemia in a cross-sectional study. *BMC Public Health*. 2021; 21: 1-9. doi: 10.1186/s12889-021-11274-x

20. Roswall N, Raaschou-Nielsen O, Jensen SS, Tjønneland A, Sørensen M. Long-term exposure to residential railway and road traffic noise and risk for diabetes in a Danish cohort. *Environmental research*. 2018; 160: 292-7. doi: 10.1016/j.envres.2017.10.008

21. Brahem A, Riahi S, Chouchane A, Kacem I, Maalel O, Maoua M, et al. Impact du bruit professionnel sur le développement de l'hypertension artérielle: enquête réalisée au sein d'une centrale de production d'électricité et de gaz en Tunisie. *Ann Cardiol Angeiol (Paris)*. 2019; 68(3): 168-174. [Brahem A, Riahi S, Chouchane A, Kacem I, Maalel O, Maoua M, et al. Impact of occupational noise in the development of arterial hypertension: A survey carried out in a company of electricity production. *Ann Cardiol Angeiol (Paris)*. 2019; 68(3): 168-174. (In French)]. doi: 10.1016/j.ancard.2018.10.008

22. Nyberg S, Abbott NJ, Shi X, Steyger PS, Dabdoub A. Delivery of therapeutics to the inner ear: The challenge of the blood-labyrinth barrier. *Sci Transl Med*. 2019; 11(482): eaao0935. doi: 10.1126/scitranslmed.aao0935

23. Sun W, Wang W. Advances in research on labyrinth membranous barriers. *Journal of otology*. 2015; 10(3): 99-104. doi: 10.1016/j.joto.2015.11.003

24. Morakinyo AO, Samuel TA, Awobajo FO, Adekunbi DA, Olatunji IO, Binibor FU, et al. Adverse effects of noise stress on glucose homeostasis and insulin resistance in Sprague-Dawley rats. *Heliyon*. 2019; 5(12): e03004. doi: 10.1016/j.heliyon.2019.e03004

25. Yaghoubi K, Alimohammadi I, Abolghasemi J, Shandiz MS, Aboutaleb N, Ebrahimi H. The relationship between noise annoyance and salivary cortisol. *Applied Acoustics*. 2020; 160: 107131. doi: 10.1016/j.apacoust.2019.107131

26. Dehaghi BF, Mohammadi A, Amiri A. Investigation of the Relationship between Noise-Induced Hearing Loss and Metabolic Syndrome in One of the Oil Industries in the South of Iran. *Indian J Otolaryngol Head Neck Surg*. 2023; 75(Suppl 1): 43-49. doi: 10.1007/s12070-022-03187-x

27. Kim MG, Ahn Y-S. The relationship between occupational noise exposure and hypertension using nearest age-matching method in South Korea male workers. *Cogent Engineering*. 2021; 8(1): 1909798. doi: 10.1080/23311916.2021.1909798

28. Chang T-Y, Yu T-Y, Liu C-S, Young L-H, Bao B-Y. Occupational noise exposure and its association with incident hyperglycaemia: a retrospective cohort study. *Scientific reports*. 2020; 10(1): 8584. doi: 10.1038/s41598-020-65646-1

29. Gupta S, Gulati S, Gupta G. Metabolic syndrome in female workers from a textile mill: effect of noise. *Asian Journal of Pharmaceutical and Clinical Research*. 2017: 400-2. doi: 10.22159/ajpcr.2017.v10i2.15917

30. Liu J, Xu M, Ding L, Zhang H, Pan L, Liu Q, et al. Prevalence of hypertension and noise-induced hearing loss in Chinese coal miners. *Journal of thoracic disease*. 2016; 8(3): 422. doi: 10.21037/jtd.2016.02.59

31. Neghab M, Karimi H, Tabatabaee SHR, Soleimani E, Kasaeinasab AA. Effects of Occupational Noise Exposure on Hearing Status, Blood Lipid and Hypertension Levels in Workers of a Fireclay Mine. *J Health Sci Surveillance Sys*. 2014; 2(3): 107-112. URL: https://jhsss.sums.ac.ir/article_42758.html [date of access: May 20, 2024]

32. Ismaila SO, Odusote A. Noise exposure as a factor in the increase of blood pressure of workers in a sack manufacturing industry. *Beni-Suef University Journal of Basic and Applied Sciences*. 2014; 3(2): 116-21. doi: 10.1016/j.bjbas.2014.05.004

33. Lee JH, Kang W, Yaang SR, Choy N, Lee CR. Cohort study for the effect of chronic noise exposure on blood pressure among male workers in Busan, Korea. *American journal of industrial medicine*. 2009; 52(6): 509-17. doi: 10.1002/ajim.20692

34. Foraster M, Eze IC, Vienneau D, et al. Long-term transportation noise annoyance is associated with subsequent lower levels of physical activity. *Environ Int*. 2016; 91: 341-9. doi: 10.1016/j.envint.2016.03.011

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