Journal of Air Pollution and Health (Autumn 2021); 6(4): 257-264

Original Article

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Histopathological changes caused by noise exposure in lung, heart, kidney, and liver tissues in New Zealand white rabbits

Amirreza Abouee Mehrizi[1,2], Yahya Rasoulzadeh[2,], Shamseddin Saed Moucheshi[1,2], Ahmad Mehdipour[3]*

[1] Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran
[2] Department of Occupational Health Engineering, Faculty of Health, Tabriz University of Medical Sciences, Tabriz, Iran
[3] Department of Tissue Engineering, Faculty of Advanced Medical Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

ARTICLE INFORMATION

Article Chronology:
Received 20 October 2021
Revised 28 November 2021
Accepted 15 December 2021
Published 30 December 2021

Keywords:
Noise; Environmental exposure; Occupational exposure; Toxicology; Histopathology

CORRESPONDING AUTHOR:

rasoulzadehy@tbzmed.ac.ir
Tel : (+98 41) 33376228
Fax : (+98 41) 33376228

ABSTRACT

Introduction: Noise exposure is a common phenomenon in all personal life activities. Due to the prevalence of exposure to noise, many people are exposed to noise. Some of the harmful effects of noise on human health have been proven so far. The purpose of this study was to experiment histopathological effects caused by exposure to white noise.

Materials and methods: Four New Zealand white rabbits were exposed to 85±2 dB white noise for five consequent days. Heart, kidney, liver, and lung tissues were studied by the Hematoxylin and Eosin staining (H&E) method. The independent t-test was used for comparing the mean weight of tissues.

Results: This study showed that exposure to 85±2 dB white noise did not significantly change heart and lungs tissues. Nevertheless, this study indicated that exposure to noise induced different pathological changes in kidney and liver tissues. Exposure to noise made congestion, unclear brush border, and tubular cell vacuolization in kidney tissue. Moreover, eosinophilic cytoplasm was made by noise exposure in liver tissue. Furthermore, no statistically significant difference was detected in the mean tissue weight/mean body weight in rabbits.

Conclusion: This study showed that exposure to noise might be a risk factor for different renal and hepatic diseases. Nevertheless, more studies need to complete these results.

Introduction

Noise pollution is an important physically harmful factors in work environments in different countries [1, 2]. In recent years, noise pollution is one of the factors affecting the quality of life of people around the world [3]. Noise exposure has made different concerns toward health experts who protect worker's life [4]. Noise pollution not only

Please cite this article as: Abouee Mehrizi A, Rasoulzadeh Y, Saed Moucheshi Sh, Mehdipour A. Histopathological changes caused by noise exposure in lung, heart, kidney, and liver tissues in New Zealand white rabbits. Journal of Air Pollution and Health. 2021; 6(4): 257-264.

creates physiological effects, but also leads to psychiatric and psychological disorders [5, 6].

Noise is a prevalent stressors in the workplace [7]. In general, the effects of noise on humans are divided into two separate parts: auditory and non-auditory [8]. The most important non-auditory effects of noise exposure include disorders of the cardiovascular system, nervous system, reproductive system, and endocrine system [1, 9].

Previous studies showed that vital organs are more susceptible to stressors than other organs [10-13]. Studies that focused on the health effects of noise have emphasized the impact of noise on different organs such as the lung, the heart, the liver, and kidneys [14-17]. Some degrees of inflammation has been shown in lung tissue due to noise exposure [14]. Nephrotoxic effects have been detected after exposure to noise [16, 18]. Moreover, liver and heart tissues were also changed significantly by different ranges of noise [14, 16, 19]. These studies demonstrated the fact that noise should not be considered a traditional stimulus. In fact, much more studies and measures need to be considered than before in order to prevent serious health effects caused by this prevalent stressor.

Due to the widespread noise exposure and the importance of non-auditory effects of noise, this study was performed to investigate the pathological effects of noise exposure on liver, lung, heart, and kidney tissues.

Materials and methods

Animals and experimental groups

In total, 8 male New Zealand white rabbits (Pasteur Institute of Tehran) were included in experiments. Rabbits were four-month old and weighing 2.83±0.41 kg. Exposure duration was 8 h/day. Exposure was done during 5 consecutive days. Time exposure was 9:00 A.M to 5:00 P.M. Rabbits were kept in stainless steel cages on a 12 h light/dark cycle. The temperature was monitored and maintained at 21±2 °C. Rabbits were free access to rabbit pellet and treated water. Rabbits were segregated into two groups including group 1 (control), group 2 (noise).

Exposure chamber

The reverberant chamber specifications and animals' welfare requirements were considered in designing the exposure chamber [19, 20]. Clear polycarbonate sheets were used to make the exposure chamber. The exposure chamber was made at the sizes of 50*60*90 cm^3.

Control setup

Control group were placed in the exposure chamber for 5 consecutive days like noise exposure group, lacking generation of noise. The air flow rate was like noise exposure group (33 L/min). The background noise for control group was below 50 dB.

Exposure setup

Group 2 was exposed to 85±2 dBA. Audacity® software (1.3.12 Beta) was used to produce using the noise. Cool Edit (Version 2.1 ©1992-2003 Syntrillium Software Corporation) was used to monitor the noise online and continuously. A noise generator device (laptop), an amplifier (3030 W, MULTI TONE), and a speaker were prepared to generate noise. A sound analyzer real-time (TES 1358 Sound Analyzer Real-Time) was used to monitor the noise practically in the exposure chamber. The microphone of the sound analyzer was located inside the exposure chamber at the animal's hearing height (Fig. 1).

Overall, the clean air flow rate was 33 L/min, and the air flow rate was checked using a calibrated flow meter (Platon, Roxspur Measurement and Control Ltd, 2 Downgate Drive, SHEFFIELD, South Yorkshire, Yorkshire and The Humber S4 8BT, England).

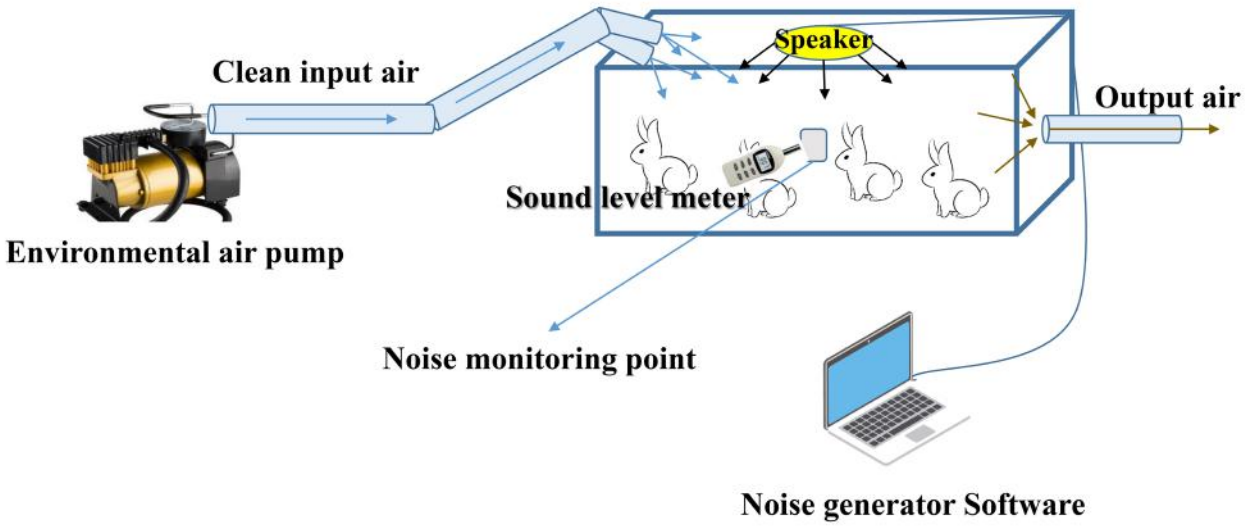

Fig. 1. Noise exposure set-up

Histopathological experiments

A mixture of 5 mg/kg xylazine and 35 mg/kg ketamine was used to anesthetize the animals after the end of experiments. Hearts, livers, kidneys, and lungs were extracted when the animals were anesthetized. After that, 1×1×1 cm^3 of the tissues were collected and fixed in formalin (10% formaldehyde solution, Merck with PH 7.2).

The process of dryness, clearing up and paraffin impregnation were done by an auto technicon. A typical diameter of 5 µm were prepared by microtome after paraffin molding. Finally, hematoxylin-eosin staining was carried out. A Nikon Eclipse light microscopy was used to observe histopathologic lesions.

Statistical analysis

The independent t-test statistical method was used to compare tissue weight/body weight between exposure group and control group using SPSS (version 25). All vales had a normal distribution.

Results and discussion

The analysis of pathologic slides showed kidneys, liver, heart, and lung tissues at a normal condition in the control group (Figs. 2 to 5). Although heart and lung tissues appeared normal in noise exposure group, liver and kidney tissues had some pathological changes by noise exposure. Eosinophilic cytoplasm appeared in liver tissue in noise exposure group (Fig. 4). Moreover, congestion, unclear brush border, and tubular cell vacuolization indicated in kidney tissue in noise exposure group (Fig. 5). Furthermore, there was no significant difference between tissue weights/body weights of rabbits (Table 1).

Table 1. The mean tissue weight/mean body weight in rabbits

Tissue	Control (X±SD)	Noise exposure group (X±SD)	P-value
Heart	5.44 ± 0.38	4.78 ± 0.44	0.74
Lung	8.89 ± 0.63	9.40 ± 0.47	0.38
Liver	45.25 ± 2.36	46.36 ± 3.34	0.35
Kidney	5.16 ± 0.15	5.50 ± 0.26	0.17

X: The mean tissue weight (g)/mean body weight (kg) (n=4)

SD: Standard deviation

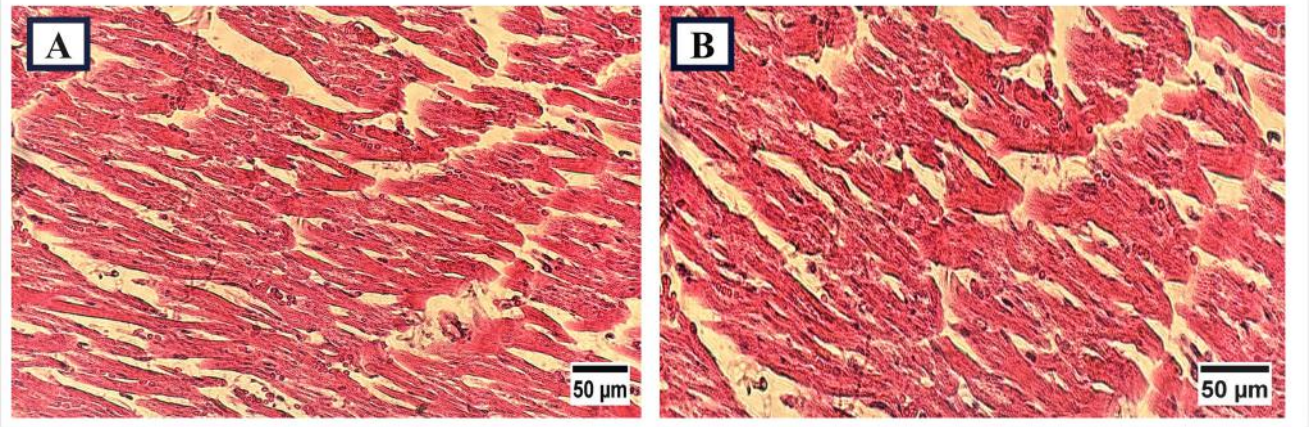

Fig. 2. Representative photographs of heart tissue lesions stained with hematoxylin-eosin at 40x objective magnification; control (A) and exposure to 85±2 dB noise (B) in normal condition (n= 4)

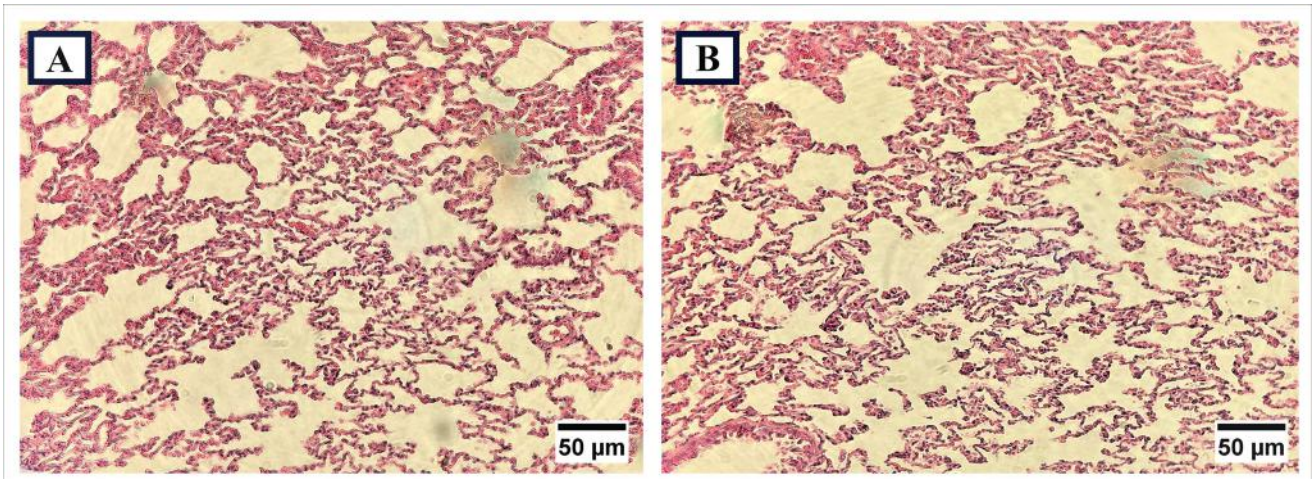

Fig. 3. Representative photographs of lung tissue lesions stained with hematoxylin-eosin at 40x objective magnification; control (A) and exposure to 85±2 dB noise (B) in normal condition (n= 4)

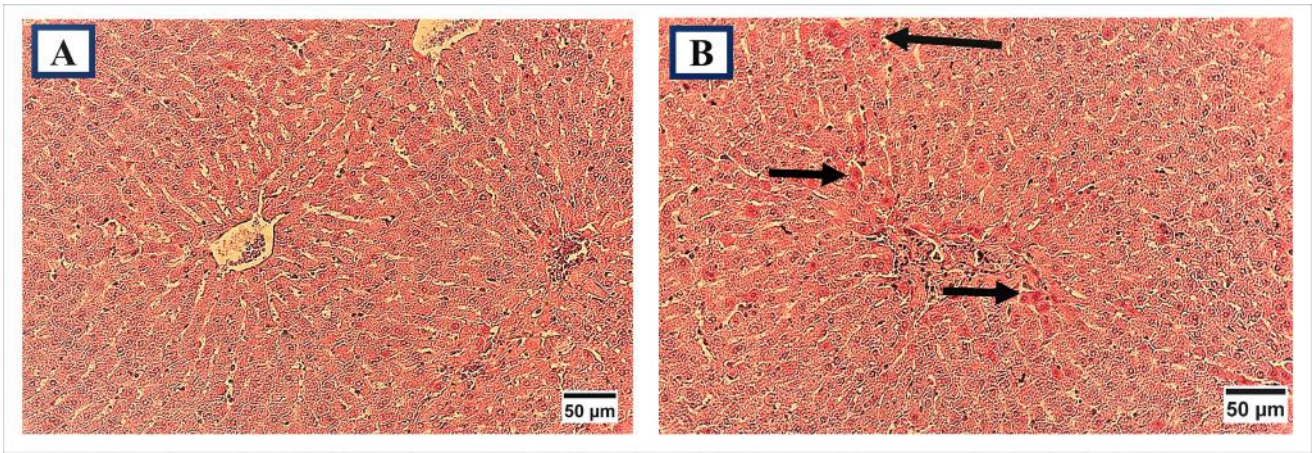

Fig. 4. Representative photographs of liver tissue lesions stained with hematoxylin-eosin at 40x objective magnification. Control group (A) appeared in normal condition, but exposure to noise (B) made eosinophilic cytoplasm (➞) (n= 4)

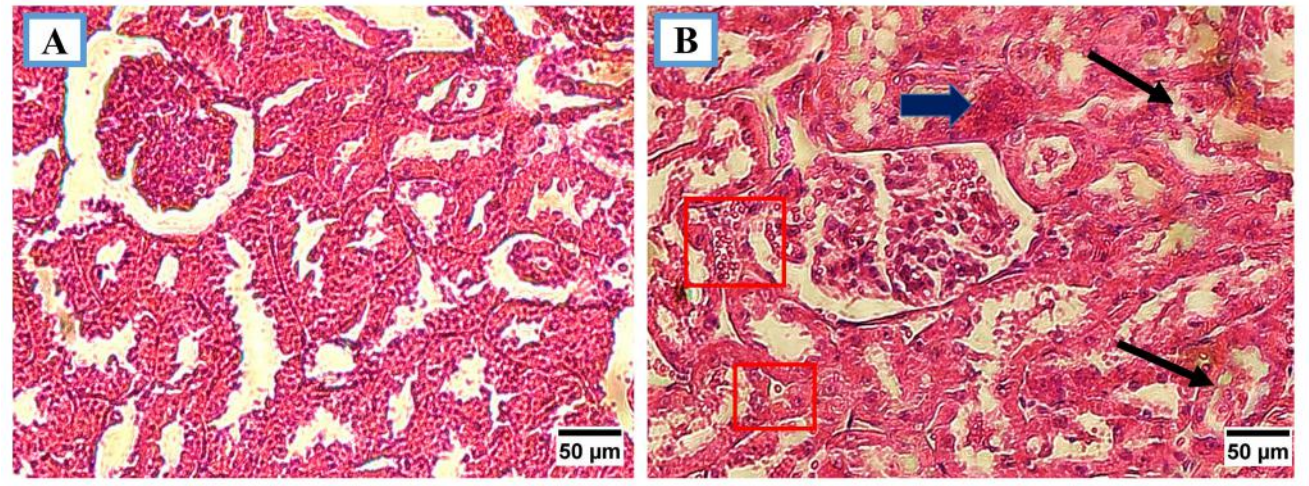

Fig. 5. Representative photographs of kidney tissue lesions stained with hematoxylin-eosin at 40x objective magnification. Control group (A) appeared in normal condition. Unclear brush border (➡), congestion (➞), and tubular cell vacuolization (▭) appeared in noise exposure group (B) (n= 4).

Noise exposure caused tubular cell vacuolization and congestion in kidneys. Previous studies reported congestion, swollen, and disorganization in renal cells that caused by 2 weeks exposure to 100 dB [18]. Furthermore, 87 dB construction noise made lipidosis and swelling after one-year exposure in kidney tissue in Wistar rats [17]. As a result, it could be discussed that exposure to noise possibly aggravates some kidney syndromes.

The current study disclosed that exposure to 85 dB white noise made eosinophilic cytoplasm in liver tissue. Some destructive effects such

as lipidosis and swelling caused by exposure to a high level of noise have been reported in Wistar rats [17]. Previous studies indicated that exposure to noise during four weeks enhanced the area of collagen connective tissue in liver tissue [21]. It has been shown that 2 weeks noise exposure at 90 dB induced congestion of the central vein and hepatic sinus. Moreover, devastated hepatic lobule in liver tissue caused by inflammatory cell infiltration was identified in female rats [22]. Therefore, noise is a significant risk factor for liver tissue.

Although this study couldn't find any significant histopathological changes caused by exposure to 85 dB noise during 5 consecutive days in heart and lung tissues in rabbits, some previous studies found some pathological changes in rats. Previous studies showed that exposure to noise induced inflammatory cells and dilated veins in endocardium in Wistar rats [23]. Mild hyperemia and deformation in myocardial cells in adult rats were revealed by exposure to 90 dB noise [22].

Fibrosis, peribronchiolar infiltration, alveoli obliteration, thickened the walls of blood vessels have been reported that induced by exposure to 90 dB noise in liver tissue in female rats [14]. Furthermore, pneumonia, congestion, and edema were identified by exposure to 87-120 dB noise for one year in liver tissue in Wistar rats [17].

This study indicated that liver and kidney tissues are more vulnerable to the disorders caused by noise exposure compared to lung and heart tissues. Duration of exposure and noise intensity are the most important factors in inducing different pathological effects. However, more studies should be done to make a definite conclusion around this matter.

Conclusion

This study showed that exposure to noise can affect kidney and liver tissues. The results obtained from this study may possibly use in in the field of environmental and occupational health sciences. Nevertheless, more studies need to define the different health effects of exposure to in laboratory animals. Limited sample size, same intensities and frequencies of noise, and limited exposure time are the most important limitation of this study.

Financial supports

This study was supported by Tabriz University of Medical Sciences.

Competing interests

There was no conflict of interest to disclose.

Acknowledgements

The authors would like to appreciate Tabriz University of Medical Sciences.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely ob-served by the authors. All experiments were done in accordance with the National Institutes of Health's ethical guidelines for the care and use of laboratory animals (NIH publication 85-23, revised 1985).

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