

## The effects of modern therapies on noise pollution affecting hearing loss: challenges and novelty

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### Abstract

**Background:** Human reactions to noise pollution can have detrimental consequences for physical and mental health. Increased infection in the workplace or the surrounding area can cause deafness and its disorders, tinnitus, high blood pressure, coronary artery disease, and sleep disorders. Changes in the immune system and birth defects have also been attributed to exposure to noise pollution. Adverse effects and cardiovascular complications due to constant exposure to noise pollution prevent human blood pressure from experiencing a regular cycle of increase and decrease around the clock. The most important sources of such pollution are cars, airplanes, long-term exposure to loud music, and industrial noise. In the European Union, more than 10,000 people die each year due to the effects of noise pollution. The level of noise pollution during the night causes the production and permanent increase of cortisol, which increases the risk of heart attack.

**Aim:** The aim of this study was to review the results of research on the role of antioxidants and other protective agents against the destructive effects of free radicals on hearing loss and deafness.

**Methods:** In this research, using the desired keywords in valid databases (PubMed, Scopus, and Medline), articles from 2016 to 2020 were performed and then this study was written by studying the selected articles.

**Results:** The results showed that most of the pollution is caused by cars, airplanes, long-term exposure to loud music and industrial sounds, as well as protection and training methods, as well as the use of neurotrophic agents and antioxidants and cell therapy. Gene therapy is effective in treating deafness caused by infection.

**Conclusion:** The most appropriate method in the treatment of noise pollution and deafness is the prevention of areas with high noise and the use of antioxidants.

**Conflicts of Interest:** The Authors declare no conflicts of interest.

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### Introduction

Today, the most important effect of noise pollution is hearing loss. Exposure to loud noise for a long time is one of the main causes of hearing loss. Following hearing loss, people often experience anxiety, depression, isolation,

academic and occupational dysfunction, and other problems. Hearing loss is gradual and painless, but unfortunately its effects are permanent and irreversible, because the cochlear hair cells are not able to regenerate.

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Contrary to popular belief, deafness and hearing loss are not due to aging, but rather to exposure to abnormal noises (1, 2). Hearing loss, deafness, ringing and tinnitus are the effects of loud noise. If a person is continuously exposed to noise above 70 decibels for 8 hours, his blood pressure will rise to 5-10 db (3). High blood pressure, vasoconstriction (due to stress and increased adrenaline levels in the blood), increased risk of cardiovascular disease is some of the side effects of noise. Stress, anxiety, headache, fatigue, stomach ulcers, dizziness, muscle contractions, gastrointestinal disorders, increased cholesterol and white blood cell count, increased respiratory rate, heartburn, changes in normal endocrine function, heartburn or heartburn There are other side effects listed for noise (4, 5). Stimulating antisocial behaviors, violence, increasing rates of work-related accidents, cognitive developmental disorders in children, memory loss, mental disorders, irritability, aggression, decreased concentration, and reduced work efficiency are other side effects of noise. Free radicals are active substances that are the result of many factors such as smoking, air pollution or incomplete breakdown. Fat or protein is produced in the body (6). Oxygen-containing free radicals, known as reactive oxygen species, are the most important biological free radicals. Peroxide super-oxides, which are made up of oxygen, are free radicals. Free radicals can attack body fat, rupture cell membranes, or release toxins into surrounding tissues (7). These irreversible damage leads to altered cell function or cell death. Reactive nitrogen and oxygen species, including free radicals, are produced in the human body under both health and disease conditions. In a healthy state, their levels may increase as a result of regular mechanisms, a variety of intracellular signals, or bacterial agents. Their production is normally controlled by antioxidant defenses, which include intracellular enzymes such as glutathione peroxidase, superoxide dismutase,

and low molecular weight compounds such as vitamin E or ascorbic acid. Lipid peroxidation leads to oxidative stress. Lipid peroxidation means the addition of oxygen to unsaturated fatty acids to form hydrogen peroxides (8). Oxidation of plasma membrane phospholipids also within membranes of internal organs, including mitochondria, leads to biophysical changes that ultimately degrade membrane and organ function (9). Over the past decades, the rapid growth of knowledge of gaseous molecules including nitric oxide and carbon monoxide and hydrogen sulfide has been shown to play an important role in biological systems. In addition, since the potential of hydrogen gas as a therapeutic gas for diseases including cerebral infarction, which is caused by oxidative stress, basic and clinical research on hydrogen has been a priority (10). The aim of this study was to review the results of research on the role of antioxidants and other protective agents against the destructive effects of free radicals on hearing loss and deafness.

## Methods

This study reviewed 20 articles published from 2016 to 2020 on the antioxidant role of the hearing loss. The terms antioxidant was extracted from a combination of Medline, Google Scholar, PubMed and Scopus databases and were used in this article after reviewing and being relevant to the topic.

## Chemical pollution

The issue of pollution is one of the most important and acute issues of human civilization in the world today. The current human environment is always exposed to various pollutions due to human activities. Toxicity of environmental substances to the ear, such as metals, solvents, and suffocates (11, 12). Non-toxic oxygen-substituted gases and their interaction with noise are among the issues that have recently attracted the attention of researchers. The spread of hearing loss is

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considered. Cigarette smoke, with its high concentration of free radicals and other oxidants and their ability to react with oxygen and produce hydroxyl radicals, is one of the most stressful substances in the ear (13). Studies on humans exposed to chemicals in the workplace and studies on animals exposed to chemicals in laboratories have shown the increasing and concomitant toxic effects of noise and chemical agents such as organic solvents, auto toxic drugs, heavy metals and carbon monoxide is such that chemical agents are known to be potentially toxic in the workplace due to their abundance. Such observations represent important concepts in the field of industry (14).

The proposed metabolic mechanism to explain the aggravating effect of these chemical pollutants on the effects of noise includes the following: metabolic depletion of succinate dehydrogenase, Krebs cycle enzymes in sensory cells, especially foreign hair cells and striavascularis cells. Oxidation of nerve structures due to the production of free radicals and lack of oxygen in the cochlea have been studied in various studies. Their results show that the level of oxygen free radicals in the cochlea of animals exposed to both noise and carbon monoxide is significantly higher than that in animals exposed to noise alone (15). Finally, if cochlear cells are damaged by noise exposure, cell death of necrosis and apoptosis occurs.

### Discussion

Given that the problem of noise and chemical pollutants has become a global crisis, various thinkers and experts are looking for solutions that use technology to reduce its harmful effects. In this regard, several programs have been presented under the title of hearing protection programs. This set of programs, in order of priority, includes pollution control at the source, control in the emission environment, control at the human level, and control by

biological solutions (16). Effective methods to protect and prevent noise-induced hearing loss, i.e. stay away from crowded and noisy environments, are more common and often require high costs and advanced technology, and in many cases by factors such as inadequate facilities, economic constraints and even Cultural and social factors are limited, which is the use of hearing protectors. These methods are not effective enough to prevent noise-induced hearing loss. For this purpose, there is another method called biological prevention method, which includes various sets such as: cell therapy and gene therapy, antioxidants, neurotransmitters and drugs that increase blood flow and calcium channel blockers (17). Due to the destructive effects of free radicals in the face of noise and toxic substances in the ear, the best way to deal with free radicals is to use antioxidants. Antioxidants greatly prevent the oxidation of substances and the production of free radicals in the body (18).

Lipid peroxidation, including oxidative attacks on hair cells and other inner ear cells, occurs after exposure to noise and increased production of oxygen-derived free radicals. Studies have shown that hydrogen significantly reduces the level of lipid peroxidation and can neutralize free radicals and reduce oxidative stress, and as an antioxidant can selectively reduce radicals (19). Hydrogen has a protective effect against ischemic lesions in the brain, heart, lungs and liver. In ischemic lesion, a secondary inflammatory reaction causes damage after the blood flow is restored following its temporary cessation (20).

Hydrogen can reduce or prevent biochemical or pathological changes in cerebral infarction, liver and intestinal lesions, heart muscle, and general inflammation in animals. The hydrogen molecule has been suggested as a suitable therapeutic agent for the inner ear due to its permeability and low side effects (21).

Noise-induced hair cell destruction causes apoptosis and necrosis. Various studies have

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shown that hydrogen by its ability to penetrate into cells and intracellular organs such as mitochondria can stop the activity of caspase enzymes, which are related to the final stages - apoptosis and inflammation of the inflammatory process, respectively (22). Hydrogen can pass through biological membranes by diffusion; affecting organs such as mitochondria and nuclei, and improving auditory self-function due to its antioxidant properties. This ability of the hydrogen molecule reduces the cytotoxicity of free radicals. The labyrinth blood barrier blocks many of the therapeutic components and prevents them from reaching the cochlear hair cells, but it has been shown that the hydrogen molecule, with its permeability, is the only unique aspect of the hydrogen molecule that protects it (23).

### Conclusion

Due to the ease and safety of using antioxidants with minimal side effects and a useful therapeutic agent in reducing noise damage, which prevents the death of cochlear hair cells due to exposure to severe noise and through removing hydroxyl radicals and preserving cochlear cells and tissues reduces oxidative stress as well as protects hair cells from oxidative stress.

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