



## Combined Effect of Noise and Chemical Substances on Hearing: What is Known and Future Research Needs.

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Noise induced hearing loss (NIHL) is one of the most prominent occupational diseases in all regions of the world which could be caused by exposure to loud sounds or noise at a work in wide spectrum of industries. Globally, it is accounting for 16% of the disabling hearing loss in adults (over 4 million DALYs) with a range of 7% to 21% in the different subregions(1,2). It has been estimated that more than 30 million workers in the United States of America and around 30 millions of people in European countries are exposed to loud sounds (defined as hazardous by WHO) which might result in hearing loss(3). Occupations at highest risk for NIHL include firemen, armed police, police motorcyclists, soldiers, construction and factory workers, printers, foundry workers, musicians, farmers, lorry drivers and miners. Noise is considered one of the most pervasive and harmful agents in crowded cities as well. In a study conducted in South Eastern city of Iran-Zahedan, approximately more than 80 % of the studied subjects ranked noise pollution too high at streets(4).

Importantly, noise is no longer noticeable as the only

source of work-related hearing loss and more attention is essential to the matter of joint risks for workers exposed to hazardous noise with work-related substances. Most threshold limit values are established for a single chemical substance and a single physical agent(5). However, the work environment is often composed of multiple chemical agent examples such as toluene, styrene and benzene exposures and physical exposure such as noise, vibration and other stress.

There is some evidence that employees exposed to the chemical substances suffered significantly from hearing impairment whereas noise levels were considerably lower than their corresponding individuals. The harmful effect of a chemical substance on ear function was first described by the Persian philosopher Avicenna (Abu Ali al-Husayn ibn Abd-Allah ibn Sina Balkhi). He notified in his Canon of Medicine that using mercury vapor for treatment of head lice could cause deafness in patients(6). Accordingly, workers at the abovementioned occupations might be possibly exposed to multiple agents simultaneously.

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► Implication for health policy/practice/research/medical education:

This manuscript explained the joint effects of hazardous noise with work-related chemical substances on hearing. Reading this article is recommended to the specialists in the field of occupational and environmental health, industrial management and health policy makers.

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Interactions can occur in a variety of ways and by a number of mechanisms such as alterations in absorption, biotransformation and protein binding. The response of the organism to combinations of toxicants may be also increased or decreased because of the toxicological responses at the site of action. The effects of two chemicals can be additive when combined effect of two chemicals is equal to the sum of the effect of each agent (i.e. 2+3 equal 5), synergistic effect is the situation in which the combined effect of two chemicals is much greater than the sum of the effect of each agent given alone (i.e. 2+2 equal 20) and potentiation in which one substance does not have a toxic effect on a certain organ or system, but it makes the later much more toxic (i.e. 0 + 2 = 10) in addition to antagonistic effects are often very desirable effects in toxicology and are the basis of many antidotes(7,8).

For example, the combined effect of noise and chemicals, particularly noise and solvents such as toluene, styrene, xylene, trichloroethylene and their mixture on hearing have been demonstrated in numerous animal experiments. Therefore, the hazardous effect of noise exposure as a well-established cause of hearing loss could be aggravated by harmful effects of other agents such chemical substances. Furthermore, the balance and auditory central nervous system function might be also affected by solvent such that it is not expected from noise exposure alone. Similarly, NIHL has been found to be potentiated by some of air pollutants such as carbon monoxide(9-12). In a study conducted on two groups of rabbits (one group exposed to noise and the second one exposed to noise plus carbon monoxide (CO); The noise group had a 44.9 dB threshold loss on 8th day and 20.3 dB threshold loss on 22nd day averaged across frequencies of 1-8 KHz, while animals receiving noise plus CO had a 58.4 dB and 27.8 dB average threshold loss on 8th and 22nd days, respectively(2). Accordingly, the discrepancy on the prevalence and degree of NIHL within a group and among groups might be partly explained by the toxic effects of industrial chemicals and their interaction with noise on auditory system.

Nevertheless, there is insufficient scientific knowledge and understanding of the risks of combined exposures, as most of conducted studies have mainly focused on single factors and mainly on animals. Moreover, the majority of these studies had a cross-sectional design which might not be adequate for interpretation of the causation relationship. There is also limited data on dose-response relationship of noise alone and along with chemical substances on hearing. Above all, developed occupational safety criteria is currently based on isolated workplace hazardous that is not adequate for protecting workers who may be exposed with multiple harmful agents at their workplace coincidentally and sequentially.

Therefore, well-designed cohort studies are needed to evaluate the impact of noise and work-related ototoxic

substance exposure in humans. Besides, standards hearing conservation practices should take the increased risk of combined exposure to noise and chemical substances into consideration. Medical surveillance should be also considered for workers co-exposed to noise and ototoxic substances frequently, irrespective of the noise exposure level. Additionally, health results of workers should be recorded and checked regularly in order to detect early changes at individual and collective levels. It is also of utmost importance to educate and motivate the relevant stakeholders in hearing conservation programmers including exposure to chemicals.

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## Authors' Contribution

This study has been done equally by authors.

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