

Noise and Air Pollution Related to Health in Urban Environments [†]

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Abstract: Environmental noise is a pollutant considered by the World Health Organization (WHO) as a threat to public health due to its harmful effects on human health. In this regard, the European Environmental Agency (EEA) indicates that road traffic is the sound source that generates the greatest number of people exposed in Europe to sound levels above what is recommended by the European Noise Directive. In a similar way, the EEA also reports that air pollution is the most important environmental health risk in Europe, where road traffic is one of the main sources of emission of polluting gases. The relationship between both pollutants, leads to think about the development of common strategies. This paper presents a review on recent researches about the relationship of these two types of pollution in urban environments with different types of diseases.

Keywords: noise pollution; air pollution; human health; urban environments; traffic noise

1. Introduction

World Health Organization (WHO) highlights in recent reports that environmental noise can be considered as a pollutant that has a significant impact on public health. This is due to the existence of evidence that links environmental noise and specific health effects, including cardiovascular disease, cognitive impairment, sleep disturbance and tinnitus [1,2]. Recent investigations approach this topic [3,4]. In fact, the concern about noise pollution among both the general public and policy-makers is a growing trend. For example, the European Union's Seventh Environment Action Programme (7th EAP) aims that noise pollution will have significantly decreased in this territory by 2020 towards noise levels recommended by WHO [5]. For this purpose, strategic noise maps are proposed by the European Noise Directive [6] as an important resource to calculate the noise levels to which the population is exposed [7,8].

In this regard, the European Environmental Agency (EEA) [9] indicates that road traffic is the sound source that generates the greatest number of people exposed in Europe to sound levels above what is recommended by the European Noise Directive. In a similar way, the EEA also reports that air pollution is the most important environmental health risk in Europe [9]. The exposure of population to air pollution varies according to the air pollutant (NO_x, PM, O₃). All them are related to the increase of the incidence of many kind of diseases: cancer, cardiovascular, respiratory, etc. [10]. Among the sources of emission of polluting gases, road traffic is a great contributor to total nitrogen oxides and black carbon emissions. In addition, as it is a source with low emission heights, its polluting gases are concentrated near the surface and have a great health impacts in urban areas.

Considering the relation of environmental noise and air pollution to road traffic, it leads to think about the development of common strategies. We will focus on presenting a review on recent researches about the joint relationship of these two types of pollution in urban environments with different types of diseases. Finally, we present a series of proposals from different authors in order to act on this serious environmental problem that affects the health of human beings.

2. Review

2.1. Health Problems

One of the problems studied is diabetes. Dzhambov [11] in 2015 carried out a systematic review and meta-analysis on the risk of type 2 diabetes due to long-term exposure to noise. People exposed to a high level of residential noise ($L_{den} > 60$ dB vs. $L_{den} < 60$ –64 dB) may have a significantly higher risk (19–22%) of developing type 2 diabetes. Exposure to noise at work ($L_{den} > 85$ dB versus $L_{den} < 85$ dB) has not been associated with an increased risk. In the same sense, Eze et al. [12] investigated 2631 participants without diabetes in 2002 and without change of residence between 2002 and 2011. Based on data from questionnaires and biomarkers, they were identified cases of diabetes in 2011. The authors conclude that transport noise may be more relevant than Air Pollution (AP) in the development of diabetes, which can be explained by disturbances of sleep induced by noise. They found positive associations of road and aircraft noise, but not traffic-related AP, in the incidence of diabetes. However, in the work conducted by Dendup et al. [13] in 2018, it is concluded that the current evidence they find suggests a moderate contribution of the environment to the risk of development of Diabetes Mellitus type 2. The data show that higher levels of NO_2 , $PM_{2.5}$ (particulate matter < 2.5 μm in diameter), and noise are related to an increased risk of developing DM2. However, due to limited data on these characteristics, causality cannot be inferred.

Cholesterol was another studied health problem. Sørensen et al. [14] presented a study in 2015 that sought to relate exposure to traffic noise and air pollution with high cholesterol levels, given the already established relationship between these pollutants and cardiovascular diseases, although the mechanisms behind this partnership are not yet clear. The authors conclude that air pollution and possibly also traffic noise may be associated with slightly higher levels of cholesterol. However, the associations for the two exposures were difficult to separate.

The relationship between chemical and acoustic contamination and daily hospital admissions in the emergency department due to multiple sclerosis (MS) has also been studied by Carmona et al. [15]. The authors found that, although there was no association between chemical pollutants caused by traffic and MS admissions, such association was evident in the case of L_{eqd} . This association is linear without a threshold and there is a level, higher than 67 dBA, from which this effect is more pronounced. The above results indicate that traffic noise can exacerbate MS symptoms, leading to hospital admissions due to this cause.

Finally, different studies point a relationship between cardio-vascular diseases and noise and air pollution. Just to indicate a few, we can cite the works of Cole-Hunter et al. [16] and Bilenko et al. [17]. In them, a relationship can be found between a long-term exposure to noise and air pollution and circulatory or heart problems. Greater awareness of the social burden of these risk factors can intensify the efforts needed for effective legislation that reduces air pollution and noise.

2.2. Solutions

There are several studies that propose different solutions to the existing problem in cities due to air pollution and noise produced by road traffic. For example, Vienneau et al. [18] investigated the association between residential green areas and adult mortality considering air pollution and exposure to transport noise. The authors have found consistent evidence that residential green areas reduce mortality risk independently of other environmental exposures. These authors suggest that the protective effect goes beyond the absence of sources of contamination. Public environmental health measures should not only aim to reduce the exposure of pollutants, but also to maintain existing residential green areas and increase them in areas where they are lacking.

On the other hand, Mueller et al. [19] focused their study on burden of disease (BD) due to exposures affected by urban planning and transportation. The findings made by the authors suggest that: (1) the reduction of road traffic together with the promotion of active transport and (2) the provision of green infrastructure would result in a considerable avoided BD and substantial savings for the public health system, since these measures can provide mitigation of noise, air pollution and heat, as well as opportunities for the promotion of physical activity (PA).

Perez-Prada and Monzon [20] studied the plan launched by the Madrid City Council to redesign its inner ring for taking traffic out of the city center. The implementation of the new speed limit policy produced a reduction of 14.4% and 16.4% in CO₂ and NO_x emissions, respectively, while the overall travel time remains practically constant and the saturation rate decreases slightly. Although this work has not studied the impact of reducing the speed on the environmental noise levels in the area, taking into account the direct relationship between the speed at which vehicles circulate with the level of sound pressure generated by these, it would be expected that the measure proposed in [21] would also suppose a reduction of the noise pollution levels near the Madrid ring road. On the other hand, Hamidi and Kamankesh [22] propose a multi-agent system for road traffic management based on swarm intelligence. The objective is to increase the quality of the entire road network, especially in case of congestion and traffic jams, taking into account real-time traffic information and the travel time of drivers to reach their destinations. With the proposed method, a hierarchical multi-agent architecture performs a grouping of cars and vehicles on the road according to the geographical distribution. In other works, reference semaphores are taken into account with the variable program green and red to improve the management of the road network.

To conclude this section, the work of Nieuwenhuijsen [23] places cities in a broader context and establishes links between urban planning and transport, the environment and health. In this work, multiple environmental exposures are considered identifying common determinants and linking the built environment, environmental concentrations, personal behavior and exposures and health. It also presents the state of the art on the health effects of important environmental exposures in cities and provides a framework for linking science and policy. Nieuwenhuijsen concludes that the city of the future must be a green, social, active and healthy city.

3. Conclusions

Recent work continues to highlight the impact on public health of noise and air pollution generated by road traffic in cities. Taking into account the relationship between both pollutants, it leads to think about the development of common strategies. Measures of action related to road traffic management (volume, speed, etc.) and urban planning (increase of green areas, urban design, etc.) are shown up to now as the most effective solutions.

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