Chelonian Conservation And Biology

Vol. 17No.2 (2022) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI:doi.org/10.18011/2022.04(1) 1793-1800

THE IMPACT OF AIR POLLUTION ON RESPIRATORY HEALTH: ASSESSING THE LONG-TERM EFFECTS AND DEVELOPING PREVENTIVE STRATEGIES

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Abstract

With the increasing worldwide awareness of air pollution, there is a growing need to provide evidence-based suggestions for measures to reduce its effect. Public policy plays a crucial role in mitigating air pollution, but individuals may also decrease their exposure via personal decisions. Empirical data strongly supports the idea of restricting outdoor physical activity on days with high air pollution levels and in close proximity to sources of air pollution. It is also advisable to minimize exposure to pollutants from roadways when commuting, make use of air quality warning systems to schedule activities, and use facemasks when necessary. Additional tactics include refraining from using solid fuels for cooking, ensuring proper ventilation and isolation of cooking spaces, and employing transportable air purifiers equipped with high-efficiency particle air filters. We provide specific suggestions to aid medical professionals and public health officials in advising individuals on personal strategies to reduce the impact of air pollution. However, it is important to note that further research is necessary to thoroughly establish and validate interventions that effectively improve respiratory health in this setting.

Keywords: air pollution, respiratory health, medical professional, long-term effects.

1. Introduction

In 2019, the World Health Organization (WHO) identified air pollution and climate change as the primary worldwide environmental hazards affecting human health [1]. A recent sophisticated analysis suggests that previous prediction models have underestimated the impact of air pollution on public health. The analysis estimates that there are currently around 9 million deaths per year worldwide caused by air pollution, with more than 99% of these deaths attributed to household air pollution. Additionally, nearly 90% of deaths caused by ambient air pollution occur in low- and middle-income countries. In these countries, the burning of solid fuels for

cooking and heating poses a significant health risk. More than 25% of premature deaths linked to air pollution were specifically related to respiratory issues [5]. In this review, we will primarily concentrate on respiratory health, as reducing exposure to air pollutants generally helps prevent cardiovascular effects as well (since inhalation is the primary route of entry) [6–8]. Given that there is no level of air pollution exposure that is completely safe, it is important to implement strategies to reduce daily exposure. These strategies can have a significant impact in various settings. Additionally, the non-linear relationship between air pollution exposure and health outcomes suggests that the greatest benefits may be achieved by further reducing relatively low levels of air pollution exposure.

Urban planning should prioritize addressing air pollution as a core aspect of development, rather than treating it as an afterthought. Additionally, city centers should be constructed in a way that encourages people to live and work in close proximity. This will prevent urban sprawl and make active transportation more feasible. Such preparation is crucial. Public policy encompasses various factors that are crucial in managing and regulating sources of pollution and implementing strategies to minimize the negative effects. To effectively reduce our reliance on fossil fuels, individuals should take comprehensive actions such as making informed consumer choices, actively participating in the democratic process, or engaging in advocacy efforts. However, human decisions may help mitigate the effects of air pollution. Hence, it is crucial to equip the general public with effective methods to reduce the impact of air pollution on respiratory health. However, there is still a lack of efforts in educating and assisting communities on how they can minimize their exposure to dangerous levels of air pollution [10].

In 2016, the Royal College of Physicians in the UK advised healthcare professionals (HCPs) to assist vulnerable patients in safeguarding themselves against the consequences of air pollution [11]. However, a subsequent workshop organized by the European Respiratory Society emphasized the absence of evidence-based resources in this area [10]. Therefore, healthcare professionals should possess current scientific information in order to provide strategies that reduce the effect. HCPs will be able to use their role as trusted communicators and accept their duty to teach and promote preventative measures instead of only providing reactive care. Our objective is to offer guidance to individuals on how to reduce their personal exposure to air pollution. This advice can be adjusted to meet the specific needs of different countries, especially for those who have respiratory conditions like asthma and chronic obstructive pulmonary disease (COPD), or are at risk of developing these conditions. We developed a search plan to discover information related to 10 primary methods for reducing exposure to outdoor or indoor air pollution. Subsequently, we thoroughly described and ultimately summarized that evidence for the reader.

2. Methodology

A systematic search was conducted on PubMed and Google Scholar, covering the period from January 1, 2013 to January 1, 2019. The search keywords used were related to air pollution, respiratory health, and methods to reduce exposure to air pollution from both outdoor and indoor sources. The comprehensive compilation of the search phrases and the corresponding "hits" may be seen in supplemental table S1. Figure 1 displays the flowchart illustrating the process of doing a literature review. By using that methodology, we discovered scientifically reviewed data that examined the efficacy of individual-level treatments in decreasing exposure to air pollution. Additionally, we explored the influence of factors such as food and lifestyle on these interventions.

In addition, the study highlighted important areas of knowledge that need to be filled and research strategies that need to be pursued in order to address the present uncertainty about the relationship between air pollution exposure and health consequences. The literature search was limited to the period of 6 years leading up to 2019 to leverage prior expert assessments and concentrate on the latest available information. To evaluate the robustness of the evidence, a level-of-evidence score was assigned based on the grading system used in the Global Initiative for Asthma (GINA). This score includes clinical studies and takes into account situations where recommendations are based more on expert opinion rather than strong primary evidence [12].

3. Traffic-related air pollution (TRAP)

Significant levels of traffic-related air pollution (TRAP) may be experienced inside automobiles owing to the close proximity of air intake to exhaust emissions from nearby vehicles, as well as when walking or cycling beside roadways [13]. A study comparing air pollution exposures between active and motorized travel modes revealed that car drivers had the highest levels of exposure to air pollutants such as PM2.5, black carbon, and UFPs, while cyclists or pedestrians had the lowest levels of exposure [14,15]. However, it is worth noting that other studies have reported contradictory findings [16-18]. Close proximity to motorized traffic was linked to increased densities of cyclists and pedestrians, especially when pedaling on roadways shared with motor vehicles.

Cyclists and pedestrians have the greatest amount of inhalation and absorption dosage of air pollutants due to their near proximity to traffic, greater respiration rates, and longer commutes. On the other hand, train, metro, and subway passengers, as well as motorcyclists, have the lowest levels of exposure to air pollutants [20-22]. Nevertheless, the advantages of engaging in physical activity while actively commuting, as opposed to using motorized transportation, seem to be greater than the risks associated with inhaling higher levels of air pollutants [23-25]. Additionally, there is evidence suggesting that physical activity can have a protective effect against mortality, even in environments with high levels of air pollution [26,27]. Walking on a road with a lot of traffic may reduce or even undo the positive effects of exercise on the heart and lungs in older people and persons with chronic heart and lung problems [28].

Nevertheless, individuals of advanced age may exhibit greater susceptibility to traffic events when engaging in walking or bicycle activities compared to younger individuals.

There has been a push to encourage people to switch from using cars and public transport to using active forms of transportation such as cycling or walking. This shift has been supported by evidence that it can lead to a decrease in traffic volume and air pollution, resulting in overall health benefits. However, it should be noted that in certain situations, there may be slight reductions in lung function.

4. Air pollutants

The inhalation of air pollutants leads to the direct and indirect initiation of oxidative stress and inflammation [29]. These two processes are crucial in the development of chronic respiratory disorders including COPD and asthma, which are worsened by air pollution [30]. A diet that contains high levels of antioxidants, fiber, protein, and polyunsaturated fatty acids (PUFAs), such as the Mediterranean diet, may decrease abnormal DNA methylation linked to cancer and cardiovascular disease after exposure to particulate matter. Additionally, taking fish oil supplements may help protect against the allergic sensitization effects of exposure to traffic-related air pollution. In contrast, diets that are heavy in fat and low in polyunsaturated fatty acids (PUFA), sometimes referred to as "Western" diets, may provide less protection against inflammatory damage caused by factors like air pollution [31-33].

Sulforaphane, which is present in broccoli sprouts, is a strong ligand for the Nrf2 transcription factor. This transcription factor controls the expression of genes involved to antioxidant response elements [30]. The ingestion of a beverage made from broccoli sprouts resulted in a rise in the elimination of cancer-causing air pollutants, such as benzene, over a period of 12 weeks. This indicates that the beverage may have the ability to detoxify some airborne contaminants. Broccoli extracts also reduced the nasal allergic reaction to diesel exhaust particles (DEPs) in patients with atopic conditions and pre-existing sensitivity to DEPs in the airways [34]. Additional extensive clinical studies are required to validate the potential advantages of sulforaphane.

In individuals who were in good health, the administration of N-acetylcysteine before treatment reduced the airway responsiveness caused by DEP in those who already had airway hyperresponsiveness at baseline [35]. In a subsequent trial with a same design, the administration of vitamin C and N-acetylcysteine before treatment enhanced the vasoconstriction caused by DEP [36]. Both investigations found that genetic diversity has a role in determining how individuals respond to exposure to DEP and antioxidant supplementation [35,36]. Supplementing the diet with vitamins C and E was found to decrease the negative effects on lung function and bronchoconstriction caused by short-term exposure to ozone, SO2, and particulate matter [37]. It also reduced airway inflammation and improved lung function in patients with asthma who were exposed to ozone [38]. However, some other randomized controlled trials did not find any positive effects. Insufficient intake of vitamin C in pregnant women exposed to PM2.5 was

shown to be linked to an increased frequency of micronuclei, which is a biomarker indicating genetic damage and an elevated risk of cancer [39-41].

In this context, antioxidant therapies have not undergone a comprehensive phase 3 study or any phase 4 trial. The reasons for this uncertainty are not clear, as it could be attributed to either a lack of financial motivation or uncertainty about the ideal characteristics to study. However, considering the magnitude of the issue and the community's strong emphasis on reducing primary exposure, it would be logical to conduct larger and well-funded trials in order to find solutions.

5. Conclusion

In light of the extensively established adverse effects of air pollution on respiratory health, it is essential to develop measures that assist healthcare practitioners, patients, and the general public in reducing their daily exposure to air pollutants. Strategies must be customized based on an individual's specific levels of air pollution exposure, susceptibility to air pollution exposure, health literacy, financial resources, and support networks. Advisors must devise a strategy that can adapt to the unique perspective of each individual, considering the acknowledged differences in how people perceive and react to the danger of air pollution [42]. However, these measures may have a significant effect since there is no minimum amount of air pollution that can be considered acceptable, and the relationship between exposure to lower levels of air pollution and its effects is steep [2]. The advantages may be particularly noticeable for vulnerable people, such as those with chronic lung disorders, those at the extremes of age, pregnant women, and individuals in utero [43,44].

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