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Editorial

Intervention of Particulate Matter: What Can We Do for Asthmatic Patients?

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▸ See the article "The Effect of Particulate Matter Reduction by Indoor Air Filter Use on Respiratory Symptoms and Lung Function: A Systematic Review and Meta-analysis" in volume 13 on page 719.

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Ambient and household air pollution are negatively associated with human health and act as the leading environmental cause of mortality and morbidity. Especially in the Asia Pacific region, air pollution has become a serious issue in recent years because of its large population, rapid industrialization and urbanization. Particulate matter (PM), one of the major air pollutants, is found ubiquitously and considered an important environmental threat to human health. It has been reported that PM involves a variety of human organs such as the respiratory system (asthma, chronic obstructive pulmonary disease, respiratory tract infections and allergic rhinitis), the cardiovascular system (myocardial infarction, arrhythmia, hypertension and stroke), the nervous system (Alzheimer's disease and dementia) and the skin (atopic dermatitis and psoriasis).[1-8] In particular, such harmful effects are notable in children who are in rapid growth and development.[9] Recent studies have even suggested that PM may be a possible carrier for COVID-19 infection.[3]

Ambient PM is a complex mixture of solid and liquid particles, and its hazardous effects on humans are influenced by sources, chemical composition, sizes and so on.[10] Airborne PM is primarily derived from either natural or anthropogenic sources such as forest fires, sea salts, biologic materials, biomass combustion, vehicle exhaust, power plants and cooking. In contrast, PM2.5, also called fine particles, are mainly generated from precursors emitted in the air including sulfur oxides, nitrogen oxides, volatile organic compounds and ammonia.[11] The route of exposure to PM is mainly through inhalation, while PM is also penetrated into the human gastrointestinal tract or skin. In this regard, the ambient PM2.5 level is regarded as an environmental risk that should be lowered because of its small size and toxic components.[12] Particularly in Asia, the high level of ambient PM2.5 is a problem to seriously be taken, since annual mean concentrations are substantially high in many developing countries and exceed the World Health Organization's Air Quality Guideline even in developed countries.[13]

It has been reported that PM can trigger acute exacerbation of pre-existing asthma and may be linked to new-onset asthma.[14] A systematic review of panel studies in children showed that the overall effect of either PM10 or PM2.5 on peak expiratory flow rate (PEFR) and lower respiratory tract symptoms were statistically significant, and that the effects of PM2.5 appeared to be greater than those of PM10.[15] A meta-analysis of 26 time-

series and case-crossover studies in children demonstrated that hospital admissions and emergency department visits for asthma were significantly associated with ambient PM2.5 concentrations (relative risk per 10 μg/m^3 increase 1.048; 95% confidence interval [CI], 1.028–1.067; I^2 = 95.7%).[16] A recent meta-analysis revealed that prenatal exposure to PM2.5 increased the risk of developing asthma by age 10 years (odds ratio per 10 μg/m^3 increase 1.12; 95% CI, 1.00–1.26).[17] With regard to biologic mechanisms, human and animal studies suggest that PM exposure influences airway inflammation through induction of oxidative cellular damage through reactive oxygen species as well as through activation of innate immunity and adaptive immunity. PM exposure also triggers neurogenic inflammation causing airway obstruction and inflammation.[18,19] When PM exposure modulates the airway epithelium, it has been shown that production of several cytokines including interleukin (IL)-1, IL-6, IL-8, IL-25, IL-33, tumor necrosis factor-α, thymic stromal lymphopoietin and granulocyte-macrophage colony-stimulating factor, are involved in the pathophysiology.[20]

Intervention studies to reduce adverse effects of PM exposure have been attempted in normal healthy individuals as well as asthmatic patients. Interventions included sending phone messages to alarm the patients, the use of air cleaner, wearing face masks and the administration of antioxidants such as vitamin C and E, but beneficial effects were inconsistent.[21-26] In this issue of the *Allergy Asthma Immunol Res*, Park *et al.*[27] attempted the systematic review and meta-analysis in 7 studies out of 2,109 published articles to investigate the effect of air filters on asthma by reducing the exposure level of PM2.5. They demonstrated that air filter lowered indoor PM2.5 concentrations and increased PEFR in patients with asthma. However, contrary to what the authors expected, the reduction in PM2.5 concentration did not result in significant improvement in respiratory symptoms or the predicted forced expiratory volume in one second. Although this study failed to prove their hypothesis that the use of air filters is beneficial for the asthmatic patients, caution is need to reach a conclusion because there are several points to consider in addition to the limitations presented by the authors. First, only 6 studies were analyzed in this meta-analysis, and the number of study population in each study is small. Secondly, the assessment of PM2.5 exposure at the individual level may not be correct. Thirdly, the effect size of PM2.5 in asthma exacerbation may be small compared with other triggers, and numerous confounding factors may not be appropriately adjusted in many studies. Fourthly, respiratory symptoms are quite subjective, depends on patient report and may not be standardized. Finally, subjects included in the previous studies may have different asthma severity or individual susceptibility to PM2.5 exposure.

Taken together, exposure to PM2.5 obviously aggravates asthma symptoms and there is no doubt that air filters can reduce the concentration of indoor PM2.5. However, as shown in the study by Park *et al.*,[27] it is not yet possible to conclude that the use of air filters can lead to clinical benefits such as alleviation of asthma symptoms or improvement of lung function. In order to validate these effects at the individual level, further investigations with a better study design in a larger population should be conducted.

REFERENCES

1. Schraufnagel DE, Balmes JR, Cowl CT, De Matteis S, Jung SH, Mortimer K, et al. Air pollution and noncommunicable diseases: a review by the Forum of International Respiratory Societies' Environmental Committee, part 2: air pollution and organ systems. Chest 2019;155:417-26.
PUBMED | CROSSREF

2. Moore E, Chatzidiakou L, Kuku MO, Jones RL, Smeeth L, Beevers S, et al. Global associations between air pollutants and chronic obstructive pulmonary disease hospitalizations. A systematic review. Ann Am Thorac Soc 2016;13:1814-27.
PUBMED | CROSSREF
3. Zhu C, Maharajan K, Liu K, Zhang Y. Role of atmospheric particulate matter exposure in COVID-19 and other health risks in human: a review. Environ Res 2021;198:111281.
PUBMED | CROSSREF
4. Balmes JR. Household air pollution from domestic combustion of solid fuels and health. J Allergy Clin Immunol 2019;143:1979-87.
PUBMED | CROSSREF
5. Kim BG, Lee PH, Lee SH, Park MK, Jang AS. Effect of TiO_2 nanoparticles on inflammasome-mediated airway inflammation and responsiveness. Allergy Asthma Immunol Res 2017;9:257-64.
PUBMED | CROSSREF
6. Xian M, Ma S, Wang K, Lou H, Wang Y, Zhang L, et al. Particulate matter 2.5 causes deficiency in barrier integrity in human nasal epithelial cells. Allergy Asthma Immunol Res 2020;12:56-71.
PUBMED | CROSSREF
7. Kim BE, Kim J, Goleva E, Berdyshev E, Lee J, Vang KA, et al. Particulate matter causes skin barrier dysfunction. JCI Insight 2021;6:e145185.
PUBMED | CROSSREF
8. Kim KE, Cho D, Park HJ. Air pollution and skin diseases: adverse effects of airborne particulate matter on various skin diseases. Life Sci 2016;152:126-34.
PUBMED | CROSSREF
9. Johnson NM, Hoffmann AR, Behlen JC, Lau C, Pendleton D, Harvey N, et al. Air pollution and children's health-a review of adverse effects associated with prenatal exposure from fine to ultrafine particulate matter. Environ Health Prev Med 2021;26:72.
PUBMED | CROSSREF
10. Morakinyo OM, Mokgobu MI, Mukhola MS, Hunter RP. Health outcomes of exposure to biological and chemical components of inhalable and respiratory particulate matter. Int J Environ Res Public Health 2016;13:592.
PUBMED | CROSSREF
11. Adams K, Greenbaum DS, Shaikh R, van Erp AM, Russell AG. Particulate matter components, sources, and health: systematic approaches to testing effects. J Air Waste Manag Assoc 2015;65:544-58.
PUBMED | CROSSREF
12. Hime NJ, Marks GB, Cowie CT. A comparison of the health effects of ambient particulate matter air pollution from five emission sources. Int J Environ Res Public Health 2018;15:1206.
PUBMED | CROSSREF
13. North CM, Rice MB, Ferkol T, Gozal D, Hui C, Jung SH, et al. Air pollution in the Asia-Pacific region. A Joint Asian Pacific Society of Respirology/American Thoracic Society Perspective. Am J Respir Crit Care Med 2019;199:693-700.
PUBMED | CROSSREF
14. Guarnieri M, Balmes JR. Outdoor air pollution and asthma. Lancet 2014;383:1581-92.
PUBMED | CROSSREF
15. Ward DJ, Ayres JG. Particulate air pollution and panel studies in children: a systematic review. Occup Environ Med 2004;61:e13.
PUBMED | CROSSREF
16. Lim H, Kwon HJ, Lim JA, Choi JH, Ha M, Hwang SS, et al. Short-term effect of fine particulate matter on children's hospital admissions and emergency department visits for asthma: a systematic review and meta-analysis. J Prev Med Public Health 2016;49:205-19.
PUBMED | CROSSREF
17. Shao J, Wheeler AJ, Zosky GR, Johnston FH. Long-term impacts of prenatal and infant exposure to fine particulate matter on wheezing and asthma: a systematic review and meta-analysis. Environ Epidemiol 2019;3:e042.
PUBMED | CROSSREF
18. Wu W, Jin Y, Carlsten C. Inflammatory health effects of indoor and outdoor particulate matter. J Allergy Clin Immunol 2018;141:833-44.
PUBMED | CROSSREF
19. Leikauf GD, Kim SH, Jang AS. Mechanisms of ultrafine particle-induced respiratory health effects. Exp Mol Med 2020;52:329-37.
PUBMED | CROSSREF

20. De Grove KC, Provoost S, Brusselle GG, Joos GF, Maes T. Insights in particulate matter-induced allergic airway inflammation: focus on the epithelium. Clin Exp Allergy 2018;48:773-86.
PUBMED | CROSSREF

21. Mehiriz K, Gosselin P. Evaluation of the impacts of a phone warning and advising system for individuals vulnerable to smog. Evidence from a randomized controlled trial study in Canada. Int J Environ Res Public Health 2019;16:1817.
PUBMED | CROSSREF

22. Noonan CW, Semmens EO, Smith P, Harrar SW, Montrose L, Weiler E, et al. Randomized trial of interventions to improve childhood asthma in homes with wood-burning stoves. Environ Health Perspect 2017;125:097010.
PUBMED | CROSSREF

23. Jhun I, Gaffin JM, Coull BA, Huffaker MF, Petty CR, Sheehan WJ, et al. School environmental intervention to reduce particulate pollutant exposures for children with asthma. J Allergy Clin Immunol Pract 2017;5:154-159.e3.
PUBMED | CROSSREF

24. Zhang Y, Chu M, Zhang J, Duan J, Hu D, Zhang W, et al. Urine metabolites associated with cardiovascular effects from exposure of size-fractioned particulate matter in a subway environment: a randomized crossover study. Environ Int 2019;130:104920.
PUBMED | CROSSREF

25. Shi J, Lin Z, Chen R, Wang C, Yang C, Cai J, et al. Cardiovascular benefits of wearing particulate-filtering respirators: a randomized crossover study. Environ Health Perspect 2017;125:175-80.
PUBMED | CROSSREF

26. Tong H. Dietary and pharmacological intervention to mitigate the cardiopulmonary effects of air pollution toxicity. Biochim Biophys Acta 2016;1860:2891-8.
PUBMED | CROSSREF

27. Park HJ, Lee HY, Suh CH, Kim HC, Kim HC, et al. The effect of particulate matter reduction by indoor air filter use on respiratory symptoms and lung function: a systematic review and meta-analysis. Allergy Asthma Immunol Res 2021;13:719-32.
CROSSREF