

Outdoor Air Pollution and Adolescent: Upcoming Public Health Issue

Sumil Mehra¹, Gulnoza Usmanova², Jagannath Behera³

¹Executive Director, MAMTA Health Institute for Mother and Child, New Delhi, India.

²Assistant Director (Monitoring, Innovation and Research), MAMTA Health Institute for Mother and Child, New Delhi, India.

³Regional Manager (Research, Monitoring and Evaluation), MAMTA Health Institute for Mother and Child New Delhi, India.

DOI: <https://doi.org/10.24321/2349.2880.201825>

Abstract

Background: In India, as in the rest of the world, young people face several challenges to their well-being. One of the important challenges is air pollution; however, the impact of air pollution on adolescents' health is not fully explored.

Objective: This article represents an attempt to explore impact of air pollution on adolescents' health through available width of information.

Method: For this study we utilized the rapid review methodology that allows comprehensive review of the literature that describes urgent public health issue in the relatively short period.

Result: It has been found that air pollution not only leads respiratory ailments of adolescents, but also has an impact on cardiovascular system, development of hyperactivity disorder, cancer, and many other conditions. Moreover, exposure to air pollution could increase susceptibility to chronic diseases later in life. This article can play a key part in raising the awareness of adolescents' health issues related to air pollution, initiate discussions and actions on preventing future damaging health effect for this subset of population.

Keywords: Air pollution, Adolescent, Evidence, Health, Migration

Background

According to WHO adolescents are young people in 10-19 age groups.¹ There are 1.8 billion young people in the world.² Around 20% (236.5 million) of Indian population is adolescents.³ Globally, adolescents experience many challenges to their well-being. According to the recent estimates 13% of all adolescent health loss in India is attributable to behavioral risk factors including unsafe sex, poor nutrition, smoking, alcohol consumption, drug use, and exposure to many of these risks also contributes to the development of non-communicable diseases later in life. Besides, in India according to the Global Burden of Diseases (GBD) data, air pollution remained the leading cause of death and disability combined in 2015. Thus, death attributable to air pollution was 5.7% of total death. Air pollution was responsible for 15 thousand Years Lived with

Disability (YLDs) and 862 thousand of DALYs for adolescents in India in 2015 that costing 3% of Indian GDP.^{4,6}

Residents of India's megalopolis exposed to hazardous level of air pollution. Air Quality Index (AQI) varied between 47 (good quality) in Navi Mumbai and 410 (severe quality) in Varanasi. Of 31 Indian cities, only one city has satisfactory AQI while rest of other cities having unsatisfactory AQI.⁷ The prominent pollutants were PM_{2.5}, NO₂, PM₁₀, O₃, CO (5). On the other hand, according to the report from Greenpeace none of Indian cities meets WHO requirement on air quality standards. This report concluded that fossil fuels are one of the key contributors to the poor air quality in India.⁵ It is important to note that urban air pollution is a combination of pollutants that are coming from transports, power generation, industrial sector, and other economic activities. On the other side household air pollution, (indoor air

Corresponding Author: Dr. Jagannath Behera, MAMTA Health Institute for Mother and Child, New Delhi, India.

E-mail Id: jagannath@mamtahimc.org

Orcid Id: <https://orcid.org/0000-0003-4258-4449>

How to cite this article: Mehra S, Usmanova G, Behera J. Outdoor Air Pollution and Adolescent: Upcoming Public Health Issue. *Ind J Youth Adol Health* 2018; 5(4): 24-30.

pollution) is a serious area of concern for rural population. Majority of rural population rely on traditional biomass, kerosene or other liquid fuels for cooking, heating and lighting, all of which are highly likely to contribute to indoor air pollution.⁸ On the other hand, recent urbanization led to high population growth and hastened migration from rural to urban areas. As a result, the density of cities and the level of air pollution is increased. Moreover, migrants mainly settle down along the major transportation corridors, rivers and in vicinity of industrial areas. This led to formation of informal settlements characterized by high density of population and in such settings pollution created by any single individual has the potential to reach many others, placing all residents at risk.^{9, 10} The work conditions of these migrants vary frequently and require them to work outdoors for prolonged time periods, thereby exposing them to air pollution.¹⁰

It is well recognized that exposure to air pollution is associated with an increase in ill health and mortality.¹¹ However, there is a dearth of literature on potential impact of air pollution on adolescent health. Hence, the objective of this article is to understand and combine existing evidence of outdoor air pollution impact on adolescents' health.

Methods

For this study we utilized the rapid review methodology (Figure 1) that allows comprehensive review of the literature that describes urgent public health issue in the relatively short period.^{12, 13} The research question was formulated according to the criteria defined by Farrugia and colleagues.¹⁴

search strategy to identify relevant articles in the following databases: PubMed, MEDLINE, Cochrane databases, country specific websites of Ministry/Department of Health, Ministry of Environment, Forest and Climate Change, Ministry of Road Transport and Highways, and World Health Organization. The search strategies and search terms for each database were designed. Additionally, we used search engines such as Google and Google Scholar and also screened reference list of relevant articles and reports. In some cases, we contacted the authors for further information including those, whose studies were finally included in this review article.

Data Collection Process

Our search yielded 90 articles. The following steps were followed to review articles:

- Titles and abstracts were reviewed to identify 16 articles that met our inclusion criteria.
- The full text of 16 articles was reviewed. At this stage authors of eligible articles were contacted through email and requested to provide full version of the article.
- Two authors independently assessed the articles against the inclusion criteria to determine whether those studies should be included in the review. Any difference of opinion was resolved through discussion and consultation with other authors. This review includes 11 articles that met our criteria.

Results

The details of the important studies included in this present

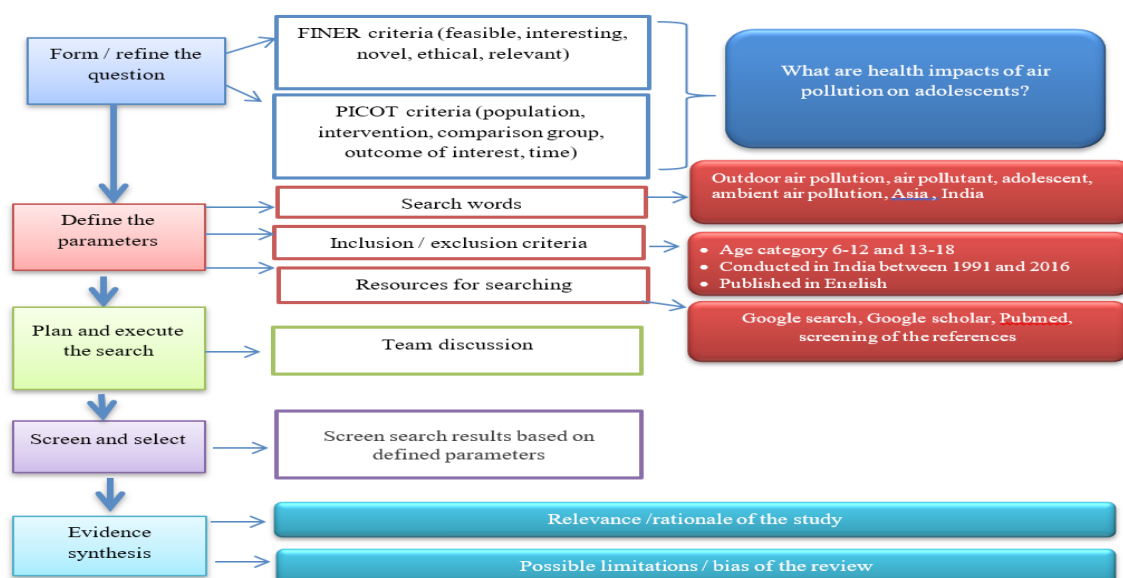


Figure 1. Rapid review strategy

Search Strategy

A search strategy was developed in order to identify peer-reviewed publications and reports related to air pollution and its effect on adolescent health. We constructed the

review are given in the Table 1. Several studies were conducted to explore the possible effect of air pollution on adolescents' health. All studies that found relevant used cross-sectional design with (15,17, 20,21, 24, 25) or

without control group (16, 18, 19,22,23). Majority of these studies explored effect of air pollution on respiratory system of adolescents', effect of air pollution on cardiovascular system, one study explored the association between

the exposure to air pollution and behavioral problems particularly attention-deficit hyperactivity disorder in Indian school children.¹⁵

Table 1. The details of the articles included in the review to explore the effect of outdoor air pollution and adolescent: upcoming public health issue

No.	Authors	Name of the article	Year and journal of publication	Age of participants	Type of the study	Main results
1.	Siddique S et al. ¹⁵	Attention-deficit hyperactivity disorder (ADHD) in child-ren chronically exposed to high level of vehicular pollution	Eur J Pediatr 2011.	9-17	Cross-sectional	ADHD was identified in 11.0% of urban children compare to 2.7% of the control group. Major risk factors were male gender, lower socioeconomic status, 12-14 year age group, and PM10 level in breathing air.
2.	Singh S et al. ¹⁶	Prevalence and severity of asthma among Indian school children aged between 6 and 14 years: associations with parental smoking and traffic pollution	J Asthma. 2016.	6-7 and 13-14	Cross-sectional	The prevalence of asthma was higher in 13-14 age group compare to 6-7 age group (6.05% vs. 5.35%). However, the odds ratio of asthma was higher in 6-7 age group than 13-14 age group (1.63 vs. 1.19). Moreover, the association between asthma and maternal and/or paternal smoking was also observed.
3.	Kalappanavar NK et al. ¹⁷	Carbon particles in airway macrophage as a surrogate marker in the early detection of lung diseases	Int J Occup Environ Med. 2012.	8-16	Cross-sectional	Children in industrial area had moderate obstructive airway and restrictive airway disease (42.6% and 20.3% respectively) compare to children in green zone (7% and 6% accordingly).
4.	Awasthi A et al. ¹⁸	Effects of agriculture crop residue burning on children and young on PFTs in North West India.	Sci Total Environ. 2010.	10-13		There was significant decrease in pulmonary test function in association with increased levels of SPM, PM (10) and PM (2.5). Small size particulate matter PM (2.5) and PM (10) affected the PFTs to a large extent in comparison to the large size particulate matter (SPM).
5.	Kumar R et al. ¹⁹	Association of indoor and outdoor air pollutant level with respiratory problems among children in an industrial area of Delhi, India	Arch Environ Occup Health. 2007.	7-15	Prospective	The majority of children had a history cough (62.7%), sputum production (24.4%), shortness of breath (32.0%), wheezing (25.6%), common cold (44.4%), and throat congestion (43.1%). Results indicate that particulate exposure may be important risk factors in the development of respiratory illness in children

6.	Kumar R et al. ²⁰	Association of outdoor air pollution with chronic respiratory morbidity in an industrial town in northern India	Arch Environ Health. 2004.	<15	Cross-sectional	The prevalence of chronic respiratory symptoms (cough, phlegm, breathlessness, or wheezing) was higher in study town compare to the reference town (27.9% vs. 20.3%). Logistic regression analysis revealed that residence in the study town was independently associated with chronic respiratory symptoms after controlling for other demographic effects.
7.	Lahiri T et al. ²¹	Air pollution in Calcutta elicits adverse pulmonary reaction in children	Indian J Med Res. 2000.	6-17	Cross-sectional	The study showed that children in Calcutta have more respiratory problems compare to the children in the comparison cities.
8.	Das P et al. ²²	Association of Ambient Air Quality with Pulmonary Function of Youngster Footballers	Asian Journal of Sports Medicine. 2014.	14-16	Cross-sectional	Exposure to air pollution can contribute to the reduction of pulmonary function in both sedentary and trained boys.
9.	Central pollution control board. Ministry of Environment and Forests ²³	Study on ambient air quality, respiratory symptoms and lung of children in Delhi	http://www.cpcb.nic.in/upload/NewItems/NewItem_162_Children.pdf . 2016.	4-17	Cross-sectional	Delhi's children had 1.8 - times more upper respiratory symptoms and 2-times more lower respiratory symptoms.
10.	Thakare A et al. ²⁴	Respiratory health status of rural and urban school children from Nagpur region.	Int J Biol Med Res. 2011.	6-15	Cross-sectional	Pulmonary function in school children is better in rural areas compare to urban areas because of less vehicular traffic in rural areas and better environmental condition.
11.	Siddique S et al. ²⁵	Effect of Air Pollution on Incidence of Asthma: A Case Study in Children	Environ. We Int. J. Sci. Tech. 2010.	6-17	Cross-sectional	The prevalence of current asthma and physician-diagnosed asthma among the children of Delhi were 4.6% and 1.7 % respectively, which were significantly higher than the corresponding values in the control group- 2.5% and 1.1% respectively (p<0.001).

Discussion

This review highlights the importance of considering and further studying different aspects of air pollution and its impact on adolescent's health while keeping in mind that

air pollution is not only impacts respiratory system of adolescents. Moreover, it's well established that normally, lung development is completed by the age of 18 and early 20s in girls and boys accordingly. Consequently, it is unlikely that these changes in respiratory system after age 18

will be reverted or developed during transition period to adulthood. These changes in lung function in adolescent may have impact to the development of respiratory system disorders conditions - for example, episodic wheezing that occurs during a viral infection. However, the greatest impact of air pollution can happen later in life, since decreased lung function is a risk factor for complications and death during adulthood.^{26, 27}

Furthermore, evidence shows that burden of non-communicable diseases are increasing in India, and their risk factors have notably high prevalence even among adolescents, although our review revealed that information related to adolescent health in general and with particular emphasis on impact of air pollution in India is in scarce, there is large number of studies in India that investigated the effect of air pollution on various groups of population.^(2, 4, 31, 32,33,34,35,36,37,38,39,40) Moreover, that there are recent attempts in examining health effects of air pollution in different age groups in India, including adolescents in a cohort study design.⁴¹

On the other hand, urbanization is happening in fast speed in developing countries with many of cities located in Asian countries with high number of population and low per capita income; consequently, population of these cities affected by air pollution along with other social and environment risk factors.^{9, 10, 42}

Conclusion

The present review revealed that basic concepts and data concerning adolescence period for air pollution are extremely scattered and inconclusive. However, available literature shows there is an impact of air pollution on respiratory, as well as other systems of adolescents.

The review highlights the importance of including and examining the effect of air pollution specifically on adolescent health; hence evidence shows that decreased lung function during adolescent period has long term impact such as respiratory complications later in life. Furthermore, the role of internal migration in getting exposed to air pollution and its implications to adolescent health should be studied separately. Investment in evidence-based programs, policies, and intervention targeted at adolescents is a key to improve health outcomes, prevent future morbidity and mortality attributed to air pollution.

Additionally, we suggest the following recommendations:

- The provision should be in place for providing information to population regarding air quality level. Besides, research institutions should be encouraged to study the long-term impact of air pollution to the different group of population.
- Safety measures should be provided to vulnerable population (pregnant women, children, adolescent, elderly people and chronically ill people) to reduce exposure to air pollution. For example, vulnerable

group of population should avoid traffic, and families limiting outdoors time for their child.

- Public transports network should be strengthened and optional mode of transportation (cycling, walking) for short routes must be encouraged by creating safe roads.
- Creating green zone by tree plantation.
- Taking into account the long-term impact of air pollution, it is advisable to organize regular health checkups for children and adolescents.
- There is an urgent need to organize the future policies and actions to ensure the commitments to reduce air pollution.

We conclude that this article can play a vital role in raising the awareness of the health issues related to air pollution and its impact on adolescent health, initiate drawing room discussions and actions on preventing future harm to the growing period of life. We recommend that the aspect of air pollution should be incorporated into existing National Adolescent Health Program.

Conflict of Interest: None

References

1. WHO. Adolescents health. Available from: http://www.who.int/topics/adolescent_health/en/.
2. Patton GC, Sawyer SM, Santelli JS et al. Our future: a Lancet commission on adolescent health and wellbeing. *The Lancet* 2016; 387(10036): 2423-2478.
3. The Registrar General and Census Commissioner, Ministry of Home Affairs, Government of India. Available from: http://www.censusindia.gov.in/2011-Documents/PPT_World_Population/Adolescents_and_Youth_in_India_Highlights_from_Census_2011.pptx. Accessed 3rd November, 2016.
4. Mokdad AH, Forouzanfar MH, Daoud F et al. Global burden of diseases, injuries, and risk factors for young people's health during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 2016; 387(10036): 2383-401.
5. Dahiya S, Myllyvirta L, Sivalingam N. Airpocalypse: assessment of air pollution in Indian cities. Available from: <https://secured-static.greenpeace.org/india/Global/india/Airpocalypse--Not-just-Delhi--Air-in-most-Indian-cities-hazardous--Greenpeace-report.pdf>.
6. Health Effects Institute. State of Global Air 2017. Special Report. Health Effects Institute, Boston, MA. Available from: https://www.stateofglobalair.org/sites/default/files/SOGA2017_report.pdf. Accessed 5th March, 2017.
7. Central Pollution Control Board. Available from: http://cpcb.nic.in/upload/Downloads/AQI_Bulletin_20161227.pdf. Accessed 3rd November, 2016.
8. TERI. Air Pollution and Health. Discussion Article by The Energy and Resources Institute: New Delhi. 2015. Available from: <http://www.teriin.org/projects/terdy/pdf/air-pollution-health-discussion-article.pdf>.

- Accessed 3rd November, 2016.
9. WHO. Global report on urban health: equitable, healthier cities for sustainable development. Available from: http://www.who.int/kobe_centre/measuring/urban-global-report/ugr_full_report.pdf?ua=1. Accessed 6th November, 2016.
 10. Sheuya S, Howden-Chapman P, Patel S. The design of housing and shelter programs: the social and environmental determinants of inequalities. *Journal of Urban Health: Bulletin of the New York Academy of Medicine* 2007; 84(1): 98-108.
 11. Rizwan SA, Nongkynrih B, Gupta SK. Air pollution in Delhi: its magnitude and effects on health. *Indian Journal of Community Medicine* 2013; 38(1): 4-8.
 12. Schünemann HJ, Moja L. Reviews: Rapid! Rapid! Rapid! ...and systematic. *Systematic Reviews* 2015; 4(4): 1-3.
 13. Khangura S, Konnyu K, Cushman R et al. Evidence summaries: the evolution of a rapid review approach. *Syst Rev* 2012; 1(10): 1-9.
 14. Farrugia P, Petrisor BA, Farrokhyar F et al. Research questions, hypotheses and objectives. *Canadian Journal of Surgery* 2010; 53(4): 278-281.
 15. Siddique S, Banerjee M, Ray MR et al. Attention-deficit hyperactivity disorder in children chronically exposed to high level of vehicular pollution. *Eur J Pediatr* 2011; 170: 923-9.
 16. Singh S, Sharma BB, Sharma SK et al. ISAAC collaborating investigators. Prevalence and severity of asthma among Indian school children aged between 6 and 14 years: associations with parental smoking and traffic pollution. *J Asthma* 2016; 53(3): 238-44.
 17. Kalappanavar NK, Vinodkumar CS, Gouli C et al. Carbon particles in airway macrophage as a surrogate marker in the early detection of lung diseases. *The International Journal of Occupational and Environmental Medicine* 2012; 3(2): 68-75.
 18. Awasthi A, Singh N, Mittal S et al. Effects of agriculture crop residue burning on children and young on PFTs in North West India. *Sci Total Environ* 2010; 408(20): 4440-5.
 19. Kumar R, Nagar JK, Kumar H et al. Association of indoor and outdoor air pollutant level with respiratory problems among children in an industrial area of Delhi, India. *Arch Environ Occup Health* 2007; 62(2): 75-80.
 20. Kumar R, Sharma M, Srivastva A et al. Association of outdoor air pollution with chronic respiratory morbidity in an industrial town in northern India. *Arch Environ Health* 2004; 59(9): 471-7.
 21. Lahiri T, Roy S, Basu C et al. Air pollution in Calcutta elicits adverse pulmonary reaction in children. *Indian J Med Res* 2000; 112: 21-6.
 22. Das P, Chatterjee P. Association of ambient air quality with pulmonary function of youngster footballers. *Asian J Sports Med* 2014; 5(1): 39-4.
 23. Central pollution control board. Ministry of Environment and Forests. Study on ambient air quality, respiratory symptoms and lung of children in Delhi. Available from: http://www.cpcb.nic.in/upload/NewItems/NewItem_162_Children.pdf. Accessed 3rd November, 2016.
 24. Thakare A, Vijaya TD. Respiratory health status of rural and urban school children from Nagpur region. *Int J Biol Med Res* 2011; 2(3): 664-7.
 25. Siddique S, Banerjee M, Ray MR et al. Effect of air pollution on incidence of asthma: a case study in children. *Environ Int J Sci Tech* 2010; 5: 163-75.
 26. Gauderman WJ, Avol E, Gilliland F et al. The effect of air pollution on lung development from 10 to 18 years of age. *New England Journal of Medicine* 2004; 351(11): 1057-67.
 27. Gauderman WJ, Vora H, McConnell R et al. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. *The Lancet* 2007; 369(9561): 571-7.
 28. Benziger CP, Roth GA, Moran AE. The global burden of disease study and the preventable burden of NCD. *Global Heart* 2016; 11(4): 393-7.
 29. Institute for Health Metrics and Evaluation (IHME). GBD Compare Data Visualization. University of Washington, Seattle, WA: IHME. 2016. Available from: <http://vizhub.healthdata.org/gbd-compare>. Accessed 7th March, 2017.
 30. Forouzanfar MH, Alexander L, Anderson HR et al. Global, regional, and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 2015.
 31. Sapkota A, Gajalakshmi V, Jetly DH et al. Indoor air pollution from solid fuels and risk of hypopharyngeal/laryngeal and lung cancers: a multicentric case-control study from India. *Int J Epidemiol* 2008; 37(2): 321-3.
 32. Puri P, Nandar SK, Kathuria S et al. Effects of air pollution on the skin: A review. *Indian J Dermatol Venereol Leprol* 2017; 37(2): 321-8.
 33. Kunikullaya KU, Vijayaraghava A, Asha P et al. Meteorological parameters and pollutants on asthma exacerbation in Bangalore, India - an ecological retrospective time-series study. *J Basic Clin Physiol Pharmacol* 2017; 28(2): 133-141.
 34. Maji KJ, Dikshit AK, Deshpande A. Disability-adjusted life years and economic cost assessment of the health effects related to PM2.5 and PM10 pollution in Mumbai and Delhi, in India from 1991 to 2015. *Environ Sci Pollut Res Int* 2016.
 35. Lewis JJ, Hollingsworth JW, Chartier RT et al. Biogas stoves reduce firewood use, household air pollution, and hospital visits in Odisha, India. *Environ Sci Technol* 2017; 51(1): 560-9.
 36. Matawle JL, Pervez S, Shrivastava A et al. PM2.5 pollution from household solid fuel burning practices in central India: 1. Impact on indoor air quality and

- associated health risks. *Environ Geochem Health* 2016; 39(5): 1045-1058.
37. Nair AJ, Nandini M, Adappa S et al. Carbon monoxide exposure among police officers working in a traffic dense region of Southern India. *Toxicol Ind Health* 2017; 33(1): 46-52.
 38. Kumar R, Singh K, Nagar S et al. Pollutant Levels at Cooking Place and Their Association with Respiratory Symptoms in Women in a Rural Area of Delhi-NCR. *Indian J Chest Dis Allied Sci* 2015; 57(4): 225-31.
 39. Naz S, Page A, Agho KE. Household air pollution and under-five mortality in India (1992-2006). *Environ Health* 2016; 15(54): 1-11.
 40. Chowdhury S, Dey S. Cause-specific premature death from ambient PM2.5 exposure in India: Estimate adjusted for baseline mortality. *Environ Int* 2016; 91: 283-90.
 41. Balakrishnan K, Sambandam S, Ramaswamy P et al. Establishing integrated rural–urban cohortsto assess air pollution-related health effects in pregnant women, children and adults in Southern India: an overview of objectives, design and methods in the Tamil Nadu Air Pollution and Health Effects (TAPHE) study. *BMJ Open* 2015; 5: 1-13.
 42. Soubbotina TP. Beyond Economic Growth. The World Bank Washington, DC. Available from: <http://www.worldbank.org/depweb/beyond/beyond.htm>. Accessed 5 March, 2017.

Date of Submission: 2018-10-31

Date of Acceptance: 2018-11-09