ijer.skums.ac.ir

Health effects of air pollution in worldwide countries: An ecological study

Mokhtar Soheilyzad[1], Salman Khazaei[2], Rizan Rezaeian[3], Mahmoud Hajipour[4], Shahab Rezaeian[3*]

[1]*Health Education Dept., Hamadan University of Medical Sciences, Hamadan, I.R. Iran;* [2]*Epidemiology Dept., Hamadan University of Medical Sciences, Hamadan, I.R. Iran;* [3]*Social Determinants of Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, I.R. Iran;* [4]*Student Research Committee, Epidemiology Dept., Shahid Beheshti University of Medical Sciences, Tehran, I.R. Iran*

Received: 4/Feb/2016 Accepted: 13/Jun/2016

ABSTRACT

Background and aims: Air pollution is one of the health problems worldwide. Previous epidemiological studies have investigated the impacts of air pollution on respiratory and cardiovascular diseases. The aim of this study was to determine the associations between air pollution levels and different health indicators among world countries.

Methods: This ecological study was performed in 2013 by using dataset of World Health Organization (WHO). The main variable in our study was air pollution index. The data including Maternal Mortality Rate (MMR) (per 100000 live births), Life Expectancy at birth (LE), preterm birth rate (per 1000 live births) and Non-Communicable Diseases (NCD) death rate (per 100000 populations) from 91 countries were extracted. Pearson correlation coefficient was used to assess the linear correlation between air pollution and investigated indexes using Stata 11.

Results: MMR (r=0.36, P=0.001) and NCD death rate (r=0.31, P=0.002) were positively associated with air pollution level. The rate of air pollution was also negatively associated with LE among world countries (r=-0.57, P=0.001). Our findings have not shown any significant liner association between air pollution and preterm birth rate (r=0.14, P=0.41).

Conclusion: Our results are in agreement with other recent findings that there is an association between air pollution and health indexes, especially mortality rate. Accordingly, from a public health perspective, reducing pollutant emissions to outdoor air should be a high priority for all countries.

Keywords: Air pollution, Health index, Ecologic study.

Brief Communication

INTRODUCTION

Air pollution is a great environmental risk to human health.[1] By definition, air pollution is a situation in which the outdoor atmosphere contains certain materials in concentrations

[*]**Corresponding author:** Shahab Rezaeian, Social Determinants of Health Research Center , Kurdistan University of Medical Sciences, Sanandaj, I.R. Iran, Tel: 00989189814634, E-mail: Shahab.rezayan@gmail.com

which are harmful to humans or their environment. Air pollution affects the health in several ways[2], while a number of short and long term epidemiological studies have surveyed the effects of air quality changes on human health.[3,4] A constant finding is that air pollutants are associated with increasing mortality and hospital admissions.[5,6]

Human health effects can range from nausea and difficulty in breathing or skin irritation, to cancer. They also include birth defects, serious developmental delays in children, and reduced activity of the immune system, leading to a number of diseases.[7-13] Health effects can be distinguished to acute, chronic not including cancer and cancerous. Epidemiological and animal model data indicate that primarily affected systems are the cardiovascular and the respiratory system. However, the function of several other organs can be also influenced.[14,15] Air pollution in both cities and rural regions was estimated to cause 3.7 million premature deaths worldwide in 2012.[1] Globally, it is estimated that 12.8% of lung cancer death can be attributed to exposure of air pollution.[16]

By reducing air pollution levels, countries can reduce the burden of diseases from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma.[1] Although several studies have been conducted to assess the effects of air pollution on different aspects of human health in different regions, there is no universal research on the effects of air pollution among world countries. Therefore, this study aimed to investigate the effect of air pollution on some health indices such as maternal mortality rate (MMR), life expectancy, preterm birth rate, and non-communicable diseases (NCDs) in the countries around the world.

METHODS

This ecological study was performed in 2014 by using the dataset of World Health Organization (WHO).

The main variable in our study was air pollution index which is defined as the mean annual concentration of fine suspended particles of less than 10 microns in diameters in a population-weighted average for urban population in a country.[17]

The data including maternal mortality rate (MMR) (per 100,000 live births), life expectancy at birth (LE), preterm birth rate (per 1000 live births) and non-communicable diseases (NCD) death rate (per 100,000 populations) from 91 countries were extracted from the various WHO datasets. Data about the Human Development Index (HDI) were extracted from the World Bank Report 2012.

Pearson correlation coefficient was used to assess the linear correlation between air pollution and investigated indexes using Stata 11 (Stata Corporation, College Station, Texas, USA).

RESULTS

Table 1 shows the mean of air pollution and the correlation by human development index and income in world countries. There was a significant difference among means of air pollution by HDI and income groups. A significant negative correlation was found between air pollution and HDI ($r=-0.60$, $P<0.001$). We also found a significant positive correlation between air pollution and income among countries ($r=0.50$, $P<0.001$).

Table 1: Mean of air pollution and the correlation by human development index and income in world countries

Groups		Air pollution (Mean±SD)	Air pollution (Correlation)	P
HDI group	Very low	114.9±43.4		
	Low	95.2±73.0	-0.60	0.001
	High	60.1±33.0		
	Very high	31.8±20.3		
Income group	Very low	35.4±30.5		
	Low	53.6±37.8	0.50	0.001
	High	94.4±65.8		
	Very high	99.3±28.3		

HDI: human development index.

Table 2: Correlations between air pollution and health related variables in world countries

	Preterm birth	Life expectancy	Maternal Mortality Rate	NCD* male	NCD female	NCD total
Air pollution	0.14	-0.57	0.36	0.13	0.11	0.31
P	0.410	<0.001	<0.001	0.226	0.304	0.002

NCD: Non-communicable diseases.

Correlations between air pollution and health related variables are shown in Table 2. MMR (r=0.36, P<0.001) and NCD death rate (r=0.31, P=0.002) were positively associated with air pollution level. The rate of air pollution was also negatively associated with LE among world countries (r=-0.57, P<0.001). Our results have not found any significant liner association between air pollution and preterm birth rate, NCD male, and NCD female.

DISCUSSION

In this study the relationship between air pollution and some health indices in countries around the world have been studied. The results suggested a significant negative correlation between air pollution and HDI. This means that by increasing HDI, the average air pollution is reduced. This negative correlation may be because developed countries have modern facilities to use of new energy sources and clean fuels such as nuclear energy, which than fossil fuels do not cause air pollution. On the other hand, there is a significant positive correlation between high income and an increase in average air pollution in the world. In many developing countries, which also have a high income due to rapid economic growth and expansion of industries and factories as well as development of urbanization in these countries[18] the indiscriminate use of fossil fuels will lead to increased air pollution.

According to the results of this study, air pollution increased the incidence of preterm birth in the world, but this increase was not

statistically significant. This finding is consistent with results of other studies.[4,19] A prospective study to evaluate the association between air pollution and adverse pregnancy outcomes revealed a significant association between air pollutants and preterm birth.[8] Another study in the USA state of Georgia reported that several ambient air pollutants such as carbon monoxide, nitrogen dioxide, and PM2.5 elemental carbon are associated with preterm birth.[20] A review study to determine the impacts of lead exposure on reproductive health and outcomes also concluded that exposures to lead prior to and during pregnancy should be considered as a factor which increases the risk of adverse effects of fetal growth and congenital malformations.[21]

We found a significant negative correlation between air pollution and LE, by increasing air pollution LE is reduced. This finding is consistent with results of other studies.[22,23] Air pollution leaves devastating effects on health and with a variety of fatal diseases leads to early death.[4] This leads to the loss of many years of life and consequently LE will be reduced.

The results showed a significant positive correlation between air pollution and MMR. Our results are in line with the findings of other studies.[24] Since air pollution by creating a variety of diseases significantly increases mortality[4,23], MMR as part of the overall mortality, in turn, will increase. On the other hand, air pollution can cause a variety of disorders and diseases in pregnant women and their fetuses[23,24] that leads to the death of the mother, resulting in the increase MMR.

The findings of this study suggest that air pollution significantly increases the incidence of non-communicable diseases. On the other hand, after stratification by gender there was no significant correlation between air pollution and the incidence of non-communicable diseases. This issue may be due to the Simpson's paradox effect.[25] The role of air pollution on occurrence of many non-communicable diseases has been revealed in some studies.[2,4,26]

This study had some limitations and strengths. The causal interpretation should be warily done because of the ecologic design of study. We used the data from WHO and the World Bank Reports. Accordingly, the use of standardized data with the consistent definitions in these data facilitated comparisons across worldwide countries. On the other hand, there are no limitations associated with sample size and selection and information bias.

CONCLUSION

The results of our study like other studies, showed a clear relationship between air pollution and multiple indicators of health, especially mortality. So, from a public health perspective, it seems necessary to reduce emissions to the ambient air; countries around the world should take the appropriate measures and consider this as one of the health priorities.

CONFLICT OF INTEREST

The authors declare that there was no conflict of interest.

ACKNOWLEDGMENTS

This paper used the data from the World Health Organization and the World Bank Report. The authors declare that there is no conflict of interests to report for this work.

REFERENCES

1. World Health Organization. Ambient (outdoor) air quality and health Geneva: WHO; 2014 [cited 2016]. Available from: http://www.who.int/mediacentre/factsheets/fs313/en/.

2. Santra S. Is Human Development Index (HDI) a reflector of quality of air? A comparative study on developed and developing countries. Int J Sci Res. 2014; 4(2): 1-6.
3. Kurt OK, Zhang J, Pinkerton KE. Pulmonary health effects of air pollution. Curr Opin Pulm Med. 2016; 22(2): 138-43.
4. Kampa M, Castanas E. Human health effects of air pollution. Environ Pollut. 2008; 151(2): 362-7.
5. Wong CM, Vichit-Vadakan N, Vajanapoom N, Ostro B, Thach TQ, Chau PY, et al. Part 5. Public health and air pollution in Asia (PAPA): A combined analysis of four studies of air pollution and mortality. Res Rep Health Eff Inst. 2010; 154: 377-418.
6. Brunekreef B, Holgate ST. Air pollution and health. The lancet. 2002; 360(9341): 1233-42.
7. Huang C, Nichols C, Liu Y, Zhang Y, Liu X, Gao S, et al. Ambient air pollution and adverse birth outcomes: a natural experiment study. Popul Health Metr. 2015; 13: 17.
8. Qian Z, Liang S, Yang S, Trevathan E, Huang Z, Yang R, et al. Ambient air pollution and preterm birth: A prospective birth cohort study in Wuhan, China. Int J Hyg Environ Health. 2016; 219(2): 195-203.
9. Yorifuji T, Kashima S, Higa Diez M, Kado Y, Sanada S, Doi H. Prenatal exposure to traffic-related air pollution and child behavioral development milestone delays in Japan. Epidemiology. 2016; 27(1): 57-65.
10. Vawda S, Mansour R, Takeda A, Funnell P, Kerry S, Mudway I, et al. Associations between inflammatory and immune response genes and adverse respiratory outcomes following exposure to outdoor air pollution: A HuGE systematic review. Am J Epidemiol. 2014; 179(4): 432-42.
11. Dabass A, Talbott EO, Venkat A, Rager J, Marsh GM, Sharma RK, et al. Association of exposure to particulate matter (PM2.5) air pollution and biomarkers of cardiovascular disease risk in adult NHANES participants (2001-2008). Int J Hyg Environ Health. 2016; 219(3): 301-10.
12. Hart JE, Puett RC, Rexrode KM, Albert CM, Laden F. Effect modification of long-term air pollution exposures and the risk of incident cardiovascular disease in US Women. J Am Heart Assoc. 2015; 4(12): 56-9.
13. Thurston GD, Burnett RT, Turner MC, Shi Y, Krewski D, Lall R, et al. ischemic heart disease mortality and long-term exposure to source-related components of U.S. fine particle air pollution. Environ Health Perspect. 2016; 124(6): 785-94.
14. Huang YC, Ghio AJ. Vascular effects of ambient pollutant particles and metals. Curr Vasc Pharmacol. 2006; 4(3): 199-203.
15. Sharma RK, Agrawal M. Biological effects of heavy metals: an overview. J Environ Biol. 2005; 26(2): 301-13.
16. Fajersztajn L, Veras M, Barrozo LV, Saldiva P. Air pollution: A potentially modifiable risk factor for lung cancer. Nat Rev Cancer. 2013; 13(9): 674-8.
17. World Health Organization. Annual mean concentration of particulate matter of less than 10 microns of diameter (PM10) [ug/m3] Geneva: WHO; 2011 [cited 2016]. Available from: http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=1349.
18. Brauer M, Amann M, Burnett RT, Cohen A, Dentener F, Ezzati M, et al. Exposure assessment for estimation of the global burden of disease attributable to outdoor air pollution. Environ Sci Technol. 2012; 46(2): 652-60.
19. Wu J, Ren C, Delfino RJ, Chung J, Wilhelm M, Ritz B. Association between local traffic-generated air pollution and preeclampsia and preterm delivery in the south coast air basin of California. Environ Health Perspect. 2009; 117(11): 1773-9.

20. Hao H, Chang HH, Holmes HA, Mulholland JA, Klein M, Darrow LA, et al. Air Pollution and Preterm Birth in the U.S. State of Georgia (2002-2006): Associations with Concentrations of 11 Ambient Air Pollutants Estimated by Combining Community Multiscale Air Quality Model (CMAQ) Simulations with Stationary Monitor Measurements. Environ Health Perspect. 2016; 124(6): 875-80.
21. Bellinger DC. Teratogen update: lead and pregnancy. Birth Defects Res A Clin Mol Teratol. 2005; 73(6): 409-20.
22. Correia AW, Pope CA, 3rd, Dockery DW, Wang Y, Ezzati M, Dominici F. Effect of air pollution control on life expectancy in the United States: an analysis of 545 U.S. counties for the period from 2000 to 2007. Epidemiology. 2013; 24(1): 23-31.
23. Wallner P, Hutter H-P, Moshammer H. Worldwide associations between air quality and health end-points:
24. Sram RJ, Binkova B, Dejmek J, Bobak M. Ambient air pollution and pregnancy outcomes: a review of the literature. Environ Health Perspect. 2005; 113(4): 375-82.
25. Baker SG. Causal inference, probability theory, and graphical insights. Stat Med. 2013; 32(25): 4319-30.
26. Kunzli N, Tager IB. Air pollution: from lung to heart. Swiss Med Wkly. 2005; 135(48): 697-702.

How to cite the article: Soheylizad M, Khazaei S, Rezaeian R, Hajipour M, Rezaeian S. Health effects of air pollution in worldwide countries: an ecological study. Int J Epidemiol Res. 2016; 3(4): 402-407.