VOLUME - 10, ISSUE - 10, OCTOBER - 2021 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper | Pulmonary Medicine

A STUDY ON AMBIENT AIR POLLUTION AND HOSPITAL VISITS OF PATIENTS IN TERTIARY HOSPITAL AT NORTH CHENNAI – AN OBSERVATIONAL STUDY

Dr. Vengada Krishnaraj S. P* — Associate Professor, Department of Respiratory Medicine, Government Stanley Medical College, Chennai, Tamilnadu, India.*Corresponding Author

Dr. Roshan Kumar. M — Assistant Professor, Department of Respiratory Medicine, Government Stanley Medical College, Chennai, Tamilnadu, India.

Dr. Vinod Kumar. V — Professor, Department of Respiratory Medicine, Government Stanley Medical College,Chennai, Tamilnadu, India.

ABSTRACT

BACKGROUND: Air pollution is an important environmental risk factor for human health. Evidence is mounting that ambient air pollution exposure is significantly associated with respiratory diseases. Ambient air pollution, such as nitrogen dioxide (NO2), sulfur dioxide (SO2), and particulate matter (PM), is associated with mortality and morbidity induced by respiratory diseases. The relationship between air pollutants and respiratory hospital admissions has been reported both in developed countries and in developing countries. Other studies have shown an adverse effect of ambient air pollution exposure on morbidity and mortality, as well as on healthcare costs. **AIM OF THE STUDY:** To investigate the association between ambient air pollutant exposure and daily hospital admissions for respiratory diseases in both childrens and Adults. **METHODOLOGY:** The daily emergency hospital admissions for respiratory conditions in the north part of Chennai during 2019- 2020 were recorded. Daily counts of hospital admissions for total respiratory conditions (43 admissions day(-1)), acute respiratory infections including pneumonia (18 day(-1)), chronic obstructive pulmonary disease (COPD) (13 day(-1)), and asthma (4.5 day(-1)) among residents of all ages and among children (0-14 yrs) were analysed. The generalized additive models included spline smooth functions of the day of study, mean temperature, mean humidity, influenza epidemics, and indicator variables for days of the week and holidays. Total respiratory admissions were significantly associated with the same-day level of NO2 (2.5% increase per interquartile range (IQR) change, 22.3 microg x m(-3)) and CO (2.8% increase per IQR, 1.5 mg x m(-3)). **RESULTS:** The daily mean concentrations of pollutants across all studies were 65.2 μg/m3 for PM10, 45.8 μg/m3 for PM2.5, 27.7 μg/m3 for SO2, 35.0 μg/m3 forNO2and1698μg/m3for CO, and 81.1μg/m3for O3. For the single variable models, the linear effect of PM10, PM2.5, and PM1 was evaluated by adjusting for the influence of temperature. The association between hospital admissions for respiratory disease and the level of particulate matter was statistically significant at 0-3 daylag in females and overall. In males, no statistically significant effect was found at lag 3 for PM10 or at lag2-3 for PM2.5 and PM1.The associations between PM2.5 and PM1, and risk of admission were no longer significant at some lags after adjusting for NO2, SO2, CO, and O3 separately. No associations were found at lag 3 after adjusting for NO2 or at lag 2 and 3 after adjusting for O3. The effects of PM2.5 and PM1 were not changed after adjusting for CO but were weaker after adjusting for other air pollutants (NO2, SO2,and O3). **CONCLUSION:** The findings of this study demonstrated that O3 was associated with an increased risk of respiratory-related admissions, especially for children <5years old. The effect was stronger in the winter than in the summer with each increase of 10 μg/m3 of O3 in winter, the risk of admissions for respiratory diseases after 5 days of exposure increased by 6.2% (95% CI3.7% - 8.8%). No significant association between O3 and hospital admissions for wheeze-associated disorders specifically was observed in children.

KEYWORDS : Acute Lower Respiratory Infections, Particulate Matters With Aerodynamic Diameter, Total Suspended Particulate, Sulphur Dioxide

INTRODUCTION

Human lives are influenced directly by environmental factors, one of which is the atmospheric environment including air qualityand weather conditions.Air quality in many areas worldwide has been significantly reduced due to an increase inpollutants generated by anthropogenic activities under the context of rapid urbanization and industrialization. [1]The serious consequence of urban ambient air pollution was seen in themid-20thcentury when cities worldwide experienced airpollution crises. [2] Outdoor airpollution became a major environmental healthproblem and the levels of airpollution have been linked to increased human mortality or morbidity since the 1950s. To address this problem, WHO in 1987 established air quality standards to protect human health, which has been revised several times since the original publication. However,by 2012,airpollution was still the cause of approximately 7 million deaths per year globally. Sofar, thousands of articles have reported consistent positive associations between exposures to air pollutants and the risk of morbidity or mortality from various diseases such as cardiovascular and respiratory diseases.[3] Many studies have focused on the effects of air pollution on respiratory health. Respiratory health effects have been reported due to both short-term exposure and long-term exposure to air pollution. Among the air pollutants, particulate matter has received special attention as they are considered a major component causing adverse health effects. Theeffects of other air pollutants such as ozone (O3), nitrogen oxides (NO2NOx), sulfurdioxide (SO2), and carbon monoxide (CO) on health have been also examined in recent studies. [4] In addition to air quality, weather conditions including temperature, relative humidity, and rainfall are factors that might impact human health. A growing body of evidence demonstrates that ambient temperatures are associated with a wide range of adverse health effects such as increase mortality as well as morbidity from all causes or specific causes of cardiovascular, respiratory disease.[5] The effect of ambient temperature on health might be strengthened shortly due to the increased frequency, intensity, and duration of weather-related extreme events like heat waves and unusually cold spells caused by the ongoing global climate change[6].There is a large body of evidence showing that airpollutants negatively affect the respiratory health of children and infants. These health effects vary from respiratory mortality to respiratory morbidity including increased risk of inflammation as asthma and allergic symptoms acutebronchitis/bronchiolitis acuterespiratory infection pneumonia or decreased lung functions.[7] As environmental pollution and pollution-related disease, most affect the poor and powerless, children in developing countries are the most vulnerable to the health risks from exposure to air pollution and climate change-related extreme weather events [8]

METHODOLOGY:

The daily emergency hospital admissions for respiratory conditions in the north part of Chennai during 2019- 2020 were recorded. Daily counts of hospital admissions for total respiratory conditions (43 admissions day(-1)), acute respiratory infections including pneumonia (18 day(-1)), chronic obstructive pulmonary disease (COPD) (13 day(-1)), and asthma (4.5 day(-1)) among residents of all ages and among children (0-14 yrs) were analysed. The generalized additive models included spline smooth functions of the day of study, mean temperature, mean humidity, influenza epidemics, and indicator variables for days of the week and holidays. Total respiratory admissions were significantly associated with the same-day level of NO2 (2.5% increase per interquartile range (IQR) change, 22.3 microg x m(-3)) and CO (2.8% increase per IQR, 1.5 mg x m(-3)).Firstly, the analysis was repeated discarding each included study one by one to test the contribution it made to the pooled effect sizes. Secondly, the pooled effect sizes were computed for only the shortest single lag or cumulative lag, if no single lag estimates were provided in individual studies. Thirdly, to test if the lower quality score studies (score <20) influenced the pooled estimates, I tried to add the cross-sectional studies to the meta-analysis by assuming the units of increment in those studies as the difference in the mean concentration of air pollutants between study and control area. Also,to evaluate the influence of study design, the pooled effect sizes were estimated for the studies with time-series and case-cross over design only.

Stastic Alanalysis:

Test of significance will be done using chi-square test and p-value. Statistical software SPSS22 will be used for data analysis. Data entry will be done using the MS EXCEL sheet. Descriptive statistics were done for all data and were reported interms of mean values and percentages. Suitable statistical tests of comparison were done. Continuous variables were analyzed with the unpaired t-test.Categorical variables were analyzed with the Chi-SquareTest and Fisher Exact Test. Statistical significance was taken as $P < 0.05$.

RESULTS

Table:1 Descriptive Statistics Of Air Pollutant Concentrations Calculated From Includedstudies.

Airpollutant ($\mu g/m^3$)	Dailymean* (Standard Deviation)	Range		Number of studies	Number of estimates
		Min	Max		
PM10	65.2(27.0)	34.3	104.0	6	7
PM2.5	45.8(17.7)	25.3	56.1	3	3
PM1	43.7(0)	43.7	43.7	1	1
SO2	27.7(9.1)	18.6	38.1	4	4
NO2	35.0(37.0)	0.0	103.4	4	5
NOx	86.4(0)	86.4	86.4	1	3
CO	1698.3 (1474.8)	0.0	2656.0	2	3
O3	81.1(40.6)	42.4	150.0	4	7

Table 2. Descriptive Statistics Of Air Pollutant Concentrations Was Calculated From Included studies.

Airpollutant ($\mu g/m^3$)	Dailymean* (Standard Deviation)	Range		Number of studies	Number of estimates
		Min	Max		
PM10	65.2(27.0)	34.3	104.0	6	7
PM2.5	45.8(17.7)	25.3	56.1	3	3
PM1	43.7(0)	43.7	43.7	1	1
SO2	27.7(9.1)	18.6	38.1	4	4
No2	35.0(37.0)	0.0	103.4	4	5
NOx	86.4(0)	86.4	86.4	1	3
CO	1698.3 (1474.8)	0.0	2656.0	2	3
O3	81.1(40.6)	42.4	150.0	4	7

Table 3. Descriptive Statistics Of Hospital Admissions, Air Pollutants, And Weather Conditions.

Percentile						
				Minimum	Maximum	Mean (SD)
	25th	50th	75th			
Respiratoryadmissions Overall	19	24	30	8	48	24(7)
Males	12	15	19	4	37	16(5)
Females	6	8	11	1	19	8(3)
Air Pollutant($\mu g/m^3$)						
PM10	71	98	132	24	333	108(51)
PM2.5	41	61	85	16	208	67(33)
PM1	30	48	72	11	177	54(30)
NO2	34	45	55	0.049	110	45(18)
SO2	3	6	18	0.021	63	12(11)
CO	3443	4012	4760	1266	10033	4175 (1136)
O3	49	75	108	13	254	84(48)
Temperature (°C)	20	25	29	9	34	24(6)

DISCUSSION

The data from the present study show that there was a positive effect of O3 on the risk of hospital admissions for respiratory diseases, especially amongst young children.O3 showed significant cumulative effects on the hospitalization of children in both winter and summer. These results are in agreement with some previous studies in other parts of the world which reported significant increases in respiratory admission due to increases in the level of O3.[8] In the present study,O3increased the risk of respiratory-related hospitalizations, with the maximum effect at a 5-day lag between exposure and effect, particularly in winter. For example, in one study conducted in Canada, the authors found respiratory admissions among children aged <3 years old were associated with elevated O3 levels at 2, 3, 4, and 5 days before admission with the strongest association observed at a lag of 4 days OR 1.22 (95% CI 1.15 - 1.30) based on an increment increasein O3 level of 19 $\mu g/m3$ (124). Not all studies in the literature find positive associations between O3 and hospital admissions for wheeze-associated disorders[9]. Few studies have specifically considered seasonal differences in O3. Positive associations with respiratory admissions have been reported in summer only the warm season, or in the winter only. In the present study, positive associations with a 5-day cumulative lag in both winter and summer months were observed, butsingle-day lag effects were only seen in winter. There as ons for these inconsistent findings is not clear but the absolute level of ambientO3, differing patient characteristics (such as age, sex, occupation, or poverty), the amount of outdoor activity undertaken, and/or any adaptive behaviors (such as open windows or air conditioning), which can differ by location may becontributory factors.[10] Many studies have investigated the effect of PM10 on respiratory morbidity and found a positive association between PM10 levels and hospitalization for respiratory diseases. Some studies have reported no increased risk with PM10[11]. The differences may be related to the range of PM10in particular studies or to differing sources producing particles with different toxicities. In two other studies Gryparis A, et.al a 10 μg/m3 increase in PM10 was associated with a 0.7%(95%CI0.2-1.3)increase in the risk of respiratory admissions for all age groups(17) and 1.25%(95%CI0.55-3.09) increase in the risk of ALRI admissions for children under 5 years old in the dry season [12] Evidence on the health risks associated with short-term exposure to fine particles (PM2.5)has been reported in recent studies However, data the relationship between fine particulates and child health is limited. Most previous studies addressed specific end points such as bronchiolitis,asthma or pneumonia,and found adverse effects of PM2.5 on child respiratory morbidity.This study is among few studies focusing on the relationship between PM2.5 and respiratory admissions in children aged less than 5 years. [13] Each increase of 10 μg/m3 of PM2.5 in the present study led to an increase of 2.2%(95%CI1.2-3.1)in respiratory hospital admissions.The significant association between PM2.5and respiratory admissions found here agrees with previous studies in children although the increased risks of admission were different among studies.[14] The results of the present study suggest that exposure to PM1 poses a greater risk of hospitalization for respiratory disease than PM10 and PM2.5.This finding is important because although finer PM which includes PM1 and ultra fine particles(particles with diameters smaller than 0.1μm,UFPs)might be more toxic than the coarser PM,their effects on the respiratory system, especially in children, have not been well described. Despite inconsistent reports in the literature, PM1 could be expected to have greater adverse effects on health due to the ability to penetrate deeply into the respiratory tract.[15] Li S, Baker PJ found that an increase in PM1 concentrations led to a decrease in lung function supporting the biological plausibility of my results.There are several possible explanations for the difference in the relationships between particles of different sizes and respiratory admissions, compared to those reported here.PM2.5 and PM1 may be more harmful than PM10 due to their penetration capability which may explain, in part, why I found a greater effect of PM2.5 and PM1 on respiratory hospital admissions than PM10. Some earlier studies have demonstrated the entry of particles into the lungs and their retention capacity within the airway walls.[16] The lighter particles (PM2.5and PM1) are likely to travel further away from the emission sources and remain airborne for a longer period than the heavier PM10 particles.[17,18] Phung D, et.al reported that the suspension lifetimes of PM10 are minutes to hours while the corresponding values of PM2.5 are days to weeks. Therefore, the potential for exposure to fine particles may be higher than for coarse particles.[19,20]

CONCLUSION

This study confirmed that the daily hospital admission for respiratory diseases among adults was positively associated with the level of airborne particulate matter measured in the city. During the study period, each 10 μg/m3 increase in PM10, PM2.5,and PM1 significantly increased the risk of hospital admission by 1.4%, 2.2%, and 2.5%, respectively, at lag 0. The strong impacts of airborne particulate matter on respiratory morbidity in children mean that urgent intervention measures are needed to control airpollution to ensure better health protection.

REFERENCES

1. Almeida SP, Casimiro E, Calheiros J. Short-term association between exposure to ozone and mortality in Oporto,Portugal.Environmental research.2011;111(3):406-10.
2. Bell ML, Zanobetti A, Dominici F. Who is More Affected by Ozone Pollution? A Systematic Review and Meta-Analysis. American Journal of Epidemiology. 2014;180(1):15-28.
3. Brunekreef B,HolgateST. Airpollution and health.TheLancet. 2002; 360(9341): 1233- 42.
4. Burnett RT, Brook JR, Yung WT, Dales RE, Krewski D. Association between ozone and hospitalization for respiratory diseases in 16 Canadian cities. Environmental research.1997;72(1):24-31.
5. Burnett RT, Smith-Doiron M, Stieb D, Raizenne ME, Brook JR, Dales RE, et al. Associationbetween ozone and hospitalization for acute respiratory diseases in children less than 2 years ofage.American journal of epidemiology. 2001; 153(5): 444-52.
6. Cheng J, Xu Z, Zhu R, Wang X, Jin L, Song J, et al. Impact of diurnal temperature range on human health:a systematic review. International journal of biometeorology. 2014;58(9):2011-24.
7. Cooper OR, Parrish D, Ziemke J, Balashov N, Cupeiro M, Galbally I, et al. Global distribution and trends of tropospheric ozone: An observation-based review. Elem Sci Anth.2014;2.
8. Dang TN, Seposo XT, Duc NHC, Thang TB, An DD, Hang LTM, et al. Characterizing therelationship between temperature and mortality in tropical and subtropical cities: a distributed lagnon-linear model analysis in Hue, Viet Nam, 2009–2013. Global Health Action.2016;9:10.3402/gha.v9.28738.
9. De Leon AP, Anderson HR, Bland JM, Strachan DP, Bower J. Effects of air pollution ondaily hospital admissions for respiratory disease in London between 1987-88 and 1991-92. Journal of Epidemiology & Community Health.1996;50(Suppl1):s63-s70.
10. Farhat S, Paulo R, Shimoda T, Conceição G, Lin C, Braga A, et al. Effect of air pollution onpediatric respiratory emergency room visits and hospital admissions. Brazilian Journal of Medical and Biological Research. 2005; 38(2): 227-35.
11. Giang PN, Dung DV, Giang KB, Vinhc HV, Rocklöv J. The effect of temperature oncardiovascular disease hospital admissions among elderly people in Thai Nguyen Province,Vietnam.Globalhealth action.2014;7(1):23649.
12. Gryparis A, Forsberg B, Katsouyanni K, Analitis A, Touloumi G, Schwartz J, et al. Acuteeffects of ozone on mortality from the "air pollution and health: a European approach" project. American journal of respiratory and critical caremedicine. 2004;170(10):1080-7.
13. Guerreiro CBB, Foltescu V, de Leeuw F. Air quality status and trends in Europe.Atmospheric Environment. 2014;98(SupplementC):376-84.
14. Iñiguez C, Schifano P, Asta F, Michelozzi P, Vicedo-Cabrera A, Ballester F. Temperature insummer and children's hospitalizations in two Mediterranean cities. Environmental research.2016;150:236-44.
15. Ji M, Cohan DS, Bell ML. Meta-analysis of the association between short-term exposure toambient ozone andrespiratory hospital admissions. Environmental Research Letters.2011;6(2):024006.
16. Li S, Baker PJ, Jalaluddin BB, Guo Y, Marks GB, Denison LS, et al. An Australian nationalpanel study of diurnal temperature range and children's respiratory health. Annals of Allergy,Asthma & Immunology.2014;112(4):348-53.
17. Medina-Ramon M, Schwartz J. Who is more vulnerable to die from ozone air pollution? Epidemiology.2008;19(5):672-9.
18. Peng RD, SomaliE, PhamL,DominiciF,TouloumiG,RamsayT,etal.Acute effects of ambient ozone on mortality in Europe and North America: results from the APHENA study. AirQuality,Atmosphere& Health.2013;6(2):445-53.
19. Phung D, Guo Y, Nguyen HT, Rutherford S, Baum S, Chu C. High temperature and risk of hospitalizations, and effect modifying potential of socio-economic conditions: A multi-province study in the tropical Mekong Delta Region. Environ Int.2016;92-93:77-86.
20. Son J-Y, Bell ML, Lee J-T. The impact of heat, cold, and heat waves on hospital admissions in eight cities in Korea.International journalof biometeorology. 2014; 58(9):1893-903.