ORIGINAL ARTICLE

Exploring the trends of breathlessness and mortality in conjunction with AQI in India's coal capital, Dhanbad

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ABSTRACT

Background: Air Quality Index (AQI) has been evidenced to be linked with various health problems including NCDs. Globally, the combined effect of ambient air and household air pollution causes 6.7 million premature deaths. **Objective:** A study was undertaken to understand various associations of AQI and morbidity data, indigenous to the coal capital region of India. **Methodology:** This was a cross-sectional study where district AQI data was obtained from the state of Jharkhand while mortality and morbidity data were collected from our medical college. MS Excel and SPSS were used to analyse the data. **Results:** During the study period, the AQI of Dhanbad has been moderate to poor. The lowest AQI was noted in May 2020 at 105 while the highest in June 2019 at 217. The highest admission, due to respiratory illness, was noted in May 2020 with AQI of 105. Using univariate analysis age categorisation was statistically significant, as the respiratory illness was highest in >85 years age group. In logistic regression, it has the highest odds of 2.9 (1.5-5.5). **Conclusion:** This region-specific indigenous information is expected to provide a valuable tool for Air quality managers for more focused action. It also highlights the health impacts of the worsening air quality.

KEYWORDS

Cross-Sectional Studies; Logistic Models; Mortality, Premature; Air Pollution; Morbidity; India; Coal

INTRODUCTION

Air pollution is the biggest environmental health risk. Air pollution harms health, lifespan, and productivity. (1) WHO estimates air pollution takes 7 million lives annually. Air pollution killed 4.2 million people in 2016 while fossil fuel cooking killed 3.8 million. Over 90% of low- and middle-income Asian, African, eastern Mediterranean, European, and American deaths are from air pollution. (2) Chronic bronchitis, lung cancer, and asthma kill 6.7 lakh Indians annually due to ambient air pollution. Outdoor pollution particles increase air pollution-related hospital visits by 20–25%. Nearly 76% of rural Indian families cook using solid biomass, causing air pollution-related ailments. Around 76.8% of Indians are exposed to particulate matter levels above 40 µg/m3, surpassing the acceptable limit set by air pollution legislation. (3) Of 480.7 million Disability-Adjusted Life Years in India, 4.4% were due to ambient PM and 15.8% to residential air pollution. If exposure was limited to national minimums, Indian life expectancy would rise by 1.7 years. (4) Terminal small airways and air sacs can collect 1-10 micrometer particles. Particles in the air are chemically and physically diverse. Particulates cause respiratory, cardiovascular, and early mortality. (5,6) Delhi and Mumbai studies link air pollution to decreased lung function, cough, wheezing, and asthma in children and adults. (7,8) Rural data links biomass fuel cooking to high indoor pollution levels that surpass health guidelines. (9) India is among the 30 most polluted nations, but its air quality policies emphasize metros over Jharkhand's coal mines. (8,10) The objectives of the study are 1. To evaluate the prevalence and severity of respiratory illnesses (morbidities) and deaths (mortalities) in Dhanbad, Jharkhand, focusing on the impact of its coal mining activities, and 2. To investigate the relationship between fluctuations in the Air Quality Index (AQI) and the occurrence of breathlessness and other respiratory diseases in Dhanbad's population.

MATERIAL & METHODS

The observational cross-sectional design was taken at SNMMCH, Dhanbad an active coal mining city in the state of Jharkhand. The study was initiated after Institutional Ethical Clearance was obtained. The study was conducted for 15 months i.e. June 2019 to August 2020. The study population was, patient catered by SNMMCH Dhanbad. It includes patients from Dhanbad, Giridhi and Jamtara districts. All the patients during the study period were scrutinized, which is 13572 admission cases and 3111 deaths. The non-random purposive sampling technique was used.

Inclusion and Exclusion Criteria The inclusion criteria were admission or death with breathing problems. Exclusion criteria used were breathing problems like birth asphyxia, respiratory distress syndrome, delayed cry, aspiration pneumonitis and meconium aspiration syndrome along with all admissions and deaths due to non-respiratory causes were excluded.

Study Tool The air quality data obtained from the Jharkhand State Pollution Control Board. The health data was gathered from SNMMCH hospital admission records.

Data analysis Data collected from hospital records manually were entered in MS Excel and analysed using SPSS 20 software. Data thus collected was categorized as Morbidity data and Mortality data. All admission with a diagnosis of diseased condition was re-categorized as breathing problems (COPD, Acute exacerbation of COPD, Asthma, breathlessness, cough, COVID-19, Haemoptysis, LRTI, Lung cancer, Pleural effusion, Pulmonary T.B, URTI, MDR T.B, Pneumonia and cor -pulmonale) or non-breathing problems. Likewise in death data sheets deaths due to respiratory causes (Asthma, breathlessness, cough, COPD, C.R. failure, COVID-19, Hypoxia, lung cancer, LRTI, Pneumonia, pulmonary TB and Respiratory Failure) were filtered.

The operational definition for AQI Range The AQI of 51-100 was taken as “Satisfactory”, 101-200 was taken as “Moderate”, 201-300 was taken as “Poor” and 301-400 was taken as “Very Poor”.(11)

RESULTS

In our study, we found that the AQI of Dhanbad was more than 100 with AQI touching more than 200 in June 2019 and Feb 2020, but after April 2020 a dip in AQI was observed, nationwide lockdown, with the AQI dipping as low as 105 in May 2020. (Table 1)

Table 1. Stratification of AQI month-wise (Data from JSPC Board)

S.No	AQI Quality	Months (June 2019 – August 2020)
1	Satisfactory (51-100)	
2	Moderate (101-200)	2019- July, Aug, Sept, Oct, Nov, Dec. 2020- Jan, March, April, May, June, July, Aug
3	Poor (201-300)	2019- June 2020-February
4	Very Poor (301-400)	

A dip was seen in the number of patients presenting to the OPD with respiratory problems with April 2020 recording the lowest number of patients' admissions due to respiratory problems. In the analysis of the association of respiratory morbidity it was found that in Dhanbad, hospital admissions due to respiratory causes were 12% of the total admissions from June to December 2019 (Table 2). The AQI data during June 2019 was recorded as poor and a significant dip in admissions was seen in July with improving AQI from poor to moderate.

Table 2. Comparison between admissions due to breathing problems out of total admissions, with AQI from June 2019 to August 2020.

Month	Total number of admissions	Month wise AQI	Total number of admissions due to breathing problems	Percentage
Jun-19	1246	217	165	13%
Jul-19	988	150	112	11%
Aug-19	1108	144	140	13%
Sep-19	1382	134	164	12%
Oct-19	1114	149	137	12%
Nov-19	1244	170	159	13%
Dec-19	782	177	65	8%
Jan-20	761	177	178	23%
Feb-20	740	202	145	20%
Mar-20	871	176	189	22%
Apr-20	687	108	151	22%
May-20	875	105	399	46%
Jun-20	870	111	238	27%
Jul-20	1007	121	311	31%
Aug-20	705	118	172	24%
TOTAL	14,380	151	2725	19%

The majority of patients, 73-76%, getting admitted were in the age range of 16 to 60 years while 19 to 20% were more than 60 years of age. It was also noted that 4-8% of the patients were less than 15 years of age group. Upon further analysis, a proportional relationship was found between the age category of patients and respiratory diseases with the highest proportion seen in individuals belonging to the 85 years and above. However, no such relationship could be established between the gender of the patients and the presenting respiratory problems. (Table 3) Therefore, the data thus obtained is statistically significant (<0.05) for age while the same cannot be said for gender.

Table 3. Univariate analysis of Respiratory and non-respiratory disease according to Age and Gender Respiratory and Non-Respiratory Diseases

	Age Category	Non-Respiratory Diseases	Respiratory Diseases	Total	p-value
Age	0-5	157	20	177	
		88.70%	11.30%	100%	χ 2 = 104.7
	5-10	123	20	143	p=<0.00
		86.00%	14.00%	100.00%	

	Age Category	Non-Respiratory Diseases	Respiratory Diseases	Total	p-value
	10-18	962	127	1089	
		88.30%	11.70%	100.00%	
	18-35	3438	740	4178	
		82.30%	17.70%	100.00%	
	35-60	4204	1048	5252	
		80.00%	20.00%	100.00%	
	60-85	1812	587	2399	
		75.50%	24.50%	100.00%	
	>85	70	27	97	
		72.20%	27.80%	100.00%	
Total		10766	2569	13335	
		80.70%	19.30%	100.00%	
Gender	Male	6555	1530	8085	
		81.10%	18.90%	100.00%	
	Female	4431	1059	5490	χ 2 = 0.2833
		80.70%	19.30%	100.00%	p>0.05
Total		10986	2589	13575	
		80.90%	19.10%	100.00%	

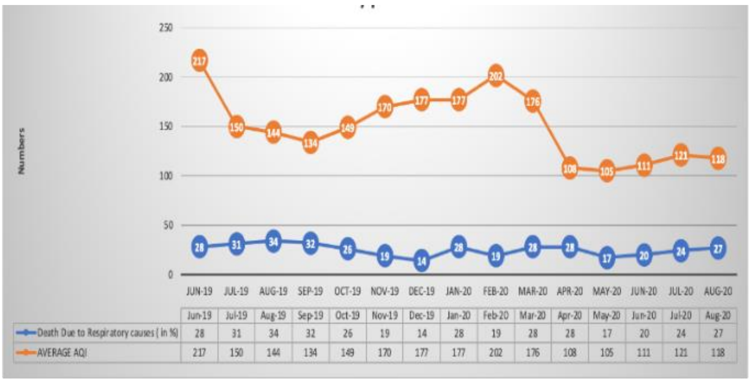
Upon using unadjusted logistic regression, it is observed, that as the age category increases, the odds ratio increases. It is minimum in the age category of 0-5, OR 1, with OR of 2.9 in the age group >85 yrs. (Table 4) This implies that as age increases odds of developing respiratory diseases increases.

Approximately, 25% of all deaths are due to respiratory illness. The fluctuation in AQI, moderate to poor, does not much change in deaths 25% to 24%, respectively. This data proves that poor AQI may not result in immediate morbidity but has long-term consequences. (Figure 1)

Table 4: Unadjusted Logistic Regression with Odds Ratio for probability of admissions with respiratory diseases with other factors

	Sig.	OR	95% CI for OR	
			Lower	Upper
Sex	0.538	1.028	0.941	1.123
Age Category (0-5 yrs)	0	1	1	1
Age Category (5-10 yrs)	0.527	1.239	0.638	2.407
Age Category (10-18)	0.982	0.994	0.602	1.642
Age Category (18-35)	0.042	1.634	1.018	2.621
Age Category (35-60)	0.008	1.896	1.184	3.036
Age Category (60-85)	0	2.454	1.526	3.947
Age Category (>85)	0.001	2.929	1.538	5.578
Dhanbad or Out of Dhanbad	0	1.719	1.635	1.815

Figure 1. A line diagram showing the relationship between AQI and Deaths due to Respiratory causes.



DISCUSSION

In this study, we found a significant association between respiratory illnesses or deaths due to respiratory causes and AQI during the 15 months from June 2019 to August 2020 except post-March 2020 when the government of India enforced nationwide lockdown, a very significant dip in the AQI was seen, but this better AQI came with the cost of the surge of pneumonia-like illness called COVID-19, thus reversing the trend, due to increase in admissions due to respiratory illnesses and while AQI getting better. The trends of both mortality and morbidity due to respiratory causes can be attributed to worsening air pollution.

This study is the first one to use the hospital data of a coal mining region of Jharkhand to study associations of respiratory morbidity and mortality with the fluctuating AQI. There is a surge in hospital admissions due to respiratory illnesses across the country from 12% from June to December 2019 to 27% from January to August 2020 while the mortality attributable to respiratory illnesses remained around 25%, this phenomenon is attributable to the high infectivity and low mortality of COVID-19.

In Delhi, Nongkynrih B et. al. (12) evaluated Air quality assessment and its relation to potential health impacts in the city, they established the association of deteriorating air quality index with the increase in numbers of non-trauma patients turning to the hospital's OPDs. They excluded only trauma and suicidal deaths while our study very specifically compares mortality and morbidity due to respiratory causes attributable to the worsening air pollution.

Guan WJ et al (13) observed that China, where air pollution poses a grave threat, have started taking measures against this threat by increasing public awareness, upgrading the industries, healthy city development, population-based measures etc. Public awareness about the detrimental effects of air pollution on human health is of utmost importance in this generation due to the high levels of air pollution owing to the ever-increasing industrialisation, increasing use of vehicles emitting hazardous pollutants and increasing biomass consumption, all of which are detrimental to the air quality and thus, to human health. (14)

Such measures are also extremely necessary for developing countries like India where air pollution poses a serious threat to the ever-increasing population. High levels of air pollution in India are a significant contributor to premature morbidity and mortality. Losses caused due to premature mortality and morbidity attributable to the worsening AQI affecting India have been well documented. (15)

While our study assesses only the health impact of Worsening AQI, Social and economic aspects have not been dealt with. In India, household air pollution (HAP) also poses a serious risk of developing respiratory problems. In a study done by Agarwal A. et al (16) have shown that the combustion of solid cooking fuels in Indian households carries a significant risk of developing respiratory morbidities and that their replacement with clean fuels like LPG is likely to reduce the risk significantly. Similarly, Abedi A et al (17) have also shown that in the long run, the effects of worsening air pollution have much more detrimental effects on the cardiovascular health of men and women as compared to respiratory health. A 10-unit increase in AQI was found to have resulted in a 7.3% increase in cardiovascular hospitalizations as compared to a 5.3% increase in respiratory hospitalizations.

COVID19 and AQI

As noted in our findings we documented a drop in AQI levels and the number of cases being admitted in hospitals in the city. This trend of AQI improvement has been documented not only in India but also in similar settings in China and other countries. (16) Subham Sharma et al(18) noted in their detailed analysis of various components across the country and noted a significant drop in the concentration of PM2.5. We are talking in terms of the number of people getting sick and dying but these are not just numbers, these are people dying prematurely or living a compromised life and all of this can be attributed to worsening AQI of the region. Singh RP et al (19) noted similar findings in levels of PM2.5, one of the major known pollutants Nigam et al., (20) in a study done in an industrial town which is close to what we have in the coal capital, also noted in their findings PM2.5 dip during the COVID19, along with other major pollutants and contributing to AQI like PM10, NO2, O3, CO, and SO2. They performed a meta-analysis on the available continuous data being collected by CPCB in an industrial town setting. They compared the data with the same time frame in the previous year. They observed a declining trend in particulate matter levels. Almost all the above-mentioned studies noted a relative increase in O3 levels. (20,21) Situation across the world was similar in terms of improvement of AQI levels and a major dip in the major pollutants during the COVID-19 lockdown. (22)

In a global study relating health and AQI, Feng Liu et al (23) data was analysed globally. They concluded that overall deaths other than COVID-19 along with morbidity from other diseases have decreased and AQI has a significant association with this. AQI of this coal mining region remains in between moderate to poor throughout the year, as compared to other metro cities where there is seasonal fluctuation from good to hazardous levels of AQI, dissemination for the risk advisories and enforcement of the precautionary measures for visible hazardous AQI for a short period while here in this region the sustained high AQI of moderate to poor level is occult hazardous AQI, the impact of which is visible through this study. Further studies are required to have a better understanding of deep relationships.

Strengths and Limitations of the study

The findings are likely to be a significant tool for air quality managers. The study highlights the relationship between the health effects of air pollution in the coal capital city of the country. This is the first study to use hospital data to investigate links between AQI in a highly active coal mining region. Limitations of this study - Due to the lack of a continuous data collecting and entry system, data from just 15 months is compared. Other confounding factors such as smoking, housing conditions, pandemic, indoor air quality, and family history were not taken into account in this study.

Conclusion

Except for the COVID-19 lockdown period, respiratory morbidity and mortality were significantly associated with AQI fluctuations. Further, if this investigation is continued retrospectively with data for the past 5 years of pre-COVID-19 times, it may reveal AQI-related death and morbidity-related trends. Moreover, if data could be tracked for multiple years, a comprehensive database could be created to compare AQI values and their associated issues. Extensive further study may reveal illness processes and prevention methods. This study supports health risk estimates and risk advisory using AQI. This report's region-specific indigenous data should help air quality managers focus their efforts. This research shows the gross health effects of air pollution. Air pollution-related morbidity and mortality may be reduced through timely AQI updates and health risk notifications.

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Authors Contribution

All authors have contributed equally.

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Conflict of Interest

There are no conflicts of interest.

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