



A Study on COPD and Asthma Cases with AQI Level in NCAP (National Clean Air Programme) Unattainable Cities of Odisha & Its Relationship with Selected Respiratory Diseases: A Hospital-Based Ecological Study

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(Received: 16 July 2025

Revised: 20 August 2025

Accepted: 29 September 2025)

KEYWORDS

Air Quality Index,
Asthma,
COPD,
National Clean Air
Program (NCAP),
Odisha

ABSTRACT:

Introduction: Odisha is rich in raw materials, which has encouraged the establishment of several industries in six different NCAP districts of Odisha. However, the rapid industrial development has led to a significant rise in air pollution levels, posing a considerable risk to public health.

Objectives: This study aims to study the association of Air quality (AQI) and respiratory diseases (COPD & Asthma) among the NCAP districts of Odisha

Methods: This is a hospital-based, exploratory study conducted in Cuttack, Odisha. A total of 170 participants were enrolled in the outpatient department for COPD and Asthma cases between February 2024 to July 2024. Descriptive statistics such as Mean, SD, frequency & percentages were calculated along with one-way ANOVA, Student t-test and chi-square test was analysed at 5% level of significance.

Results: The statistical analysis conducted revealed a significant difference in the Air Quality Index (AQI) across various districts ($F(43.119)$, $p < 0.001$). An independent Student's t-test was conducted to compare mean AQI levels between asthma patients and those with Chronic Obstructive Pulmonary Disease (COPD). The results indicated that asthma patients exhibited a slightly lower mean AQI ($M = 80.32$, $SD = 17.47$) in comparison to COPD patients ($M = 83.15$, $SD = 18.31$); however, this difference did not reach statistical significance ($t(168) = 1.03$, $p = 0.30$). Furthermore, exposure to particulate matter (PM₁₀) was found to be significantly associated with an increase in asthma cases, whereas exposure to both PM_{2.5} and PM₁₀ was correlated with a higher incidence of COPD cases ($p = 0.002$).

Conclusions: This study underscores the urgent need for improved air quality management in Odisha's NCAP cities to mitigate the growing burden of COPD and asthma. Strengthening pollution control measures and integrating health-based air quality action plans could significantly reduce the morbidity and mortality associated with respiratory diseases in these urban centres.

1. Introduction

Ambient air pollution is responsible for an alarming number of approximately 6.7 million premature deaths and 4.2 million deaths annually worldwide.(1,2) India stands at the forefront of this industrial expansion, which is further exacerbating the deterioration of air quality. In response to this pressing issue, the Indian government has rolled out the National Clean Air

Programme (NCAP), targeting 131 cities characterized by poor air quality across 24 states.(3) Notably, this initiative includes seven cities within the State of Odisha, which has emerged as a significant focus area due to its distinct industrial and environmental challenges. These NCAP cities are Cuttack, Bhubaneswar, Balasore, Angul-Talcher, Jajpur-Kalinga Nagar, and Rourkela. (4)



These operations of industries in these states have resulted in substantial emissions of various pollutants, including particulate matter (PM_{2.5} and PM₁₀). There is empirical evidence correlating air pollution exposure with an increased risk of respiratory illnesses. (5) Air Pollutants can obstruct airways and impact both the upper and lower respiratory systems, depending on the particulate matter's size and chemical composition. (6) These air pollutants are known to affect various components of the respiratory system, including the respiratory tract, lungs, bronchioles, and alveoli, leading to the development of chronic lung diseases such as Chronic Obstructive Pulmonary Disease (COPD) and asthma. (7) COPD (Coronary Obstructive Pulmonary Disorder), a significant global health burden and leading cause of death worldwide. (8,9) According to the global burden diseases an estimated 213.39 million cases of COPD and 33400 cases of Asthma burden were reported in 2021. (10,11) Similarly in India the COPD and Asthma cases among the middle-aged to older population have reached a prevalence of 4.38% and 2.1%. (12) Odisha has also shown a prevalence of pediatric Asthma of about 18.5%. (13) This study is a facility-based study in unattainable NCAP districts of Odisha.

2. Objectives

This study aims to study the association of Air quality (AQI) and respiratory diseases (COPD & Asthma) among the NCAP districts of Odisha.

3. Methods

Study design, Setting & Study population

This is a hospital-based, exploratory study conducted in Cuttack, Odisha, focusing on the prevalence of chronic obstructive pulmonary disease (COPD) and asthma and its association with AQI (Air quality index). A cohort of 170 participants was meticulously selected from the outpatient department, representing cases diagnosed between February 2024 and July 2024. The initial patient pool comprises of 493 individuals, among which 170 met stringent eligibility criteria established for patients reporting from the National Clean Air Programme (NCAP) districts of Odisha.

Other demographical data on age, gender, district of residence, and provisional diagnoses, were systematically extracted from a standardised pulmonary outpatient department (OPD) register maintained by the private healthcare institution. Concurrently, environmental data related to air quality indices specifically, the monthly average concentration of pollutants were collected from six designated pollution monitoring stations operated by the Odisha State Pollution Control Board (OSPCB).

The data collection was done using MS Excel, and statistical analysis was performed in SPSS v31. For the data

descriptive statistics such as mean, standard deviations, frequencies and percentage for all baseline variables were conducted further inferential statistics such as one-way ANOVA, Student's t-tests were executed to state the association and difference among variables with a significance threshold at 5% variance.

Selection criteria

The data includes all demographic information and information on provisional diagnosis for respiratory diseases. From all 493 patients 170 were included based upon the selection criteria.

Inclusion criteria: All patients who reported from NCAP districts in the out-patients department of the hospital in Cuttack Odisha and undergone examination by the physicians at the facility and reported for COPD and Asthma were included.

Exclusion criteria: Patients who reported from other cities than the NCAP cities of Odisha and patients who reported other morbidity outcome other than COPD & Asthma were excluded. Any incomplete data and data discrepancies were also removed.

The data collected was analysed using Microsoft Excel and SPSS 29v software. Descriptive statistics such as Mean, Standard deviation, frequency & percentages were calculated. Additionally inferential statistics like one-way ANOVA, Student t-test and chi-square test were conducted at 5% level of significance for comparing all the variables.

Ethical Consideration and Participant Consent

This study approval has been obtained from the Institutional Ethics Committee of the Indian Council of Medical Research-Regional Medical Research Center, Bhubaneswar, EC/NEW/INST/2023/3983 (DHR) Institutional Review Board-Regional Medical Research Center, Bhubaneswar, before data collection.

4. Results

A total of 170 cases were enrolled in the study, out of which 88 patients were diagnosed with Chronic Obstructive Pulmonary Disease (COPD) and 82 patients were diagnosed with asthma. A Statistical analysis conducted across districts demonstrates a significant difference in the Air Quality Index (AQI) among various districts ($F(3, 166) = 43.119, p < 0.001$). An independent Student's t-test was executed that showed asthma patients had a slightly lower mean AQI (mean = 80.32, SD = 17.47) compared to COPD patients (mean = 83.15, SD = 18.31) however, this difference was not statistically significant ($t(168) = 1.03, p = 0.30$).



Further, a chi-square test conducted that indicates a seasonal pattern in the prevalence of respiratory conditions, revealing that asthma cases primarily occurred in the spring, whereas COPD cases peaked during the summer months ($p < 0.001$). It was also found that gender did not significantly affect the prevalence of either condition ($p = 0.5$). The observation depicts a higher number of respiratory cases were reported of COPD were more prevalent in Jajpur and asthma cases were more frequent in Bhubaneswar and other districts ($p = 0.004$).

In terms of pollutant exposure, a significant correlation was found between exposure to PM₁₀ and asthma cases, while exposure to both PM_{2.5} and PM₁₀ was associated with a higher incidence of COPD ($p = 0.002$). This underscores the detrimental impact of air pollution on respiratory health. A one-way ANOVA was performed among the districts, revealing a significant variation in average AQI across the four study locations. Specifically, Cuttack exhibited the lowest mean AQI of 75.78 ± 11.84 , while Jajpur recorded the highest mean AQI of 105.92 ± 14.80 , followed by Angul-Talcher and Balasore at 107.43 ± 23.71 . This substantial variation in AQI among the districts was confirmed by earlier statistical analysis ($(3, 166) = 43.119, p < 0.001$). Additionally, the independent Student's t-test reaffirmed that asthma patients had a slightly lower mean AQI compared to those with COPD, although this difference did not reach statistical significance ($t(168) = 1.03, p = 0.30$).

5. Discussion

This study findings shows an association between air quality and respiratory diseases in all selected NCAP districts. Odisha is rich in raw materials, which has encouraged the establishment of several industries in six different NCAP districts of Odisha. However, the rapid industrial development has led to a significant rise in air pollution levels, posing a considerable risk to public health. (14)The results have also shown that AQI significantly varies across all the NCAP districts and the cases of COPD and Asthma which varies with the exposure of PM₁₀ & PM_{2.5} both as each districts has a specific level of AQI and pollutant type Table 4.1.

Out of 170 cases 88 were COPD & 88 were Asthma cases which also sheds light on an issue of public health concern espically in the non-containment NCAP cities outlined by Government of India, Center for Pollution Control Board. The baseline characteristics also shows varies across all districts and consequently morbidity rates also varies along with AQI (15,16).

Therefore, prioritizing air quality monitoring and implementing effective health policies in high-risk regions is imperative to mitigate the public health impact of pollution and protect vulnerable populations.

AQI & COPD

In 2015 a massive death toll of 3.2 million was reported due to COPD worldwide (17). Studies reveal COPD is a major Global Health threat and a leading contributor to the Global burden of diseases (GBD), resulting in disability adjusted life years and has very steeply increased in rank from 11th to 6th in DALYs. A study demonstrated that COPD patients in Beijing shows that AQI was significantly worse (113.1) impact on COPD which was assessed using CAT (26.4) (18). Similarly another PLOS ONE study shows that increasing AQI level, particularly due to PM_{2.5} which strongly associated with hospitalization due to COPD which is different from another study published in European respiratory journal that shows PM₁₀ has stronger association with number of COPD cases compared to PM_{2.5} and PM₁₀ as causes a prolonged association with more adverse health conditions as detected to trigger the occurrence of Chronic Obstructive Pulmonary Disorder (19,20). These particles have high toxicity; even short exposure (of 0-3 days approx) leads to great deposition, which increases the oxidative stress and thereby results increase in exacerbation leading towards hospitalization due to Asthma and COPD cases (21). Future research should incorporate long-term exposure modeling, personal air pollution monitoring, and intervention-based studies to better understand the causal mechanisms and effectiveness of mitigation strategies.

AQI & ASTHMA

In 2012 a Population-based study conducted among 14 monitoring stations in Ontario revealed that each unit increase in AQI is associated with 5.6% rise in out-patient visits due to Asthma cases and out of which around 1.3% were emergency visits (22). In 2015 the prevalence of Asthma gradually had increase by 12.6% (0.9-16.4) from 1990 (17). A study which was conducted in Allgheny country using medical records data from 2010-2018 with primary diagnosis of Asthma which is also similar to our study shows a stronger Association with AQI. It is also confirmed that childhood Asthma and AQI shares a strong relationship as it is a powerful predictor for Asthma morbidity and is among the most common chronic disease of Childhood (23,24). Though some studies conducted in the past reveals Asthma is responsible for more number of DALYs among females than in males while this study proves gender does not plays a significant role in rise in Asthma cases (0.5) due to AQI (25).

Limitations

The study is hospital-based and may not capture cases that do not seek medical attention at the OPD of the private hospital. Additionally, individual-level exposure assessments, confounding factors such as smoking, occupational exposures, and genetic predisposition, were not fully accounted for. This



study does not evaluate the length of exposure of participants to the individual pollutants or AQI, or similar in the chosen districts. The selection of districts is limited to the non-attainment cities identified by NCAP.

CONCLUSION

This study is unique in nature as it presents demographic and morbidity data from patients reporting from non-attainable NCAP districts of Odisha.

This study also highlights variation in AQI across different NCAP districts and also highlights the growing burden of Asthma & COPD in these districts. Based on the research conducted it shows that there is need of robust data collection from all NCAP districts of Odisha on respiratory diseases and to make it more accurate the data from household within a maximum radius of 5km from the monitoring should be collected. This study also demands in depth research on pollutant type and their sources across all the NCAP districts which will enable ease in source reduction thereby preventing severity of diseases due to air pollution. This research suggests integration of health-based air quality action plan that will be an important public health initiative.

Acknowledgment

This study is a part of a PhD study. We acknowledge Ashwini Hospital, Cuttack, Odisha, for their contribution to data collection, and we are extremely obliged to Dr Sampat Dash for his consistent effort that enabled this data collection procedure. I am thankful to SRM University, Kattankulathur, Chennai for allowing me to publish this paper, and I also acknowledge ICMR for enabling me to conduct this study in Ashwini Hospital, Cuttack, for data access.

Funding: NONE

Conflicts of Interest: NONE

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