Temporary Improvement of air quality amidst lockdown and post-pandemic prospects: A perception-based case-study of Bihar

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Abstract

Lockdown has been a great boon for the environment, the lockdown bought temporary improvements in air quality around the world. The air pollutants showed a declining trend and the people witnessed the changes. This paper examines the temporary change in the air quality amidst the lockdown and post-pandemic prospects for the state of Bihar. The study is based on primary and secondary data which applies a mixed research approach. The state's air quality which usually was unsatisfactory improved to a satisfactory level during the lockdown. The main reason behind the air pollution in the state was vehicle transportation and the burning of waste disposal, which is adversely impacting the public health of the state. The rate for the prevalence of morbidities related to air pollution has increased over the years. The situation will worsen post-pandemic with the resume of all the economic activities, this time it will occur at a faster pace to recover the loss ignoring the degrading environmental outcomes. Thus, the state requires proper post-pandemic policies for the degrading air quality levels.

Keywords: Air Pollution, Lockdown, Environment, Bihar, Health

Background

We live on earth and for our survival, greenhouse gases like Carbon dioxide, Methane, Ozone, Nitrous oxide, water vapor, etc. are extremely important. For humans, greenhouse gases are extremely important because they lock some of the heat energy of the earth and do not let it disperse into space, this is how earth remains habitable. However, if too little greenhouse gases will make the world icy cold, similarly too much of these

gases will make the world too warm. Since the last century, people have burnt so much fossil fuel and caused so much pollution to the environment. When these fossil fuels are burnt, carbon dioxide is generated as a waste byproduct and is released in the atmosphere and far too much Carbon dioxide has resulted that the earth has become warmer now. If humans continue such behavior, the earth will become even warmer and eventually become inhabitable, that's why control over the emissions of greenhouse gases is necessary and air pollution needs to be controlled.

The lockdown triggered by catastrophic COVID-19 has resulted in a dramatic fall in greenhouse gas emissions around the globe. According to the first definitive study of the global carbon output of 2020, it is found that daily emission levels of the greenhouse gases fell by 17 percent by early April when compared to the levels of 2019 (Harvey, 2020). The research results prove that the world is witnessing the sharpest decline in carbon output from when records began. This is because the global economy has somehow nearly come to a complete halt. At the point of time when the lockdown was most strict, the fall in the emissions was recorded up to 26% in some countries (Harvey, 2020).

In the Southeast Asian region, there is a drastic fall seen in tropospheric NO_2 of around 27% to 30%. Especially in Malaysia during the lockdown, the decrease observed in concentrations of PM_{10} is 26% to 31%, $PM_{2.5}$ is 23% to 32%, NO_2 is 63% to 64%, SO_2 is 9% to 20% and CO is 25% to 31% as compared to same periods of 2018 and 2019 in the urban areas (Kanniah, 2020).

National Aeronautics and Space Administration (NASA) in collaboration with the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) formed a task force to study the greenhouse gas emissions during coronavirus lockdown. It is found by their satellite that there is a small reduction in CO_2 of around 0.5 parts per million or 0.125% in Mumbai and other cities. Also, the task force found a drastic drop in NO_2 levels of around 40% to 50% in Delhi and Mumbai from March 25 to April 20 (NASA, 2020). This is due to reduced industrial activity and reduced traffic for three months. However, in Northeast India, NO_2 levels were found constant because of coal-based power plants in which electric power generation did not decrease during the pandemic induced lockdown. Authorities have implemented policies like Enhanced parking fees, Odd-even formula, Ban on Civil Construction, and Strict compliance of Graded Response Action Plan, Ban on the entry of Trucks in some places to curb air pollution. Also, National Green Tribunal has restricted Industrial Activities and has banned waste burning in Delhi.

Mainly these laws regulate and control Air pollution in India: The Air (Prevention and Control of Pollution) Act, 1981 (Air Act) and Environment (Protection) Act, 1986 (EPA). The main aim of the Air Act, 1981 is to conserve the quality of air and to reduce air pollution. The aim of the Environment Act, 1986 is to take proper steps for the protection of the environment and protect it from hazards done by human beings.

In a study, it is found that Particulate matter (PM) concentrations have reduced around 50% to 60% over the southern part of India and it is as much as 75% over the Indo-Gangetic basin, like in Bihar (The Hindu, 2020).

Bihar, an important state of India which is situated in its eastern part, is also affected by COVID-19. This crisis has affected the economy and educational sectors in a very bad manner. The state is one of the

developing states of India and is also one of the most prone states due to climate change. The northern part of the district is flood-prone while the latter half is drought-prone. The impacts of urban growth are very serious on Bihar. Unplanned urban growth has led to worse air quality, excessive noise, and air pollution, improper disposal of hazardous wastes, etc. These are the reasons for ecosystem destruction and climate change in Bihar. People are willingly or unwillingly destroying nature and making it vulnerable to flooding and other disasters. In 2015, 33 districts in Bihar were declared as drought-hit. In 2019, heavy rainfalls in Patna led to flooding in most parts of the city. Unplanned and uncontrolled urban growth has made the droughts and floods very common in Bihar. When the modification is done in urban flora, it destroys the biodiversity of that place, changes the stability and fertility of the soil, especially in wetlands. Alarming environmental issues like air pollution and bad air quality in major cities like Patna, Muzaffarpur, Bihar Sharif, Bhagalpur, Gaya, etc., has been improved due to pandemic induced lockdown. According to an article in Financial Express on May 6, 2020, Mount Everest was visible from Singhwahini village, Sitamarhi district of Bihar due to cleaner air quality. To control the level of Air pollution, the government of Bihar has prohibited the use of government vehicles more than 15 years old. The same law applies to India also applies to Bihar for air pollution control. Those laws are The Air (Prevention and Control of Pollution) Act, 1981 (Air Act), and the Environment (Protection) Act, 1986 (EPA). The duty of enforcing these laws is done by Bihar State Pollution Control Board (BSPCB).

So, there is a challenge for legal structures and approaches built upon outdated presumptions. There is a need to make some changes in existing environmental laws to make it relevant for the times during and after this pandemic. Also, there is a need to bring a change in the lifestyle of people in such a manner that they reduce their dependence on such things that pollute the environment. Proper action and policy interventions should be implemented to promote such an active lifestyle. Renewable and green energy will also play a major role in the protection of the environment from degradation.

When this COVID-19 crisis will end, all human activities will increase to revive the economy rapidly. In this way, the condition of the environment will only be worsened and this would lead to environmental destruction. If the Environment and Ecosystems are not protected and not taken care of, Humankind can face far bigger and lethal threats than COVID-19.

Literature Review

The average temperature of the earth has been steadily rising due to the greenhouse effect. Rapid industrialization, burning of fossil fuels and motor vehicles leads to emissions of greenhouse gases which cause global warming. The air pollutants bring acid rain which contaminates the food crops and ultimately leads to deterioration of public health (Ramasamy, 2020). Due to the suspension of transportation and industrial activities, the daily global CO_2 emissions have declined by 17% compared to last year (Le Quéré et al., 2020). Recent studies have shown an NO_2 reduction ranging between 20% and 30% in China, USA, Italy, Spain and France (Dutheil et al., 2020). All over the world, the hydrosphere has been polluted by urbanization and over-exploitation. Rivers of countries like Mongolia, Bangladesh, Indonesia and India are more polluted

than that of developed nations due to the remains of faecal matter, organic and metal pollution and more human-related activities (Sikder et al., 2013). In overpopulated developing countries, inefficient forest management and overexploitation of forest land lead to ecological degradation while in developed nations market-oriented interests have led to unsustainable forest harvesting over the years (Mallik and Rahman, 1994). So, community forestry should be practiced all over the world for sustainable development.

India has achieved high economic growth over the few decades which has steered its environmental degradation due to overpopulation and overuse of its resources. But the pandemic has resulted in cleaner air and a greener environment in India. Until the end of April 2020, there was a 98 metric CO_2 reduction in India (Kissler, et al., 2020). A recent study showed that Delhi has shown a massive 52.68% and 30.35% reduction in NO_2 and CO levels (Mahato and Ghosh, 2020). By 14th April, Northern cities like Faridabad, Amritsar, Jodhpur and Delhi witnessed a 44% improvement in air quality while Southern cities such as Amravati, Bengaluru, Thiruvananthapuram and Chennai saw a 33% improvement in air quality following a reduction in atmospheric pollutants like $PM_{2.5}, PM_{10}, NO_2, CO, CO_2$ (Mahato and Ghosh, 2020).

Bihar is the 3rd most populous state in India and lies in the eastern side of India bordering Nepal. It is one of the least developed states of India in terms of Per capita income and industrial development. Patna, the capital of Bihar, has been constantly ranking in the most air polluting cities of India. According to the Economic Survey of Bihar (2018-19), of the total patients visiting the hospital, 36.2% of patients suffer from acute respiratory diseases resulting due to air pollution. The forest cover in the state is a mere 7.23% which is not adequate by any standard. COVID crisis has brought the pollution under control in Bihar. After 11 years monsoon arrived early. There is a need to check illegal sand mining and hunting of endangered species in Bihar. It is a huge challenge for the government to maintain better air quality caused by the pandemic.

Post-Pandemic policies should be made on the environment as the countries will be more focusing on their economic recovery and in the way forget the environmental degradation and for a state like Bihar, the major concern has always been economy and people employment. The state has a poor Human Development Index, which is the lowest in the country. The state has a bunch lot of seasonal migrants who have returned home and are quite afraid to return back to the workplace. The state government would much focus on these aspects leaving the environment. Therefore, urgent need is to focus on the post-pandemic policies and programmes on environmental recovery and sustainability.

Materials and Method

The study is based on both Primary and Secondary data. The primary data have been collected from all the districts of Bihar. While the secondary data have been collected from different sources including, the dataset for air pollution has been downloaded from Central Pollution Control Board website which contains air pollutants with corresponding AQI values. The health indicator data for Bihar has been taken from the Global Burden of Disease.

The relevant literatures are collected from the various research institutions and journals, related government departments and different organisational websites.

The methodology will consist of several phases such as; Questionnaire preparation, Sampling, Selection of the study area, Data collection, Data entry and Data analysis was the essential phases involved in the methodology.

Data Source

Primary data has been collected from the residents of Bihar and other stakeholders in the state based on the pre-designed questionnaire according to the objectives of the study. The Time series data on air pollution has been collected from the secondary dataset from the Kaggle website, particularly a company which provides datasets. The air pollution data set includes the data of Patna air pollution station. The health data has been fetched from the Global Burden of Disease. Whereas the field level impact and manifestations could be gathered from the people of Bihar and officials. The basic data from the people in particular about the specific problems being faced by the environment in Bihar. The field-level impact data/ information can then be corroborated with the empirical data collected from relevant sources.

The methodology of the proposed study involves conceptual as well as applied techniques of research. The research was based on a distinct methodology, which in turn involve stages:

➢ **Pre-Field Survey Stage:**
  i. Study of literature relevant to the study topic.
  ii. Collection of study materials, data and maps
  iii. Preparation of questionnaire

➢ **Online Survey:**
  i. An online survey of 952 sample population of Bihar identified voluntarily from all the districts of Bihar state, the online survey was conducted on Kobo toolbox and collection of data/ information from primary stakeholders was through telephonic interview and email interaction.
  ii. Certain aspects of the survey were also conducted in KI (Key Informant) with relevant officials who were expert in the same.
  iii. Telephonic interviews with different government officials, Department of environment, forest & climate change, Govt. of Bihar, Wildlife Trust of India, etc was done.

➢ **Post field survey stage:**
  i. Compilation and tabulation of primary data.
  ii. Analysis of secondary data.
  iii. Preparation of report.
  iv. Preparation of policy brief.

Research Design

A descriptive and analytical research design was used. A descriptive research design is used to obtain information concerning the current status of the phenomena. The purpose of these methods is to describe "What exists" concerning situational variables. Analytical research design aims to understand phenomena by discovering and measuring causal relations among them.

The locale of the study and sampling

This topic explains how states, districts and respondents have been chosen for the needful study:

Selection of the state

Bihar, with its bountiful natural resources of fertile soil, abundant water, varied climate and rich cultural and historical heritage is one of the most fascinating states of India. As we know Bihar is a developing state in India, these COVID times have been hard on the state. The environment conditions in the state during the lockdown period bloomed. Thus, to make this long-lasting in the state of Bihar the study is being done in the state to help the policymakers in the post COVID formulation of environmental policies. As the state environment may suffer post-COVID as all the economic activities will resume and we will return to normal again and that too at a faster pace.
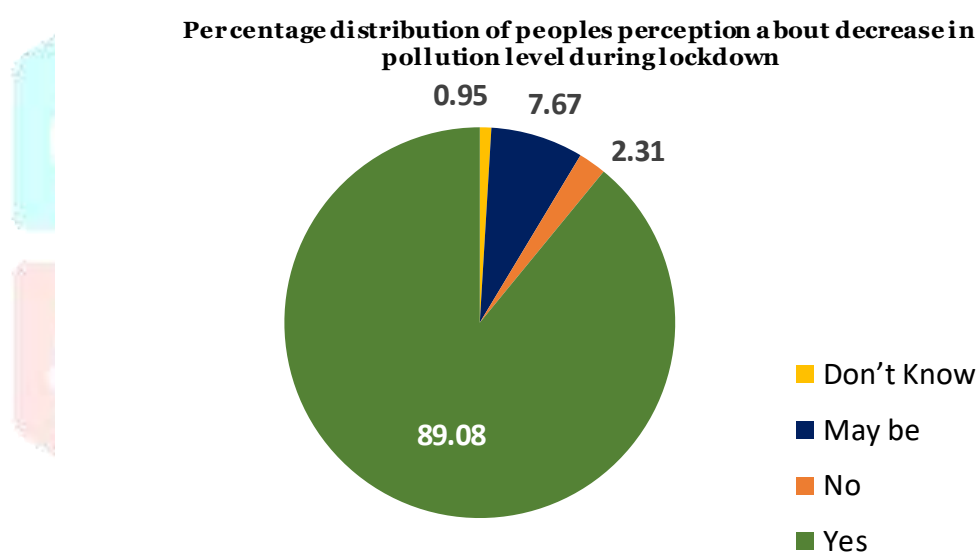
Selection of Respondents

The sample population was be selected from the state of Bihar only. The participants were free to take part it was voluntary. Each district participated in the online survey actively, the minimum sample population from all the 38 districts is 10 sample population, the total sample size is 952. The major cities of the state such as Patna the capital city have a high concentration of sample population. The sample population was interviewed during the period from (29th June 2020 to 7th July 2020). The collection of information was done through a structured online interview by the kobo toolbox software as per the pre-design questionnaire. The map below states the number of samples taken from each district.

Figure 1: Sample size population from each district of Bihar

Sample Population from each district of Bihar

Methodology

A structured Interview Schedule was constructed in Hindi as well as English to understand the awareness level of the respondents about the environment and COVID-19. The questionnaire was prepared on Kobo Toolbox, the respondents filled the forms with the help of the same.

The interview schedule is the most appropriate method to generate baseline information required for this study and allow the respondents to reply independently to sensitive questions about the environment without the influence of others. Key informant interviews were also scheduled for the study.

The data were analyzed in Stata 13 application and the results determined, using appropriate statistical techniques which include bivariate analysis to meet the aims of the study. Qualitative data have been manually compiled according to diverse issues considering the research sites. The spatial analysis was carried out on Arc Map 10.3.1. The results have been presented in tables and graphs to better demonstrate the findings. Adopting the methodology explained above, data for the present study were gathered, processed and analyzed.

Results and Discussion

The following are major findings of the study based on the online survey in all the districts of Bihar. The total sample size of the study was 952 samples, all the 38 districts were included in the study. The minimum sample from any district is 10 individuals.

Figure 2 states that almost 90 percent believed that air pollution has been decreased during this lockdown and only 2 percent don't believe that. The opinion is in favour of pollution decrease, which may be because of the shutdown of the industries and reduced use of transportation facilities due to lockdown in the past months in Patna. The capital of Bihar has been constantly ranking in the most air polluting cities of India. Until the end of April 2020, there was a 98 metric CO_2 reduction in India (Kissler, et al.,2020). The air quality index for Patna has been very unsatisfactory but during the lockdown, it showed satisfactorily and people breathed fresh air (Rumi, 2020).

Figure 2: People's perception of decrement of pollution level during the lockdown in Bihar

Percentage distribution of peoples perception about decrease in pollution level during lockdown

0.95   7.67   2.31   89.08

- Don't Know
- May be
- No
- Yes

Source: Based on a primary survey in Bihar

The secondary sources in figure 3 and figure 4 also confirmed that air pollution decreased during the countrywide lockdown. The air pollutant concentration decreased tremendously from January 2020 to June 2020 in Bihar. Figure 3 visualizes the weekly average concentration of PM 2.5, PM 10, NO2, SO2 and O3 in Bihar from January 2020 to June 2020. It's clear that all the pollutants have shown a decline. PM 10 decline at a greater pace from 196 in Jan, 2020 to 55 in June, 2020 almost a reduction of 140 points. Pm 2.5 declined by 126 points from 148 to 22 followed by NO_2, SO_2 and O_3 by 9, 5 and 2 points respectively. Unplanned urbanisation and the rising population day by day and with that increasing number of vehicles have led to increase in the climate change rate but during the lockdown, the rate decreased for a certain period. Air pollutants are also having ill effects on human health causing allergic respiratory diseases and

asthma (D'amato, 2015). The air quality index improved to a satisfactory level from 290 to 81 from Jan, 2020 to June, 2020 as show in figure 3.
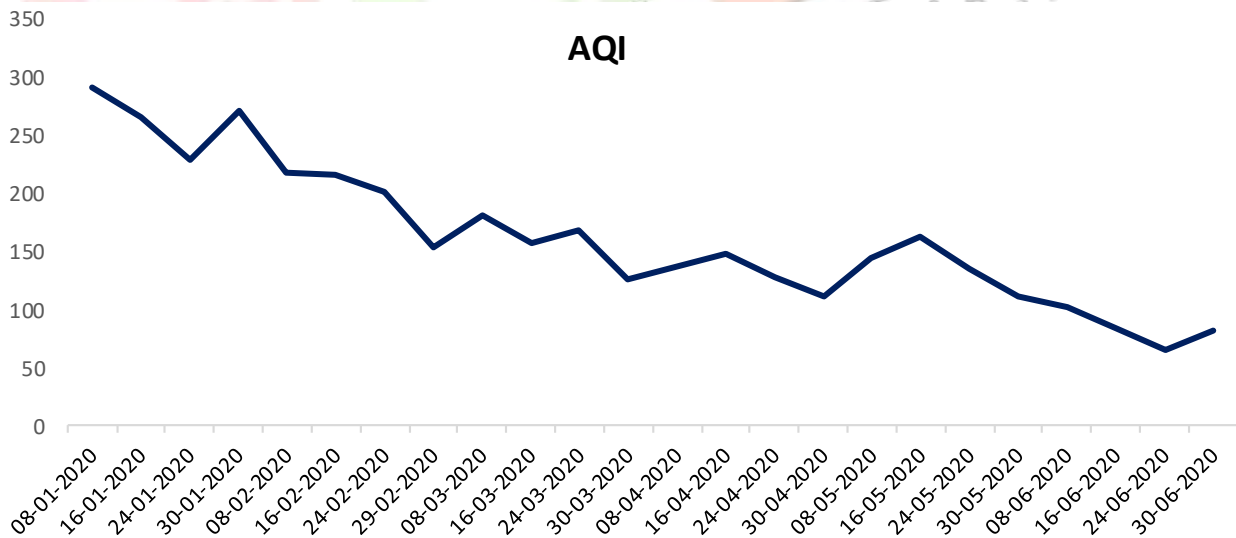
Figure 3: Weekly average concentration of PM 2.5, PM 10, NO_2, SO_2 and O_3 in Bihar from January 2020 to June 2020
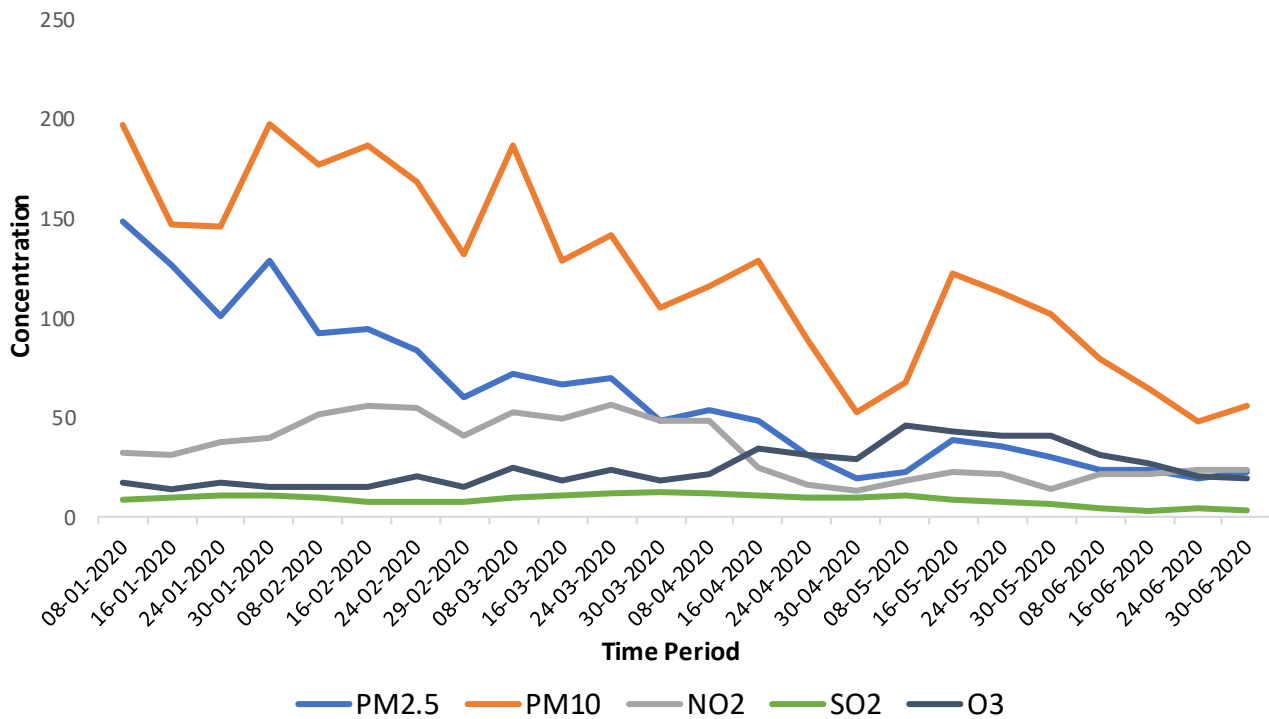
Source: Central Pollution Control Board

Figure 4: Weekly average of Air Quality Index (AQI) in Bihar from January 2020 to June 2020

Source: Central Pollution Control Board

major health risk from ambient air pollution is estimated to be 4.2 million premature deaths globally mainly from heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections in children (WHO, 2018). Figure 5 explains the trend of rate of prevalence and deaths of major health issues as a result of poor air quality in Bihar from 1990 to 2017. It's clear from the graphs that for almost all the morbidities the prevalence rate has increased, for the respiratory infection and tuberculosis the

graph has turned a downward slope since 2011. The death rate trend for all the diseases has reduced since 1990 only for Tracheal, bronchus, and lung cancer the death rate has increased over the years. The decrease in the death rate for all the other diseases might be due to the advanced medical facilities in the state.

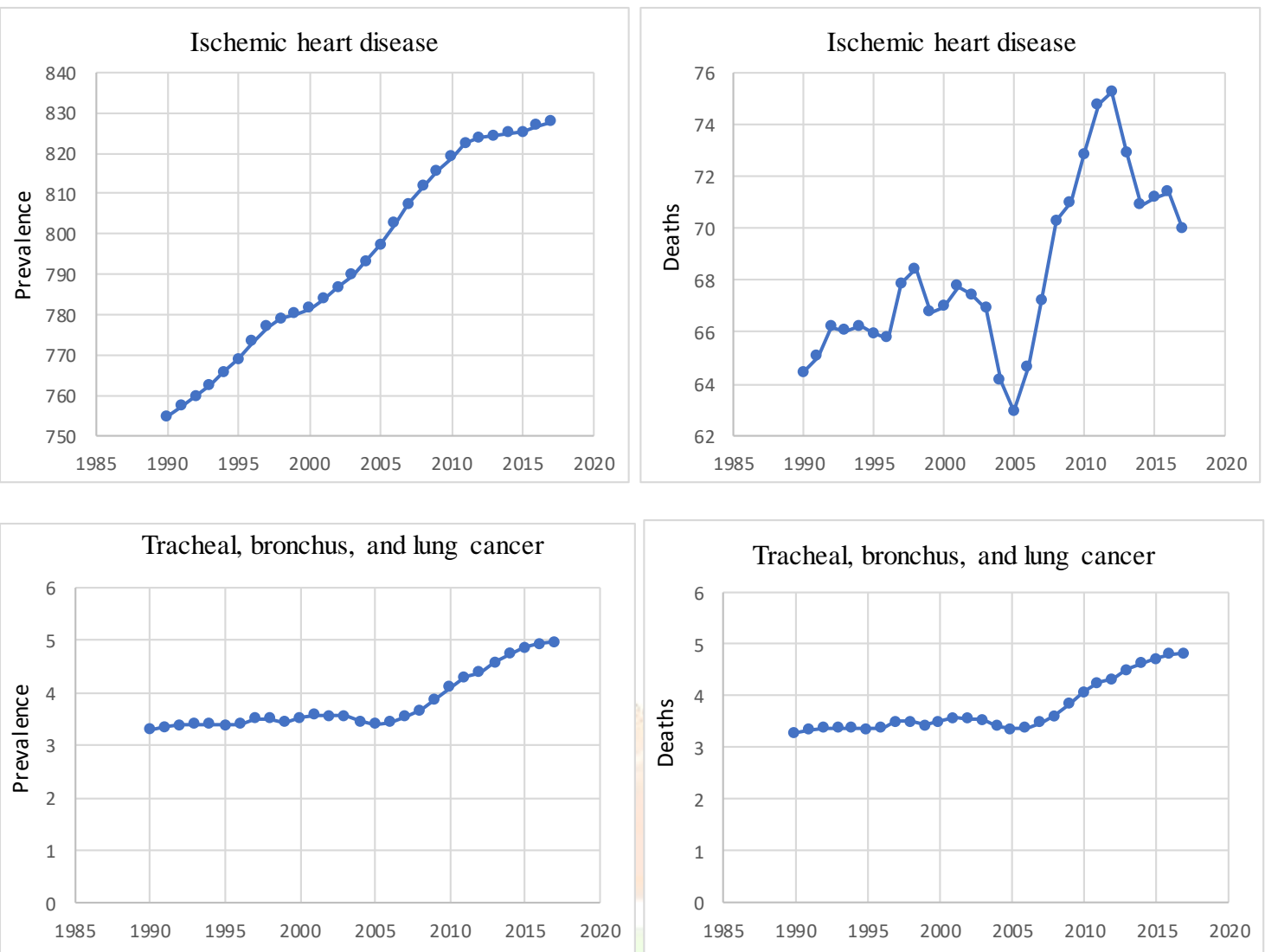**Figure 5: Rate of prevalence and deaths of major health issues as a result of poor air quality in Bihar (1990 - 2017)**
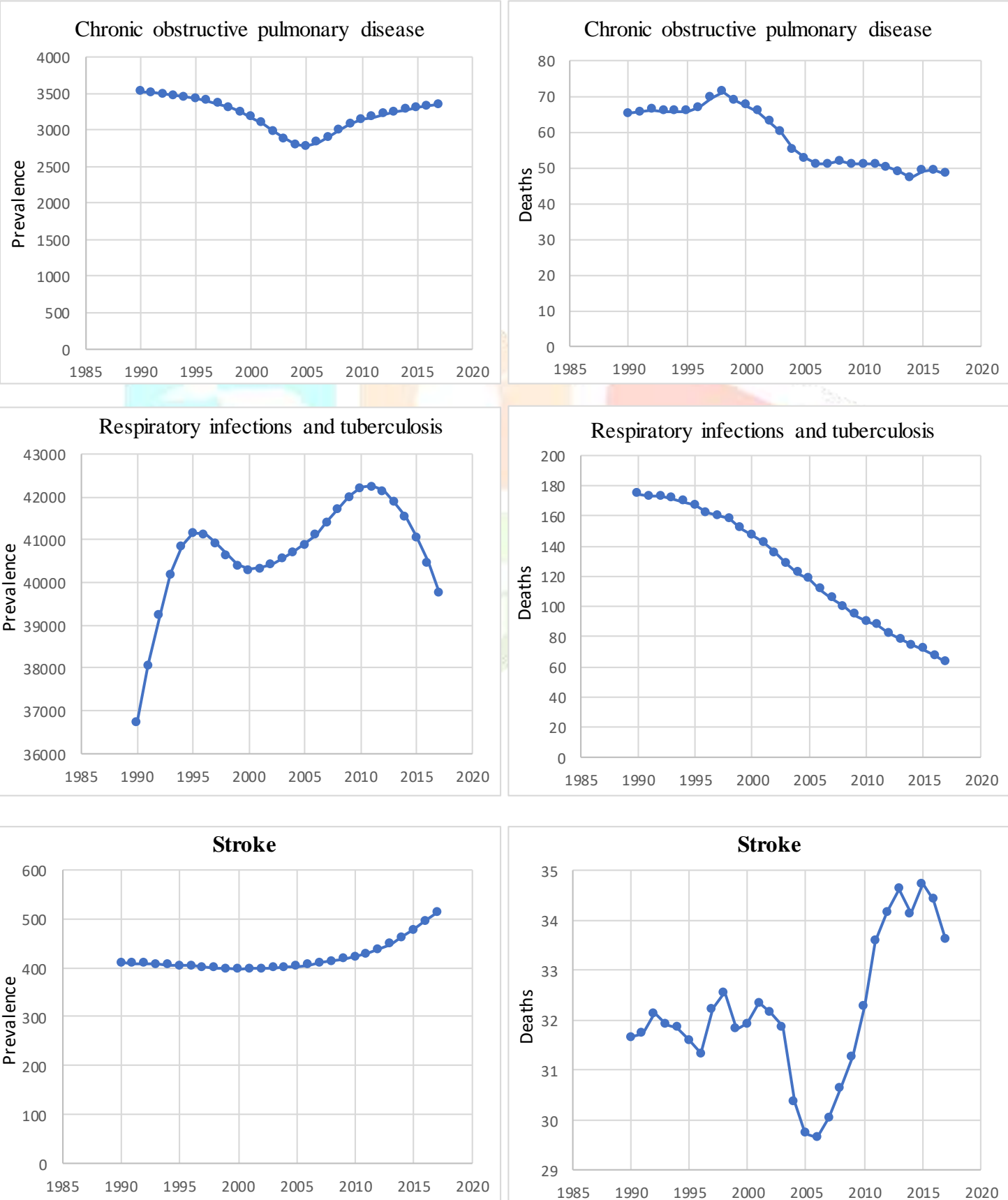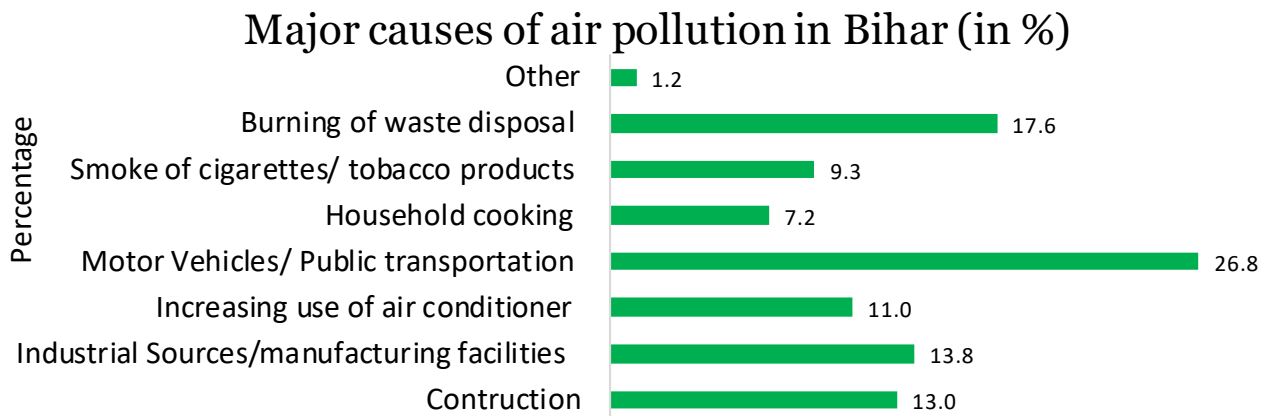
Figure 6 states, around one-fourth of the population, perceived that motor vehicles/public transportation are the main cause of air pollution. The key informant also reported that the government has upgraded the Bharat-stage for the fuel system of the vehicle i.e. Bharat Stage 5, Bharat Stage 6, but at the same time the old generation vehicles are still running on the road, so the government should implement some policies for that also. More awareness should be there to use public transport instead of personal transport like their own bike, personal cars, etc. While nearly one-fifth of the population said that the burning of waste disposal is the main cause of the air pollution, and around 15 percent of the sample population of Bihar stated that industrial sources/manufacturing facilities, construction, and increasing use of air conditioner as a cause of air pollution. Few of them perceived reasons like the smoke of cigarettes/ tobacco products, household cooking as the cause of air pollution in Bihar. The evidence stated, during the lockdown according to the secondary data sources shut down of the industries and factories and restrictions on people's movement lead to the decrease. Bihar also produces tonnes of solid waste each day and it is also increasing at an unprecedented growth of which most of the solid wastes are used for landfills. These wastes are also sometimes burnt and adds to the toxic air of the state.

In major cities of India, vehicles have been the major cause of air pollution emitting about 261 tonnes of CO_2 (Shrivastava, 2013). In India, the number of vehicles has increased drastically 700 times from only 0.3

million in 1951 to 210 million in 2015 (The Economic Times, 2019). Thus, the emission of these pollutants into the air causes a tremendous change in the climate.

Figure 6: People's perception of the major cause of air pollution in Bihar

Major causes of air pollution in Bihar (in %)

| Category	Percentage
Other	1.2
Burning of waste disposal	17.6
Smoke of cigarettes/ tobacco products	9.3
Household cooking	7.2
Motor Vehicles/ Public transportation	26.8
Increasing use of air conditioner	11.0
Industrial Sources/manufacturing facilities	13.8
Contruction	13.0

Source: Based on the primary survey in Bihar

The fig 7 states the number of ways air pollution is affecting the population of Bihar residence wise, the variation in the reason stated has a very slight difference, around 30 percent of the population from both rural and urban areas of Bihar are worrying about the environment which is affected by air pollution, while nearly one-fourth of the population in both urban and rural Bihar population got affected by irritation to eyes/nose/throat, breathlessness/having difficulties in breathing. The air pollutants bring acid rain which contaminates the food crops and ultimately leads to deterioration of public health (Ramasamy, 2020). According to the Economic Survey of Bihar (2018-19), of the total patients visiting the hospital, 36.2% of patients suffer from acute respiratory diseases resulting due to air pollution. Around 10 percent of the population is feeling depressed and little less are affected by asthma incidences in both rural and urban Bihar by air pollution. The air pollution has affected human health as well as the environment.

Figure 7: Residence wise the number of ways air pollution affected the people of Bihar

The ways air pollution affected the people of Bihar
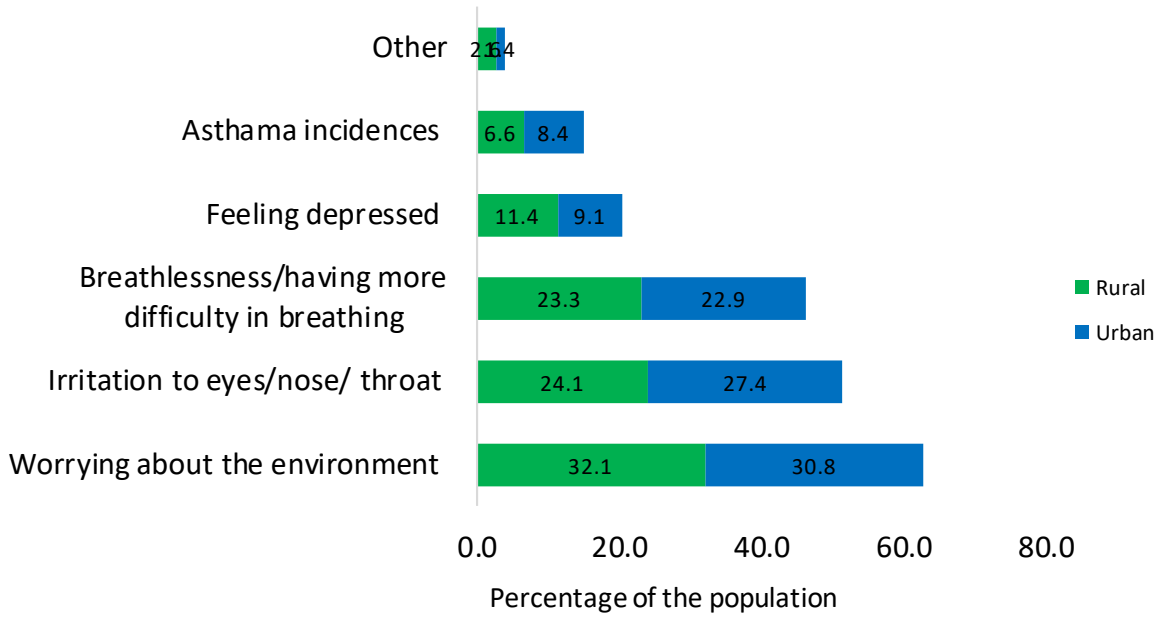
Source: Based on the primary survey in Bihar

The chart below visualizes the burden of disease due to certain risk factors as of 2017 in Bihar, the behavioural risk factor has the highest-burden i.e. 30% followed by environmental risk factors 25% in Bihar.
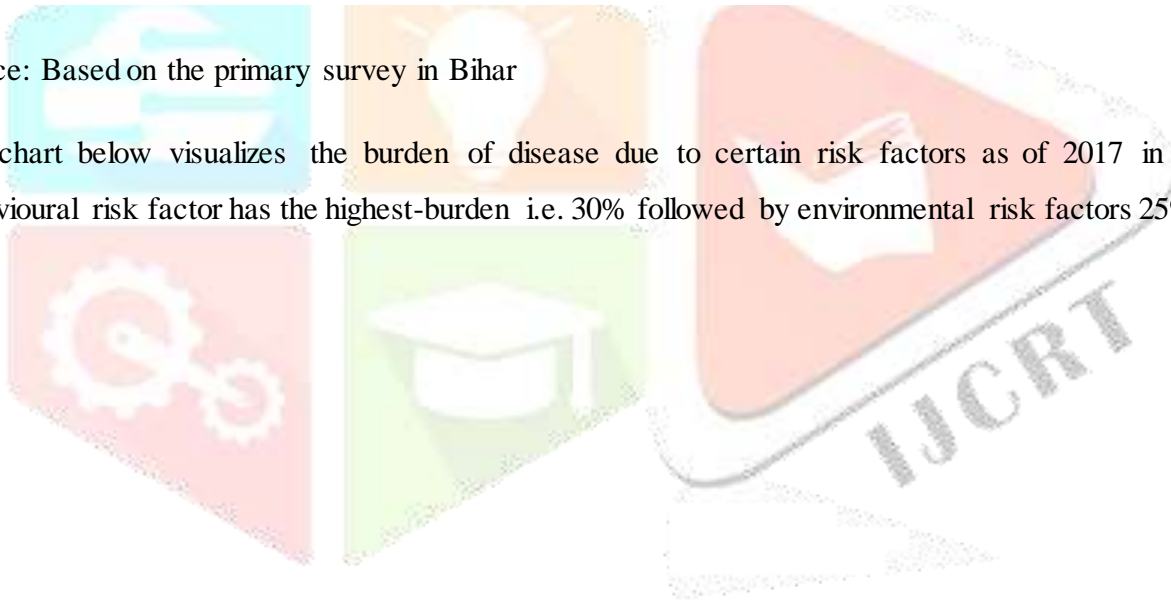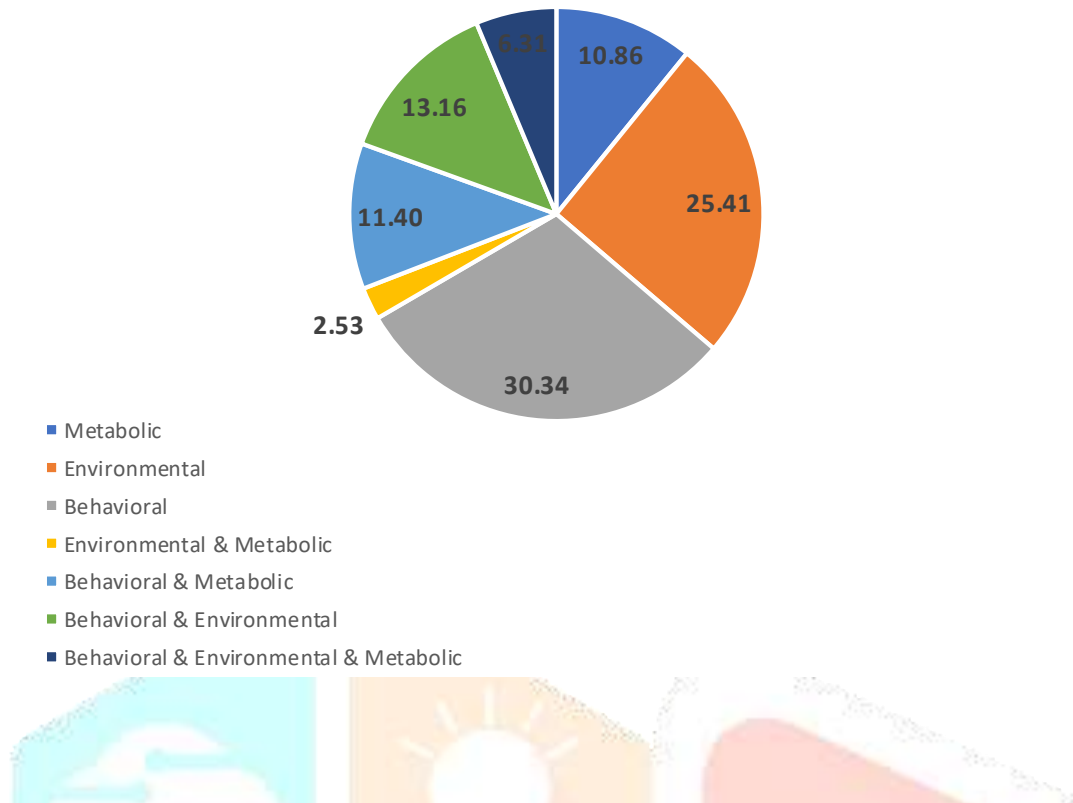
Figure 8: All factors attributable to risk factors Bihar, 2017, Deaths

- ■ Metabolic
- ■ Environmental
- ■ Behavioral
- ■ Environmental & Metabolic
- ■ Behavioral & Metabolic
- ■ Behavioral & Environmental
- ■ Behavioral & Environmental & Metabolic

Conclusion

Air Pollution has been a potential risk for flora as well as fauna. The most impacted are human beings resulting in several morbid conditions. The worldwide lockdown brought a temporary positive change in the air quality levels, with this nature healed itself. The temporary change was mainly due to the suspension of vehicles and industrial activities. Most of the population observed the changes occurring. The main concern now is to maintain the quality, which will be a tougher task for a state like Bihar which is in it's developing stage. The state economy has poorly been hit due to the lockdown and restrictions. The state will be much focus on the economy rather than environmental concerns. The rush to get the economy back on track rapid increases in the industrial activities manufacturing and transportation of goods which would lead to worsening air quality levels in the state and the likeliness of people suffering from airborne morbid conditions would increase.

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