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Review Article

Environmental Pollution and Cancers in India

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Abstract

Environmental pollution poses a risk of cancer to the vulnerable population. With more and more industrialisation and migration of people to the cities, a large number of Indian people are at an increased risk of developing cancer. Pollution in many places and cities across the country are reaching hazardous levels. Thus, there is a need to review the rising cancer incidences, changing cancer trends and environmental pollution in the country. The issue of environmental pollution must be addressed sooner than later to mitigate the risk of cancer to India's vulnerable individuals. This brief review summarises the environmental pollution trends, most recent evidences of changing cancer burden and types in the country highlighting the underlying pollution trends in India, since economic liberalisation which began in early 1990s and its impact on cancer risk two and half decades later.

Keywords: Air pollution, cancer, environment, India, risk

Introduction

Environmental pollution is now a global phenomenon, and its impact is evident in several regions globally. In India, economic liberalisation followed by rapid industrialisation started in 1990s, and with that the resultant impact on the environment has been growing ever since. Now, after more than quarter of a century, the environmental pollution will show its impact in the rising number of cancer cases in the country.

In India, 1.6 million new cancer cases are detected each year. The problem across the country is a lack of adequate workforce and infrastructure to tackle the large number of new cancer patients. The allopathic doctor to patient ratio in India is inadequate, as revealed in the National Health Profile, 2018, released by the Central Bureau of Health Intelligence, which stands at 1/11,082 people against required 1/1000 people.[1] As such, it is imperative that the focus should be on preventive strategies for cancer. At present, the government of India is focused on industrial growth, more so in the manufacturing sector, with little improvement in the resource allocation for the health sector.[2] The 'Make in India' initiative for creating avenues for more industries is praiseworthy to generate employment for large number of unemployed youths of the country. However, at the same time, the government must also focus on implementing stricter rules for creating a pollution free environment for its citizens. According to the World Bank estimates, in 2013, pollution incurred roughly 8.5% of India's Gross Domestic Product due to forgone labour output (0.84%) and increased welfare costs (7.69%). Environmental pollutants are the risk factors for many cancers, and the most common is lung cancer followed by urological cancers, haematological malignancies, head and neck and gastrointestinal cancers. Recent reports suggest the association of gall bladder cancer (GBC) with water pollution. The prime objective of this article is to highlight the growing environmental pollution and measures in place to curb this menace with evidences of changing cancer trends of gall bladder and lung cancers.

Early Ecological Correlation

The research findings from a recently published study on GBC trends in urban Delhi in the Northern India over 25 years does raise the question on the role of environmental water pollution in its causation.[3] The study had shown a plateau

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in the incidences from 1991 to 2004 followed by the rise of GBC cases from 2005 onward in both men and women with an estimated average annual percentage change of 6.0% and 5.7%, respectively. This assumes significance in light of ever rising water pollution in the country. Now health policy experts must look at the trends in the environmental pollution that took place in the 1990s, as it could have impacted in the rising incidence of GBC in urban Delhi in particular and in the country as a whole. In another study, the time trends of cancer incidence in men and women from selected cancer registries of India showed an unequivocal trend of age standardised incidences since 1988–2005, with some registries showing an upward trend during the period from 2000 to 2005.[4]

The effects of economic liberalisation of 1991 indicate that exports and Foreign Direct Investments grew in the more polluting sectors relative to the less polluting sectors between the pre- and postliberalisation periods.[5] Thus, environmental pollution that started in the 1990s will eventually show its impact now, as far as disease like cancer is concerned. Due to the rapid industrialisation postliberalisation, there has been an increase in the amount of effluen being disposed to natural water bodies and rivers of the country.

Water and Air Pollution the Overall Scenario

A white paper on the water pollution of Delhi has shown the pollution load being discharged into river Yamuna, which is the major source of water for the National Capital Region; a consistent rising biochemical oxygen demand from 1988 to 1996.[6] In 1988, it was 159.6 tonnes/day and it rose to 193.8 tonnes/day in the year 1996. Biochemical oxygen demand (BOD) is marker for water pollution, and it is the amount of dissolved oxygen required by aerobic biological organisms to break down organic material present in a given water sample at the certain temperature over a specific time period. Similarly, the growth of small scale industries (SSI) in Delhi have more than doubled from 42,000 units in 1981 to 85,050 units in 1991.[7] Moreover, several tens of thousands of polluting SSI are located in non-conforming areas of Delhi.[8] Furthermore, a research has shown an alarming contamination of ground water and soil by heavy metals due to unauthorised E-waste recycling site in Delhi.[9] Heavy metals such as arsenic and cadmium are the risk factor for the causation of GBC in endemic areas.[10] This is only expected to rise in the near future, as more E-waste is expected to be generated across India. River water pollution due to heavy metals is one of the major concerns in most of the metropolitan cities of India. Recent initiatives by the National Green Tribunal stopped the farmers to cultivate the vegetables on the land along the Yamuna bank because soil contained heavy metals and allowed only the non-edible crops.[11] Reports indicate that, SSI in India today account for 40% of industrial production, 35% of total exports, and employ almost 17 million people in 3.2 million industrial units across the country.[12] In India, during 1995–2009, the number of observed sample with BOD values less than 3 mg/l was 57% to 69%; in 2007 the observed samples rose to 69%. Similarly, during this period of 15 years between 17% to 28% of the samples observed BOD value between 3 and 6 mg/l and the maximum number of samples in this category were observed in the year 1998.[13] Thus, from 1995 to 2009, maximum water pollution in the country happened around 1998 and then declined thereafter from 2007. Small-scale industries in India generated 3900 million litres of wastewater per day.[12] In the year 1992, Central Pollution Control Board (CPCB) of India launched water pollution control programme for industries. It was seen that many of these industries have effluen treatment plants, but despite these, they did not comply with prescribed pollution standards.[14] Further, in the year 2015, CPCB laid guidelines for implementing liabilities for environmental damages due to handling and disposal of hazardous waste and penalty. Compensations that are envisaged in the guidelines were loss of life, property, yield, crop and treatment costs toward human health impacts. For the last one, it may not be possible to ascertain 'cancer' that can be certainly attributed to environmental pollution. Thus, the risk of cancer due to pollution will be out of the purview, despite growing concern of environmental pollution and risk of cancer. Furthermore, the CPCB imposes immediate response one-time liability of around 12,000 € for non-compliance, and it may not be the strictest of deterrent for compliance to the norms, especially by the bigger corporate houses. The Air Prevention and Control of Pollution Act was enacted in 1981 and amended in 1987 to provide for the prevention, control and abatement of air pollution in India. The revised guideline (2009) for the annual safety concentration level of ambient particulate matter (PM) of <2.5 μ set by ministry of Environment, Forests and Climate in industrial, rural and ecologically sensitive regions is 40 ug/m^3. Now, it is a matter of grave concern that 11 cities of India out of 12 cities globally have the worst air pollution levels [Table 1], as per the World Health Organisation's World Global Ambient Air Quality Database.[15] The average ambient air pollution in Indian cities is two to three times higher than the safety level. Hence, it is just a matter of time that India's cities are set to become the lung cancer capitals of the World.

Table 1: The list of most air polluted cities in the world

Country	City	Annual mean, ug/m^3 (PM2.5*)
India	Kanpur	173
India	Faridabad	172
India	Varanasi	149
India	Gaya	146
India	Patna	144
India	Delhi	143
India	Lucknow	138
Cameroon	Bamenda	132
India	Muzaffarpu	131
India	Srinagar	120
India	Gurgaon	120
India	Srinagar	113

*Particulate matter with a diameter of <2.5 μ

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Metaanalyses have shown that, lung cancer risk associated with PM 2.5 μ was higher in former smokers, current smokers and even non-smokers.[16] International Agency for Research on Cancer (IARC) had decided to classify PM and outdoor air pollution as carcinogenic (Group 1). Furthermore, vehicular emission and traffic-related air pollution is the risk factor for lung cancer. Occupational exposure to air pollution among professional drivers signific ntly increased the incidence odds ratio (OR): 1.27, 95% confidence interval [CI]: 1.19–1.36) and mortality of lung cancer (OR: 1.14, 95% CI: 1.04–1.26).[17] Benzene, asbestos, formaldehyde, radon and involuntary smoking are considered as Class I (carcinogenic to humans) carcinogens present in air pollution, as per IARC.[18]

More Recent Links to air Pollution and Lung Cancer in India

So far in India, environmental pollution raised concerns for communicable diseases such as water borne, chronic obstructive airway, and ischaemic heart diseases and linking the risk of cancer in vulnerable population with environmental pollution should not be viewed as distinct entity now. There is a serious apprehension among the informed public across the length and breadth of the country regarding the rising environmental pollution and consequent rising number of cancer cases. The rising incidence of cancer is partly well explained by the burgeoning population and increase in the life expectancy, leading to an expected increase in the number of cancer patients. However, an increase in the incidences and changing pattern of cancer cannot be solely due to the previously known prevailing risk factors in the population. Any ecological correlation between lung cancer and air pollution might get confounded due to smoking. Furthermore, the prevalence of smoking in men is higher than women. Hence, it is important to look for the rising incidences of lung cancer in women to attribute rising lung cancers in women with air pollution. Recent reports indicate a changing pattern in the occurrence of cancer in India, such as the increase in lung cancer in women.[19] Similarly, lower risk of developing breast cancer among women residing in the rural areas compared to urban areas was shown earlier.[20] This may also be related to lower pollution in rural areas, as this aspect was not really looked at in that study. The typical critique 'high incidence of breast cancer in urban women is attributed to sociocultural determinants and more exposure to oestrogen, and there is no study to support major role of pollution for high breast cancer incidence in women living in urban area' is the fundamental flaw of lateral thinking and research context in India. More recently, a national cancer burden study has highlighted the changing cancer burdens in India from 1990 to 2016.[21] The present study was done on data from multiple sources, including 42 population-based cancer registries and the nationwide Sample Registration System of India, to estimate the incidence of 28 types of cancer in every state of India from 1990 to 2016. Despite the decline in smoking population in the country, the proportion of Disability-Adjusted Life-Years due to lung cancer in both men and women combined in 2016 was 7.5%. Lung cancer occupied the third position in 2016 from the seventh position in 1990 in number of DALYs (mean percentage change in number was 136.0%) and mean percentage change in number of new cases was 116.0% (89.1–132.1). Now, there is enough epidemiologic and experimental evidence of the genotoxic and mutagenic effects of air pollution on human DNA,[22] which is key cancer driver. Thus, environmental pollution that started in 1990s could be the reason for the changing trends of different types of cancer and more particularly lung cancer due to air pollution. In addition, there is now some evidence that air pollution is also associated with cancers of digestive system (hazards ratio [HR], 1.35; 95% CI, 1.06–1.71), breasts (HR, 1.80; 95% CI, 1.26–2.55), and female genital organs (HR, 1.73; 95% CI, 1.17–2.54).[23]

Curbing environmental pollution has inherent health benefits and prevention of cancer will have huge economic benefit in addition to preventing valuable loss of lives.

Recommendations

- The Ministry of Environment, Forest and Climate Change (MoEFCC) of the government of India is having environment health section, and it should actively review with cancer epidemiologists to monitor environmental pollution and consequent risk of cancer in vulnerable populations of the country
- The MoEFCC must act to curb environmental pollution by the non-complying and repeated offending industrial units by making provision for harsher punishments. Having said that, we understand the challenge of enforcement of law. To this, the Ministry should coordinate with the Home Ministry by creating a special coordinating cell
- Indian Council of Medical Research's National Institute for Research in Environment Health and National Institute of Occupational Health should now commission independent panel (s) that can review the cancer hazard due to the environmental pollution in India. Such reviews and detailed future action plan will have a profound and significant impact on the health status of the future generation (s) of India
- The Department of Health Research under the Ministry of Health and Family Welfare of the government should include cancer as one of the potential health hazards due to environmental pollution in India
- Indian Space Agency under the Department of Science and Technology should generate geo-spatial map of cancer and environmental pollution in the vulnerable population for re-location of non-complying polluting industrial units from those locations, if any.

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Conflicts of interest

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References

1. Doctor-Population Ratio: In India, One Allopathic Doctor for 11,082 People, Officia Data Shows; Bihar, UP Worst Hit. Available from: https://www.financialexpress.com/indi -news/doctor-population-ratio-in-india-one-allopathic-doctor-for-11082-people-offici -data-shows-bihar-up-worst-hit/1213243/. [Last accessed on 2019 Jul 01].
2. National Health Profile 2018: Here's How Well India is Healthwise. The Indian Express. Available from: https://indianexpress.com/article/india/national-health-profile-2018-heres-how-well-india-is-health-wise-5228742/. [Last accessed on 2019 Jul 01].
3. Malhotra RK, Manoharan N, Shukla NK, Rath GK. Gallbladder cancer incidence in Delhi urban: A 25-year trend analysis. Indian J Cancer 2017;54:673-7.
4. Badwe RA, Dikshit R, Laversanne M, Bray F. Cancer incidence trends in India. Jpn J Clin Oncol 2014;44:401-7.
5. Gamper-Rabindran S, Jha S. Environmental Impact of India's Trade Liberalization. Available from: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan024230.pdf. [Last a ccessed on 2018 Jul 01].
6. White Paper on Pollution in Delhi with an Action Plan. Ch. 4. Ministry of Environment and Forests, Government of India. Available from: http://www.envfor.nic.in/divisions/cpoll/delpolln.html. [Last accessed on 2018 Apr 12].
7. Economic Survey of Delhi 1999-2000, Industrial Development. Available from: http://www.delhi.gov.in/wps/wcm/connect/DoIT_Planning/planning/economic+survey+of+dehli/content/industrial+development. [Last acessed on 2019 Jul 01].
8. Agarwal A. Water pollution problems posed by small industries: a case study of India and China. Water Sci Technol 2002;45:47-52.
9. Panwar RM, Ahmed S. Assessment of contamination of soil and groundwater due to e-waste handling. Current Sci 2018;114:166-73.
10. Chhabra D, Oda K, Jagannath P, Utsunomiya H, Takekoshi S, Nimura Y. Chronic heavy metal exposure and gallbladder cancer risk in India, a comparative study with Japan. Asian Pac J Cancer Prev 2012;13:187-90.
11. The Green Panel Said No Activity Can be Permitted in that Area Till the Time Yamuna is Restored and Made Pollution-free. Available from: https://economictimes.indiatimes.com/news/economy/agriculturengt-says-no-to-farming-on-polluted-yamuna-land/articleshow/55439022.cms. [Last accessed on 2019 Jul 01].
12. Agarwal A. Small Scale Industries Drive India's Economy but Pollute Heavily: What Can be Done? Available from: http://environmentportal.in/files/Small%20scale%20industries.pdf [Last accessed on 2019 Jul 01].
13. India Infrastructure Report 2011. In: Murty MN, Kumar S, editors. Water Pollution in India. Chapter 19. New Delhi: Oxford University Press; 2011. Available from: http://www.idfc.com/pdf/report/IIR-2011.pdf. [Last ac cessed on 2019 Jul 01].
14. Rajaram T, Das A. Water pollution by industrial effluen in India: discharge scenarios and case for participatory ecosystem specific local regulation. Futures 2008;40:56-69.
15. World Health Organization's World Global Ambient Air Quality Database Available from: www.who.int/airpollution/data/aap_air_quality_database_2018_v12.xlsx. [Last accessed on 2019 Jul 01].
16. Hamra GB, Guha N, Cohen A, Laden F, Raaschou-Nielsen O, Samet JM, *et al*. Outdoor particulate matter exposure and lung cancer: A systematic review and meta-analysis. Environ Health Perspect 2014;122:906-11.
17. Chen G, Wan X, Yang G, Zou X. Traffic-related air pollution and lung cancer: A meta-analysis. Thorac Cancer 2015;6:307-18.
18. Straif K, Cohen A, Samet J. Air Pollution and Cancer. IARC Scientific Publications. Vol. 161. In: International Agency for Research on Cancer: Lyon, France: World Health Organization; 2013.
19. Sharma DC. Cancer data in India show new patterns. Lancet Oncol 2016;17:e272.
20. Nagrani RT, Budukh A, Koyande S, Panse NS, Mhatre SS, Badwe R. Rural urban differ nces in breast cancer in India. Indian J Cancer 2014;51:277-81.
21. India State-Level Disease Burden Initiative Cancer Collaborators. The burden of cancers and their variations across the states of India: The global burden of disease study 1990-2016. Lancet Oncol 2018;19:1289-306.
22. Wong IC, Ng YK, Lui VW. Cancers of the lung, head and neck on the rise: perspectives on the genotoxicity of air pollution. Chin J Cancer 2014;33:476-80.
23. Wong CM, Tsang H, Lai HK, Thomas GN, Lam KB, Chan KP, *et al*. Cancer mortality risks from long-term exposure to ambient fine particle. Cancer Epidemiol Biomarkers Prev 2016;25:839-45.