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Research Article

An Analysis on Spurt of Cancer Cases in Amaravati River Basin, Tamil Nadu, India – Evidence Based Research

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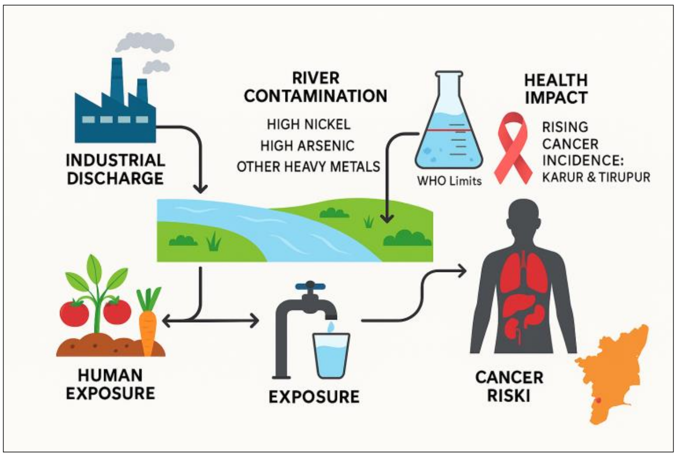
Abstract— **Background:** Environmental health tracking is an emerging area that spans the traditional public health and environmental protection sectors. **Aim:** To investigate whether carcinogens in the Amaravti river belt are associated with increased cancer cases in Karur and Tirupur districts, Tamil Nadu. **Materials and Method:** Carcinogens were identified based on the "International Agency for Research on Cancer" lists of carcinogens with cancer sites. Between 2011 and 2022, cross-sectional studies were included in the study. The levels of cadmium, hexavalent chromium, nickel, lead, arsenic, nitrite/nitrate, and phosphates in drinking water were compared with the WHO standard limits. The number of cancer cases recorded in each district was determined using data from the Tamil Nadu Cancer Registry Project for 2021. **Results:** The study found the levels of nickel and arsenic in the Amaravati River Basin to be in the range of 0-0.090 and 0.358-0.961, respectively. Nickel levels are fourfold higher than the WHO standard limits for drinking water, while arsenic levels are fifty-fold higher. **Conclusion:** There is evidence that shows the presence of carcinogens in the vegetable samples collected in the Karur district, indicating contamination has already entered the human food chain.

Keywords— Amaravati, Cancer, Industrialization, Heavy metals, and River Pollution

Graphical Abstract



1. Introduction

Basic sanitation, air pollution, chemical substances, microbial agents, poor water quality, climatic changes, global environmental issues such as microplastic invasion, and developing drug resistance are some of our health's environmental determinants. According to a WHO report, reducing ecological risks can prevent one in four child deaths [1]. Climatic change is the biggest threat to humanity – it serves as social and environmental determinants acting directly on air and water quality and food security [2]. There are 1.7 billion people without access to basic sanitation. As a result, there is a substantial increase in waterborne diseases, respiratory illnesses, food-borne diseases, extreme heat wave-related illnesses, mental and psychosocial health, and non-communicable diseases like cancer. Based on WHO data, it was estimated that 45% of the domestic wastewater was discharged without being properly treated in 2020, and at least 10% of the world's population consumed food irrigated with wastewater [3]. Predominantly, industries, farming-based activities, and domestic sewage contaminate the groundwater system, which in turn enters the food chain, leading to deadly diseases. According to WHO 2016, 24% of all global deaths are linked to environmental issues, accounting for 13.7 million deaths annually [4].

A list of more than 500 toxic substances that are known to cause cancer in humans has been produced by the International Agency for Research on Cancer [5,6]. Among these, arsenic, benzene, cadmium, chromium, lead, nickel, cobalt, nitrite, nitrate, and phosphates are excessively present beyond the standard limits of drinking water in the districts of Tamil Nadu, India. The literature also identified numerous cancer-causing substances in water, sediment, and vegetable samples collected from the river Amaravati. River Amaravati originates between Anaimalai and Palani hills in Tiruppur district in Tamil Nadu/Kerala Border, India. It runs through Dharapuram and Avarakurichi and joins Cauvery at Thirumukkudalur in Karur district. Amaravati river basin lies across numerous textile, dyeing, and bleaching industrial processing units and irrigates 60k acres of agricultural land. In this study, the aim is to determine whether the presence of carcinogenic toxic substances increases the number of cancer cases in a district.

1.2 Problem Statement

Significant public health concerns are being raised across various regions due to increased environmental pollution-including industrial effluents, agricultural runoff, and untreated sewage. Toxic contaminants like heavy metals, nitrates, and other carcinogens are commonly found above recommended levels, resulting in possible long-term exposure via drinking water and the food system. In spite of increasing evidence of environmental impairment, no extensive studies have been done on the direct link between environmental carcinogen exposure and increased incidence of cancer. This research gap constrains our knowledge of the public health impact beyond this population and prevents us from formulating effective prevention interventions and policy actions at regional and national levels.

1.3 Objectives

The main objectives of the study are:

1) Estimate the concentration of known carcinogen in Amaravati River Basin from previous literature.
2) Compare the detected level to that of the WHO recommended limits.
3) Study the cancer prevalence rates in Karur and Tirupur districts.
4) Assess the correlation existing between environmental contamination and increased cancer rates.

2. Related works

Though environmental carcinogenesis is still a scarcely researched field in India, some few research efforts have started to elucidate the relation between environmental pollution and cancer prevalence in a number of river basins of Tamil Nadu. Studies have established that there is an important relationship between high incidence rates of cancer and exposure to contaminated water from big rivers like the Vaigai, Bhavani, Thamirabharani, Thenpennai-Palar, Noyyal, and Cauvery [7–12]. These river networks traverse heavily populated and industrially developed areas, where industrial effluents, predominantly from the textile, tanning, and chemical sectors, are regularly released into water bodies without being treated. The intensive agricultural operations on these riverbanks further result in pollution due to pesticide runoff and leaching of nitrate- and phosphate-rich fertilizers. Long-term exposure to these toxins either directly through the consumption of drinking water or indirectly through the ingestion of locally planted crops has been associated with rising rates of all types of cancers, including gastrointestinal, liver, kidney, and hematologic cancers.

These results indicate a twofold pathway of human exposure: direct ingestion of contaminated water and bioaccumulation via foodstuffs. Specifically, the vegetables produced in areas that are river water-reliant for agriculture contained greater amounts of organophosphates and trace metals and presented added carcinogenic hazards to the inhabitants [13,14]. Collectively, these studies indicate that Tamil Nadu's environmental carcinogenesis is not due to any singular cause, but is the result of a multifaceted combination of waterborne pollutants, industrial emissions, residues of agrochemicals, and improper waste management practices.

3. Materials and Method

3.1 Search Strategy

From 2011 to the present, search strategies like Boolean operators and keywords were applied to PubMed, Elsevier Science Direct, SpringerLink, and ResearchGate databases to find original articles.

3.2 Search category

Boolean operators were used in the search strategies for the following keyword combinations: “olive oil”, “extra virgin olive oil”, “colorectal cancer”, “cancer prevention”, “cancer reduction”, “oral administration”, “cancer risk”, “animal models”, “phenolic compunds”, and “tumour prevention”.

3.3 Inclusion criteria

Studies were conducted in the Amaravati River and the river supplying Karur and Tirupur districts.
Original studies with full-text in the English language were included.
Studies those used standardized measurements and validation tools.

3.4 Exclusion Criteria

Studies reported accidental spillage and exposure to toxic substances.

Studies conducted by the Tamil Nadu Pollution Control Board.

3.5 Methodology

The possible content levels of the carcinogenic pollutants in water bodies in Karur and Tirupur districts were compared and contrasted with World Health Organization (WHO) standard drinking water quality limits. COSMIN Risk of Bias (RoB) checklist, 2020 [15] was used for quality assessment of available information. Cancer incidence data were collected from the Tamil Nadu Cancer Registry Project Report (2021), where the proportion of reported cancer cases in Karur and Tirupur districts was derived [16]. The values were compared to the levels of detected carcinogens to investigate whether chronic exposure in the environment could lead to higher cancer incidence.

To set up a comparative reference point, the aggregate number of reported cases of each type of cancer state-wide throughout Tamil Nadu was divided by 38—the number of districts in the state—to calculate an average district incidence rate. This provided contextual meaning to cancer burden in Karur and Tirupur against the state average. The detailed description of the methodology was based on a study conducted on the Noyyal and Cauvery rivers [11, 12].

3. Results

According to Fig. 1, 6 of the 388 full-text articles that were screened met the eligibility criteria for inclusion in the study. The concentrations of heavy metals are elevated in almost all of the studies.

As shown in Table 1, the results indicate the presence of various carcinogens in environmental samples from the Amaravati River Basin, especially in the Karur and Tirupur districts. Chromium concentrations in surface water samples from Karur varied between 0.04 and 0.08 mg/L, consistently higher than WHO permissible limit of 0.05 mg/L at different seasonal phases. Lead was detected up to a concentration of 19 mg/L in sediment and wastewater samples, which is much higher than the permissible limit of 0.01 mg/L. Vegetable samples taken from Karur and Trichy had arsenic levels as high as 0.899 ppm, almost 90 times the WHO permissible level. Likewise, nickel was found in up to 0.090 mg/L concentration in water samples—more than four times the normal threshold (0.02 mg/L).

Based on the standard WHO guidelines, lead levels in Karur district exceed the recommended level by nearly 200 times, while nickel levels increase by four times as represented in Table 2. As indicated by Table 2, cancer occurrence in Karur district is consistent with exposure to some carcinogenic substances. For instance, cadmium—traceable up to 0.101 mg/L—is responsible for lung, prostate, and kidney cancers. Arsenic, also present at high levels (0.358–0.961 mg/L), is responsible for bladder, lung, skin, prostate, kidney, and liver cancers. The most frequent cancer sites reported in Karur were the nasal and paranasal cavity (2%), stomach (1.2%), kidney (1.2%), skin (1.1%), liver (0.9%), and lung (0.7%). In Tirupur district (Udumalpet Taluk), nitrate levels varied from 8.3 to 9.8 mg/L, which was far lower than the WHO limit of 45 mg/L, but phosphates were also found at 2.5–4.2 mg/L. Stomach cancer, it should be mentioned, was reported to have a prevalence of 1.6% in Tirupur, and this may indicate possible relations with long-term exposure through diet and water, though more causative research is indicated.

The COSMIN Risk of Bias (RoB) checklist (Table 3) was employed to assess the methodological quality of the included studies. K. Mahmoodah Parveen et al., Abirami L et al., Jafar Ahamed A et al., and Arthi T et al. studies scored "Very Good" (VG) for reliability and measurement error in various domains, especially in the form of consistent measurement conditions. Nevertheless, a number of studies did not apply strong statistical measures of validation like intraclass correlation coefficients (ICC) or agreement percentages. Saravanamoorthy et al. and Sivakumar KK et al. studies were graded "Inadequate" in more than one category by reason of poor methodological disclosure and threats to measurement protocols.

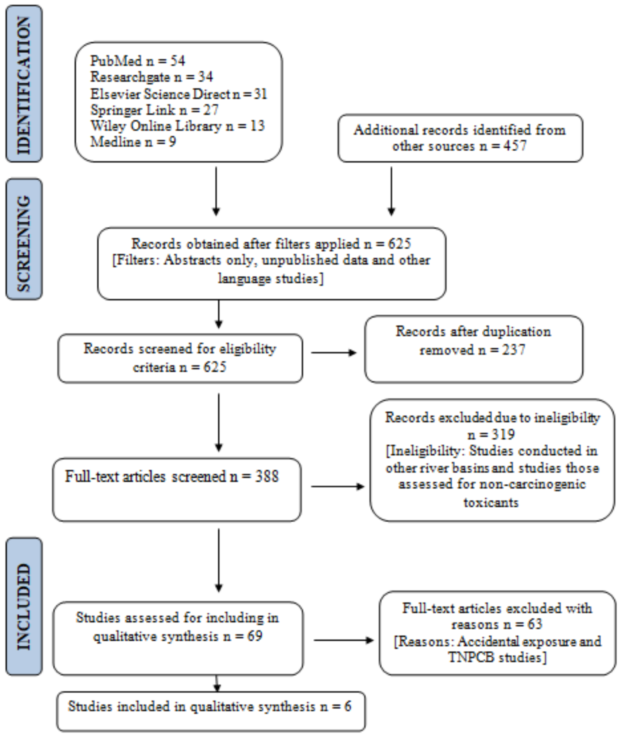


Figure 1: Flow diagram of the study selection process

4. Interpretation

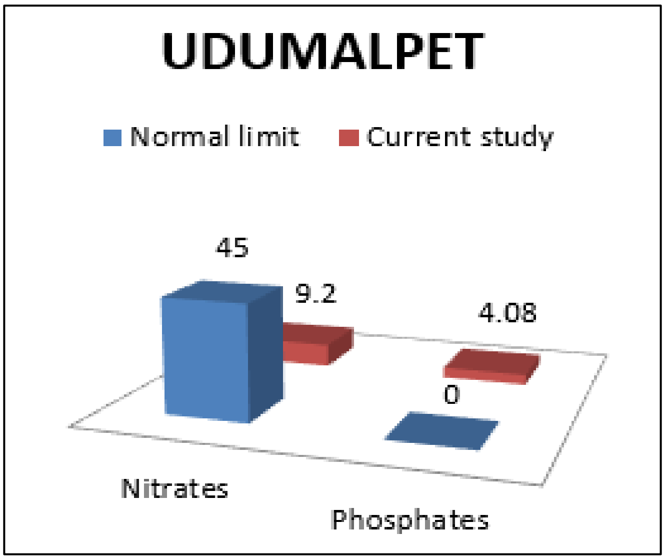


Figure 2: A graphical illustration of the concentration of heavy metals in Udumalpet taluk is compared with the normal limit specified by the World Health Organization

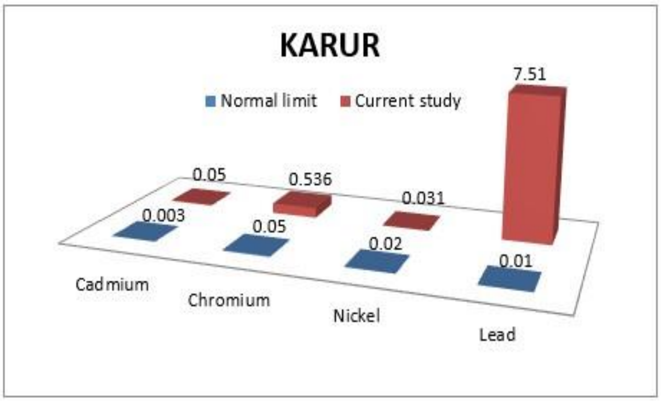


Figure 3: A graphical illustration of the concentration of heavy metals in Karur taluk is compared with the normal limit specified by the World Health Organization

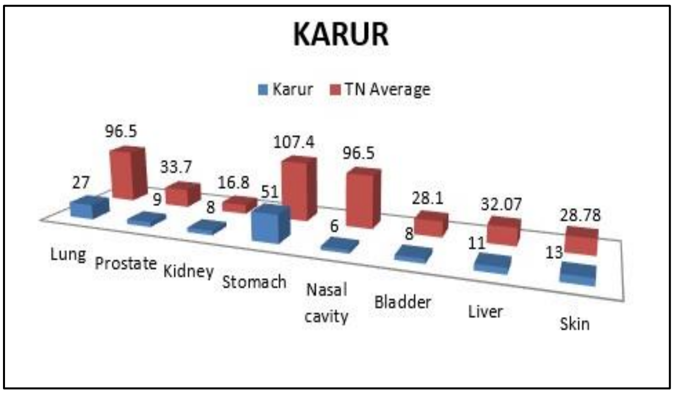


Figure 4: A graphical illustration of the number of cancer cases diagnosed in Karur district in comparison to the Tamil Nadu average

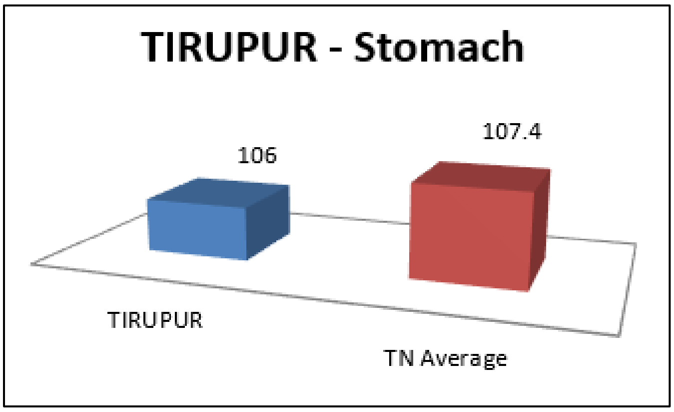


Figure 5: A graphical illustration of the number of stomach cancer cases diagnosed in Tirupur district in comparison to the Tamil Nadu average.

Table 1: An overview of the study characteristics, methodologies, and interpretation of results

Author Year **Place of Study**	**Study Duration**	**Sample Size** **Sample Site**	**Methods of** **Measurements**	**Carcinogen**	**Results**	**Normal Permissible** **Limit (PL)**
K. Mahmoodah Parveen et al 2019 Karur [17]	May 2014 Premonsoon August 2014 Monsoon Nov 2014 Post monsoon	S1: Parametric S2: Thennilai S3: Thalapatti S4: Pugalur S5: Panjapatti S6: Kattalai S7: Velliyanai S8:Thoranakalpati S9: Thogamalai S10: Lithalai	Atomic absorption Spectrophotometer	Chromium Lead	Premonsoon: 0.06-0.08mg/l Max at S4 Monsoon: 0.04 – 0.07mg/l Max at S3 & S4 BDL-all sites	WHO -0.05mg/l 0.01mg/l
Abirami L et al 2016 Karur Trichy Thanjavur [18]	Apr 2015	0.5kg brinjal was collected Trichy (Kundur station & Mathur station) Karur-Pugalur& Velayuthapalayam Thanjavur (Patteswaram)	Atomic absorption Spectrophotometer using Perkin Elmer AA 200 Model.	Chromium (ppm) Arsenic Lead Cadmium	0.28±0.023 to 0.38±0.026 0.384±0.026 to 0.899±0.062 0.0005±0.0001 to 0.001±0.0001 0.0001±0.00001 to 0.0002±0.00001	0.05ppm 0.01ppm 0.01ppm 0.003ppm
Jafar Ahamed A et al 2015 Karur [19]	Nov 2011 Nov 2012 & 2013	12 surface water 24 groundwater Amaravati belt	Atomic absorption spectrophotometer (Perkin Elmer A analyst 400	Surface water: Cadmium Lead Nickel Groundwater Nov 2012 Cadmium Lead Nickel Nov 2013 Cadmium	ppm 0.013-0.099 0.213-0.314 0-0.051 0.013-0.099 0.142-0.314 0-0.090 0.012-0.101	 0.003 0.01 0.02 0.003 0.01 0.02 0.003

				Lead Nickel	0.127-0.293 0-0.083	0.01 0.02
Saravanamoorthy et al 2013 Karur [20]	May 2003	2 sediment samples	Atomic absorption Spectrophotometer	Lead Sediment Water	 3.18- 342 156.68- 212.19	 0.02
Sivakumar KK et al 2011 Karur [21]		Waste waste primary sedimentation	Atomic absorption spectophotometer	Lead Chromium	1.12-19 0.24-0.7	0.05 0.05
Arthi T et al 2011 Udumalpet [22]	Aug 2005-July 2006	Water samples Udumalpet Taluk	APHA 2005	Nitrates Phosphates	8.3-9.8 2.5-4.2	45

Table 1 displays a review of articles on the methodology of measuring a specific carcinogen and the outcomes to a particular location, as provided by K. Mahmoodah Parveen et al., Abirami L. et al., Jafar Ahamed A. et al., Saravanamoorthy et al., Sivakumar KK et al. and Arthi T et al.

Table 2: Analysis of the association between carcinogenic levels and cancer cases in Tamil Nadu

District	Carcinogens	Range obtained†	Normal value‡	Cancer site [5.6]	Percentage of cancer cases [8]
Karur	Cadmium	0.0001-0.101	0.003	Lung, Prostate & Kidney	KARUR: Nasal cavity and paranasal cavity – 2% Stomach – 1.2% Kidney – 1.2% Skin – 1.1% Liver – 0.9% Bladder – 0.7% Prostate – 0.7% Lung – 0.7%
	Chromium	0.04-0.7	0.05	Nasal cavity and paranasal cavity & Lung	
	Nickel	0-0.090	0.02	Nasal cavity and paranasal cavity & Lung	
	Lead	0.0005-19	0.01	Stomach	
	Arsenic	0.358-0.961	0.01	Bladder, Lung, Skin, Prostate, Kidney & Liver	
Udumalpet Taluk, Tirupur dist.	Nitrate	8.3-9.8	45	Stomach	TIRUPUR: Stomach – 1.6%
	Phosphates	2.5-4.2	-	Stomach	

Table 2 represents the spurts of cancer cases in the districts along the Amaravati River basin. Excluded Trichy and Thanjavur from the analysis as the major water source for the two districts is from Cauvery, and inclusion might confound the results.

Source: †The mean value of carcinogens was the cumulated score of different studies described in Table 1. Units: water mg/l; soil mg/kg.

‡Mean score was compared with WHO 2013 standard limits for drinking water: Units – mg/l.

Table 3 Quality Assessment- COSMIN RoB, 2020 [15]

Authors	**Were patients stable in the time between the repeated measurements on the construct to be measured?**		**Was the time interval between the repeated measurements appropriate?**		**Were the measurement conditions similar for the repeated measurements – except for the condition being evaluated as a source of variation?**		**Did the professional(s) administer the measurement without knowledge of scores or values of other repeated measurement(s) in the same patients?**		**Did the professional(s) assign scores or determine values without knowledge of the scores or values of other repeated measurement(s) in the same patients?**		**Were there any other important flaws in the design or statistical methods of the study?**		**For continuous scores: was an intraclass correlation coefficient (ICC) calculated?**		**For dichotomous/nominal/ordinal scores: Was the percentage specific (e.g. positive and negative) agreement calculated?**	
	Reliability	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**	**Reliability**	**Measurement error**
K. Mahmoodah Parveen et al	NA	NA	VG	VG	VG	VG	NA	NA	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	VG	VG
Abirami L et al	NA	NA	VG	VG	Adequate	Adequate	NA	NA	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	VG	VG
Jafar Ahamed A et al	NA	NA	VG	VG	VG	VG	NA	NA	NA	NA	No	No	VG	VG	VG	VG
Saravanamoorthy et al	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	NA	NA	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Sivakumar KK et al	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	NA	NA	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Arthi T et al	NA	NA	VG	VG	VG	VG	NA	NA	NA	NA	Inadequate	Inadequate	Inadequate	Inadequate	VG	VG

NA – Not Applicable; VG – Very Good

5. Discussion

Groundwater is the primary source of drinking water available for human consumption in many places. Industrial, agricultural, and domestic wastewater have severely deteriorated the groundwater system in India. The New Indian Express newspaper is consecutively reporting the river quality status for the past three years [23]. In November 2020, they gave a shocking face-to-face comment to authorities that Amaravati would turn into the second Couum in Tamil Nadu state [24]. They reported that factories and industries were discharging the effluents into the river but along with them, municipalities were also releasing the district's domestic waste directly into the river. A decade later, the Amaravati Irrigation and Effluent Affected Farmers Association brought a lawsuit against the government; the court ordered the government to compensate 1750 farmers for their barren land with 6.36 Crore Indian rupees. In line with the government's directive, the Southern bench of the National Green Tribunal (NGT) continuously monitors industries. It directs Karur municipality and block development officer in implementing waste management rules within its jurisdiction [25]. A study by Mahmoodah Parveen K et al. in 2019 found that most water samples contained chromium levels slightly above permissible levels. The concentration of chromium levels is slightly high during pre-monsoon season > Monsoon > Post-monsoon season [17]. Several factors contribute to the high chromium level, including anthropogenic activities like industrial effluents and household sewage. All water samples tested were lead-free and below detectable levels. Notably, among ten sites in almost every season, Pugalur samples show the highest values, possibly due to the paper mill industry in the location. In Ahamed, A. Jafar et al. study in 2015, descriptive statistics for metals in surface and groundwater for 2012 are the same [19]. In almost all the samples, cadmium values are above the standard limit due to battery, electroplating, and pigment industries. As the study suggests, the high lead concentration in the region is due to the usage of unleaded petrol and lead-containing pesticides. Saravanamoorthy et al. 2013 show a high lead concentration in the sediment samples collected from Vetti palayam and Pasupathy palayam [20]. According to Sivakumar et al. 2011, heavy metal concentrations are studied in effluents discharged from 3 textile industries [21]. All three textile industries show high concentrations, but E1 exceeds the acceptable limit. The study has not mentioned the textile industry's location or name. Arthi et al. 2011 study shows elevated levels of nitrites and phosphates during June and May [22]. Abirami et al. 2016 study showed the presence of heavy metals in brinjal collected from 5 different sites, namely Gundur, Mathur, Pugalur, Patteswaram, and Velayuthapalayam [18]. Steel sheet work industries, metal industries, and manufacturers are located in all five sites, giving us a possible clue of what caused the bioaccumulation of toxic substances in vegetables available for human consumption. Fredick Ejime Chegwe et al. (2024) study successfully demonstrated how clay ball pellets absorbed heavy metals from industrial wastewater successfully proving it as one of the best alternate treatment materials [26].

Literature suggests that deficiencies of micronutrients, commonly iron, zinc, magnesium, selenium, and vitamins A, C, and E, lead to increased uptake of these heavy metals, meeting the needs and gradually decreasing the levels of toxic substances. High-risk populations such as young children, pregnant women, very old age people, and those who consume alcohol and tobacco products are more susceptible to mutagenesis. Henceforth, preventive measures include consuming more vitamin and mineral-rich diets for all age groups [27]. Since the oral cavity is the reflection of the entire body, oral manifestations are commonly elicited in cases of chronic toxicity of heavy metals, such as the following table 4:

Table 4 Oral manifestations of each toxic heavy metals

Heavy metals	Oral presentations
Cadmium	Bone resorption -Osteoporosis Yellowing of teeth?
Chromium	Oral Lichenoid Reaction(ORL) Lichen Planus (LP) Erosion and discoloration of the teeth Gingivitis/ Periodontitis
Arsenic	Rain-drop pigmentation Hyperpigmentation Hyperkeratosis Squamous Cell Carcinoma Basal Cell Carcinoma
Nickel	Oral Lichenoid Reaction(ORL) Lichen Planus (LP) Hypersensitivity reactions
Lead	Chronic plumbism Metallic taste Lead hue Astringency

Table 5 List of micronutrient acting as antidotes for carcinogenic heavy metal in the body [26]

Heavy metals	Anti-dotes	Recommended Diet
Cadmium	Iron and zinc	Greens, Nuts & Seeds, Liver, Fish, Meat and dairy products
Chromium VI	Calcium and magnesium	Broccoli, Cabbage, Lady's finger, Bananas, Oranges and dairy products
Nickel	Iron and magnesium	Greens, Beans, Peas, Bananas, Nuts & Seeds, Liver and dairy products
Lead	Iron, calcium, zinc and vitamin C	Nuts & Seeds, Oranges, Grapes,Watermelon, Indian Gooseberry, Greens, Tomato, Potato, Broccoli, Cabbage, Lady's finger, Fish, Meat, Liver and dairy products
Arsenic	Vitamin A, B9, E and selenium	Papaya, Watermelon, Wheat germ, Nuts & Seeds, Carrots, Greens, Sweet potato, Broccoli, Pumpkin,

		Cauliflower, Spinach, Chick peas, Peas, Brown rice, Eggs, Chicken, liver, Fish and dairy products
Cobalt	Iron and Glutathione	Greens, Nuts & Seeds, Avocado, Broccoli, Okra, Almonds, Liver, Fish, Meat and dairy products
Nitrite Nitrates/ Phosphate	Include all vitamins and mineral rich foods	Greens, Mushrooms, Peanuts, Soya bean,Cereals, Legumes including all the above mentioned items.

6. Limitations

Data availability is restricted to a few regions rather than the entire district. Samples collected from the sites nearer to the industries showed high toxicity levels. More precise studies on the causation, concentration, and management are expected shortly.

7. Conclusion

The study results clearly show that concentration levels of carcinogens are high near agricultural lands, industries, and factories. This practice seriously threatens public health. Immediate action needs to be taken to reduce the levels of carcinogens, protect the public from the potential harm they may cause, and ensure that industries and factories adhere to safety standards. Government initiatives should also be implemented to help educate the public on the benefits of clean water and healthy environmental practices. Long-term health surveillance of exposed populations, creation of affordable water treatment technologies, and the contribution of nutrition to preventing heavy metal uptake are areas of future research. These actions are necessary to stop the development of disease and protect future generations.

Data Availability

Data that supported the findings of the study will be provided upon request.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

Funding Source

None

Authors' Contributions

Sujitha S: Literature search and tabulation of data

Sindhu R: Manuscript reviewing

Prabu D: Methodology and conceptualization

Rajmohan M: Quality Assessment and Plagiarism

Dinesh Dhamodhar: Manuscript writing and editing

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References

[1] WHO, "WHO - Children's environmental health," 2017. Last assessed on Oct 16, 2024. [Online].

[2] WHO, "WHO - Climate change and health fact sheet," Oct. 30, 2021. Last assessed on Oct 16, 2024. [Online]

[3] WHO, "WHO – Sanitation," 2023. Last assessed on Oct 20, 2024. [Online]

[4] A. Prüss-Ustün, J. Wolf, C. Corvalán, R. Bos and M. Neira, "Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks," World Health Organization. Vol. 147, 2018.

[5] WHO, "IARC list of carcinogens, IARC Monographs Volumes 1-132," 2022. Last assessed on Oct 16, 2024. [Online].

[6] WHO, "List of classification by cancer sites with sufficient or limited evidence in humans, IARC Monographs Volumes 1-132," 2022. Last assessed on Oct 16, 2024. [Online].

[7] S. Sujitha, M. Rajmohan, D. Prabu, R. Sindhu, Dinesh Dhamodhar, "An Evidence based Research on Presence of Carcinogens and Increasing Spurts of Cancer Cases in Vaigai River Basin, India," *International Journal of Scientific Research in Biological Sciences*, Vol.11, Issue.2, pp.12-20, 2024.

[8] S. Sujitha, D. Prabu, R. Sindhu, Dinesh Dhamodhar, M. Rajmohan, "Fact-finding analysis on carcinogenic compounds and its impact on spurts of cancer cases in Bhavani River Basin, Tamil Nadu, India - Evidence-Based Research," *International Journal of Health Science and Research*, Vol.15, Issue.4, pp.176-187, 2025.

[9] S. Sujitha, D. Prabu, Dinesh Dhamodhar, M. Rajmohan, R. Sindhu, "An analysis of cancer causing agents and its association with the prevalence of cancer cases in Noyyal river basin, Tamil Nadu, India - A Explorative study based on scientific evidences, *International Journal of Health Science and Research*, Vol.13, Issue.9, pp.1-13, 2023.

[10] S. Sujitha, R. Sindhu, D. Prabu, M. Rajmohan, Dinesh Dhamodhar, "An Analysis of Cancer causing Substances and its Impact on Prevalence of Cancer Cases among General Population residing along Thamirabharani River Basin – Evidence based research," *Research Journal of Humanities and Social Sciences*, Vol.15, Issue.1, pp.24-30, 2024.

[11] S. Sujitha, Dinesh Dhamodhar, M. Rajmohan, R. Sindhu, D. Prabu, S. Sathiyapriya, "Presence of Carcinogenic compounds in Palar-Thenpennai River Basin and its Impact on increasing spurts of cancer cases in Northern Tamil Nadu, India – An evidence based fact analysis" *International Research Journal of Biological Sciences*, Vol.13, Issue.1, pp.1-14, 2024.

[12] S. Sujitha, M. Rajmohan, D. Prabu, R. Sindhu, Dinesh Dhamodhar, V. V. Bharathwaj, "Carcinogenic environmental pollution and its correlation with increasing spurts of cancer cases in Cauvery basin, Tamil Nadu state, India – An Exploratory Analysis. Research." *Research journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical sciences*, Vol.10, Issue.1, pp.01-18, 2024

[13] Elakiya Sugumaran, M.R. Prashanthy, V.V Bharathwaj, D. Prabu, S. Manipal, M. Rajmohan, M. Vishali M, "Glyphosate, Phorate, and Monocrotophos Hazardous Pesticide Usage and Its Public Health Impact – An Empirical Analysis," *I. Journal of Forensic Medicine & Toxicology*, Vol.15, Issue.5, pp.156–161, 2021.

[14] P. Nimmy, D. Prabu, Dinesh Dhamodhar, R. Sindhu, M. RajMohan, V.V. Bharathwaj, S. Sathiyapriya, S. Savitha, "An alarming presence of carcinogenic pesticide residues above recommended maximum residual limit (MRL) in fruits and vegetables in Tamilnadu, India causing a public health catastrophe.," *International Journal of Chemical and Biochemical Sciences*, Vol.24, Issue.8, pp.211-226, 2023.

[15] B. Lidwine, Mokkink, Maarten Boers, CPM van der Vleuten, et al., “COSMIN Risk of Bias tool to assess the quality of studies on reliability or measurement error of outcome measurement instruments: a Delphi study,” *BMC Medical Research Methodology*, Vol.20, Issue.293, 2020.

[16] P. Sampath, R. Swaminathan on behalf of the TNCRP Study Group, “Cancer incidence and mortality (Year 2017), incidence trend (2012-2017) and estimates (2018-2021) for Tamil Nadu state. Tamil Nadu Cancer Registry Project, *Cancer Institute (W.I.A), Chennai*, Tamil Nadu, India,” 2021. Last assessed on Oct 16, 2024. [Online].

[17] K. Mahmoodah Parveen, Mohamed Sihabudeen, J. Sirajudeen J, “Seasonal variation of heavy metal contamination of groundwater in and around Karur district, Tamil Nadu,” *International Journal of Pharmacy and Biological Sciences*, Vol.9, Issue.2, pp.45-50, 2019.

[18] L. Abirami, P. Mohamed Sirajudeen, “A study on heavy metals contamination in brinjal of Karur, Tiruchirapalli and Thanjavur district, Tamil Nadu, India,” *Asian Journal of Innovative Research*, Vol.1, Issue.4, pp.01-05, 2016.

[19] Jafar Ahamed, K. Loganathan, R. Jayakumar, “Hydrochemical characteristics and quality assessment of groundwater in Amaravathi river basin of Karur district, Tamil Nadu, South India,” *Sustainable Water Resources Management*, Vol.1, Issue.3, pp.273–291, 2015.

[20] M.D. Saravanamoorthy, R. Sivasankari R, “A study on the distribution of organic matter and toxic metals in the sediments of Amaravathi river in Karur district, Tamil Nadu,” *International Journal of Scientific and Research Publications*, Vol.3, Issue.11, pp. 1-5, 2013.

[21] K.K. Sivakumar, C. Balamurugan, D. Ramakrishnan, Leena Hebsi Bhai., “Assessment studies on wastewater pollution by textile dyeing and bleaching industries at Karur, Tamil Nadu,” *Rasayan Journal*, Vol.4, Issue.2, pp.264-269, 2011.

[22] T. Arthi, S. Nagarajan, A. Sivakumar, “Physico-chemical Characteristics of the River Amaravathy, Tamil Nadu, India,” *Nature Environment and Pollution Technology*, Vol.10, Issue.4, pp. 647-650, 2011

[23] A. Raj, “A Cooum in the making in Karur?,” The New Indian Express. Tamil Nadu, 2020 Nov 27. Last assessed on Nov 6, 2024. [Online].

[24] A. Raj, “Modern times unkind to Amaravathi -- the Sangam-era river,” The New Indian Express. Tamil Nadu, 2021 Sept 28 Last assessed on Nov 6, 2024. [Online].

[25] “Industries polluting Amaravathi River directed to take measures,” *DTNEXT Bureau*. Tamil Nadu; 2022 September 15. Last assessed on Nov 6, 2024. [Online].

[26] Fredrick Ejime Chegwe, Ochu Abdulmajeed , Samuel Oseji , Ebiye Ayo, Achugwo Chomezie Nathaniel , Adedeji Olugbenga, Egbe Chukutem, Nwori Augustine Nwode, “Efficient Heavy Metal Removal from Industrial Wastewater Effluent Using Low-cost Clay Pellets: Case Study of 7-UP Bottling Company,” *International Journal of Scientific Research in Biological Sciences*, Vol.10, Issue.12, pp.113-120, 2024

[27] Toxicology profiles, “Agency for Toxic Substances and Disease Registry,” *U.S. Department of Health & Human Services*. Last Reviewed: May 3, 2023, Last assessed on Oct 16, 2024. [Online].

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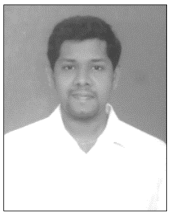

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