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CARCINOGENIC ENVIRONMENTAL POLLUTION AND ITS CORRELATION WITH INCREASING SPURTS OF CANCER CASES IN CAUVERY BASIN, INDIA – AN EXPLORATORY ANALYSIS RESEARCH

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ABSTRACT: Over exploitation of water systems in the process of urbanization has led to deterioration of general health and quality of life**.** The aim is to study the quantified levels of carcinogens in the environment such as Arsenic, Cadmium, Chromium, Nickel, Lead, Nitrite/Nitrate, Phosphates based on previous literatures and findings its association with spurts of cancer cases across certain sites that lie along the Cauvery river basin, Tamil Nadu, India. TNCRP 2021 was taken as reference to analyze the percentage of cancer cases reported in the districts. The significant association between exceeding of the permissible limit of various heavy metal elements and compounds and percentage of cancer cases at that particular site is established in this study. Oral findings commonly associated with chronic toxicity of carcinogenic heavy metals are listed which serves as an alarming signal to adapt to healthy lifestyle and dietary modifications as required.

Keywords: Heavy metals, Carcinogens, Industrialization, Environmental Pollution, Cancer.

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1. INTRODUCTION

Water is a vital resource for human habitat. According to the Global Cancer Observatory (GLOBOCAN) estimation, there were 193 lakhs new cancer cases worldwide for the year 2020. GLOBOCAN predicted that prevalence of cancer cases in India would increase to 20.3 lakhs, rise of 57.5% in 2040 from 2020 and incidence of cancer cases is likely to rise from 14.6 lakhs in 2022 to 15.7 lakhs in 2025[1]. According to the study conducted from Medenta Hospital, Delhi during 2012-2022, found 50% of the lung cancer patients are non-smokers, among which 70% of patients were less than 50 years of age and 100% of patients under 30 years of age were Non-smokers which is high when compared to CDC report where in US every year about 10-20% of lung cancers patients are non-smokers [2]. In India, Non-Communicable diseases (NCDs) are responsible for 63% of the total deaths, among which cancers account for 9% of deaths with a proportion of 3% in Tamil Nadu [3]. Due to rapid urbanization, the nation's economy grows tremendously building up various large scale industries, small scale industries, and foundries, developing infrastructures that are essential for transport, education and health care sectors. The other aspect of urbanization comes along with deleterious effect on environment affecting air, water and soil quality, getting into the food chain ultimately increasing health risk of population. A large number of industrial activities release chemicals or waste into the environment without properly treating them, either deliberately or unintentionally. When groundwater becomes polluted it poses big difficulty cleaning it. Groundwater is a vital source of water meeting up with basic domestic needs, agricultural requirements and renders industrial development in the sustainability and functioning of ecosystems. Groundwater quality is threatened by anthropogenic activities that are induced by overpopulation, which may emit contaminants into the environment. Cauvery is considered as Goddess for South Indian population as it originates from Kodagu in Karnataka and joins Bay of Bengal in Poompuhar, a small town in Nagapattinam district of Tamil Nadu. Cauvery Delta Zone (CDZ) occupies 14.47 lakh hectares in the eastern part of Tamilnadu, India running across Thanjavur, Tiruvarur and Nagapattinam, Trichy, Ariyalur and Pudukkottai districts[4]. Thanjavur has a privilege of being called as "Rice bowl of Tamil Nadu;" Thiruvarur district is popularly known as "the Granary of South India" and Nagapattinam as 'Naval Pattinam'- The city of ships. Rice is the main principal crop in these districts and completely depends on Cauvery. Tiruchirappalli also called Trichy, is a major tier II city in the state of Tamil Nadu and own a title "Energy Equipment and Fabrication Capital of India" as it has got numerous energy equipment manufacturing units in and around the city limits. Despite its industrial presence, Bharat Heavy Electrical Limited (BHEL), Golden Rock Railway Workshop, Ordnance Factory Tiruchirappalli (OFT) and High Energy Projectile Factory (HEPF) have made Tiruchirappalli the cleanest city in Tamil Nadu and it has maintained this title so far. Ariyalur has eight Cement factories are located in and around the

district and one Lignite Corporation at Jayamkondan. Pudukkottai is in the valley of the Vellar River. Amaravathy, Noyal, Bhavani, and Cauvery rivers flow through the district. Pudukkottai district is an agricultural oriented district. Paddy, groundnut, millet, pulse, cotton, sugarcane, gingerly are the crops that are cultivated in this district. Apart from alcohol, smoking, radiation, hereditary background and various anthropogenic activities such as vehicular pollution, improper sewage disposal system, industrial effluents and misuse of agricultural fertilizers contribute to the environmental pollution, thereby leading to increased incidence of cancer. Natural radiations and radiations used for diagnostic and therapeutic purposes are unavoidable. High risk population such as children below 18 years of age and pregnant women are more susceptible to mutagenesis [5]. The study aims at analyzing the excess presence of various carcinogens, their source and its association with cancer cases.

2. MATERIALS AND METHODS

Search strategy: A systematic literature review has been aimed at analyzing the presences of carcinogens that are present in the groundwater system available for human consumption, potentiality of developing into a cancer and its possible association with the development of cancer risk. The authors systematically identified the original studies published from period 2013 to 2022 that reported the presence of numerous carcinogens in the groundwater, soil, fishes and vegetables of Cauvery river basin using electronic databases such as PubMed, Wiley online library, Elsevier science direct, SpringerLink, ResearchGate and Medline following PRISMA guidelines. The search strategies included Boolean operators for the following combinations of keywords: ‘Environmental toxicity’ or ‘carcinogens’ or ‘heavy metal intoxication’ or ‘toxic pollutants’ or ‘heavy metal status’ or ‘Industrial contaminants’ or ‘Occupational exposure’ or ‘air pollution’ or ‘water pollution’ or ‘soil pollution’ or ‘industrial effluents.’ IARC lists of classification of carcinogens and classification by cancer site monographs, Volumes 1-133 were used to enumerate the group of carcinogens along with cancer site. Tamil Nadu Cancer Registry Project report 2021, published by the Cancer Institute, Adyar (W.I.A) and the state health department was taken as a reference to analyze the percentage of all types of cancer cases reported along the Cauvery river basin.

Study selection: Abstracts of all original studies identified through search engines were stored in a separate folder to avoid repetitions. The literature search was restricted to studies conducted in the state of Tamil Nadu from the period 2013 to know the status of risk then to compare it with TNCRP 2021 and predict the present situation. Original studies that were published in English with available full-text were included. Studies that used standardized methods of measurements and validation tools were included in the study. Studies that have been carried out with appropriate statistical analysis had included in the study. Exposure to toxic substances occurred due to accidental spillage was excluded from the study. Studies undertaken by Tamil Nadu Pollution Control Board were excluded.

Data extraction and methodology: For studies that met the eligibility criteria, the following data was

collected: Citation (author/year), study area, study duration, number and type of samples (air/water/soil) collected, carcinogens found in the samples, method of testing samples and test result values. Methodology is based on the study conducted in Noyyal river [6]. The values were compared with standardized normal limits set by WHO/BIS/CEQG for drinking water source, air and soil. Quality assessment was carried out using Newcastle Ottawa Scale. Carcinogens exceeding the standard limit were checked for its carcinogenic potential and cancer sites showing sufficient and limited evidences in humans by IARC lists of classification of carcinogens and by cancer site respectively[7,8]. According to IARC list of classifications by cancer sites with sufficient or limited evidences in humans, the above specified carcinogens leads to the development of lung, prostate, kidney, bladder, stomach, skin, breast, liver, pancreas cancers and leukemia. TNCRP report 2021 was used to calculate the percentage of contribution of respective cancer in the respective district [9]. With the help of the registry, we calculated the average score of each cancers for each districts by formula, Total no. of particular cases recorded in Tamil Nadu divided by 38 (38 districts).

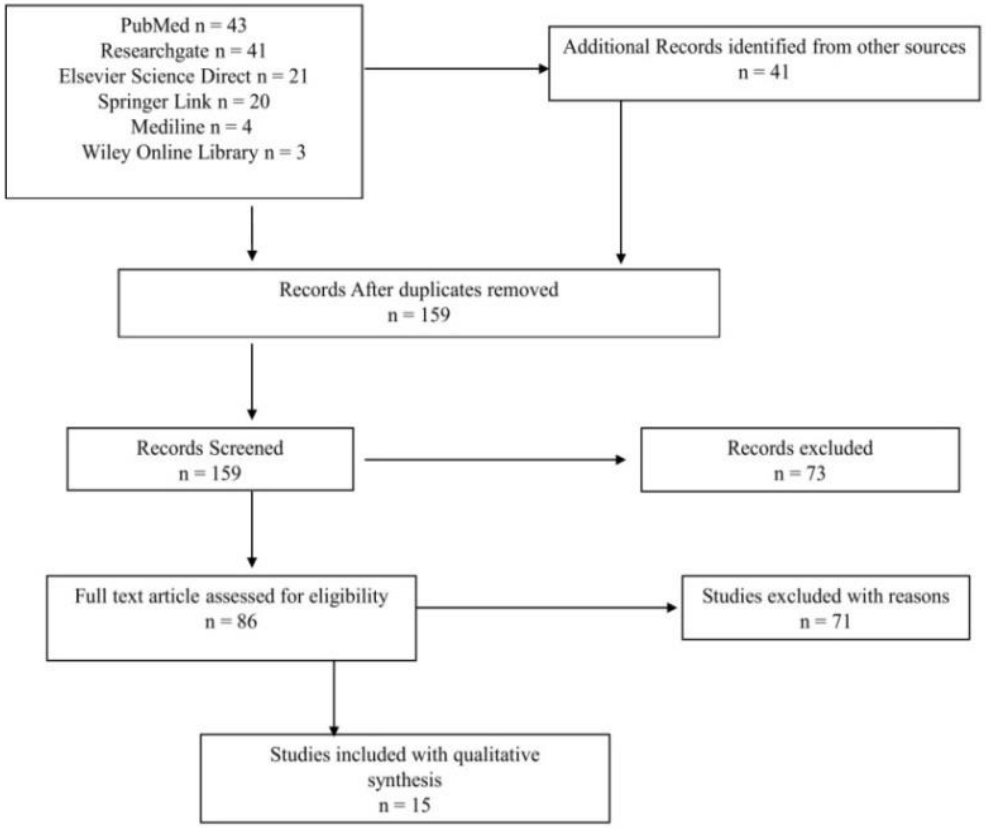


Figure 1: Flow diagram showing the number of studies identified screened assessed for eligibility excluded and included in systematic review

3. RESULTS AND DISCUSSION

Table 1: Review of articles on the presence of carcinogenic agents in the Cauvery river basin, its method of assessment and the results obtained.

Author Year of Publication Place of Study	Study Duration	Methods of Measurements	Sample Size Sample Site	Carcinogen	Results (mg/l)	Normal Permissible Limit (PL)
Bhuvaneshwari R et al [10] 2016 Cauvery river		Atomic Absorption Spectrophotometer (Perkin Elmer AA 800)	Water and sediment samples 20 locations	Water(mg/l) - Chromium Lead Nickel Cadmium	 0.02 **0.12** **0.011** 0.003	BIS 0.05 0.05 NA 0.01
				Sediments(mg/kg) -Chromium Lead Nickel	**58.5** 13.9 **16.7**	TEL 37.3 35 NA
Vinothkannan Anbazhagan et al [11] 2021 Cauvery	Aug 2018 Oct 2018	Atomic Absorption Spectrophotometer (Perkin Elmer AA 7000)	29 water and topsoil samples Cauvery river basin Kollidam river	Water(mg/l) Cadmium Lead	 **0.13-2.02** **0.52-2.88**	BIS, IS-2012 0.003 0.01
				Sediment-mg/kg Cadmium Lead	**0.85-7.21** 0.17-7.62	CEQG 0.7 30.2
Kannan D et al [12] 2015 Thanjavur	Nov - 2013	Spectrometric method Chromotropic acid Method Dimethyl Glyoxime method Diphenyl carbazide method	12 groundwater Thirubuvanam, Pattukkotai, Papanasam, Tiruvidaimaruthur Ammapet, Adirampattinam, Alivalam, Thanjavur near railway station Srinivasapuram, Thiruvaiyaru near bus stand, Kumbakonam near railway station Kumbakonam	Chromium (mg/l) Nickel	**0.006 – 0.01** 0.009 – **0.30**	BIS DL-0.005 0.02
Prem Nawaz M et al [13] 2017 Thanjavur	Jan 2016 to Dec 2016	Atomic Absorption Spectrophotometer	Water samples at station1 and station2 Adirampattinam seashore	Lead(mg/l)	A1:**0.26-0.31** A2:**0.19-0.25**	WHO – 0.01
				Cadmium	A1:**0.02-0.03** A2:**0.03-0.04**	0.003
				Arsenic	A1:**2.01-2.82** A2: **0.99-1.82**	0.01
Karpagam K et al [14] 2018 Thanjavur		Atomic Absorption Spectrophotometer	Gills Liver skin and muscles of three fish species - (Catlacatla, Oreochromisniloticus and	Cadmium	Liver > skin > muscles > gills; Catlacatla>oreochromisniloticus >cyprinuscarpio var. communis; Red lake > Varun lake >Amni lake.	

			Cyprinuscarpio var. communis) Varan lake, Red lake Amni lake	Chromium	Liver > skin > gills > muscles; Catlacatla>cyprinuscaprio var. communis>oreochromisniloticus; Red lake > Varun lake >Amni lake.	
Kanmani S et al [15] 2013 Trichy		Atomic Absorption Spectrophotometer	60 fresh solid waste samples 14 groundwater and 20 leachate samples Around open dump sites, Ariyamangalam; Srirangam; Ponmalai; Abishegapuram	Cadmium	Fresh leachate- 0.35-1.40 Stabilized – 0.16(BDL)	
				Lead	Fresh leachate – 1.80-5.15 Stabilized – 0.77(BDL)	
				Groundwater: Cadmium Lead	**>0.01mg/l** **0.59 mg/l**	BIS 0.01mg/l 0.05mg/l
Arulnangai R et al [16] 2019 Ariyalur	Summer Monsoon seasons during the year 2015	Atomic Absorption Spectrophotometer	Sixteen groundwater samples Udayarpalayam taluk	Lead	Summer: 0.01-**0.02**ppm Monsoon: 0.01-**0.03**ppm	WHO – 0.01ppm
				Nickel	Summer: 0.01-**0.02**ppm Monsoon: 0.01-**0.02**ppm	WHO – 0.01ppm
MahmoodahParveen K et al [17] 2019 Karur	May 2014 (Pre-monsoon) August 2014 (Monsoon) Nov 2014 (Post-monsoon)	Atomic absorption Spectrophotometer	10 water samples S1 – Parametric S2 – Thennilai S3 – Thalapatti S4 – Pugalur S5 – Panjapatti S6 – Kattalai S7 – Velliyanai S8:Thoranakalpati S9 -Thogamalai S10 - Kulithalai	Chromium	Pre-monsoon: **0.06 – 0.08**mg/l Max at S4 Monsoon: 0.04 – **0.07**mg/l Max at S3 & S4	WHO - 0.05mg/l
				lead	BDL at all sites	0.01mg/l
Abirami L et al [18] 2016 Karur, Tiruchirappali Thanjavur	April 2015	Atomic absorption spectrophotometer (Perkin Elmer, model 200).	0.5kg of each brinjalTiruchirapalli (Kundur station and Mathur station), Karur (Pugalur station and Velayuthapalayam station) Thanjavur (Patteswaran station) districts	Chromium	0.28±0.023 to 0.38±0.026 Mathur>Kundur >Pugalur>Pattes waram>Velayutapalaym	
				Lead	0.0005±0.0001 to 0.001±0.0001 Mathur>Kundur >Pugalur>Velayuthapalaym>Patteswaram	
				Arsenic	0.384±0.026 to 0.889±0.062 Mathur>Kundur >Pugalur>Velayuthapalaym>Patteswaram	

				Cadmium	0.0001±0.00001 to 0.0002±0.00001 Mathur>Kundur >Patteswaram> Pugalur>Velayu tapalaym	
Vellaichamy K et al [19] 2017 Pudukottai	Pre-monsoon(Apr) and post-monsoon (Nov) seasons	Atomic Absorption Spectrophotometer (AAS).	Sixteen different sediment samples locations of the Vellar watershed	Chromium	PRM: 5.96-30.36 POM: 9.87-100	
				Lead	PRM: 0.49-9.07 POM: 1.043-23.456	
Ramanathan S et al [20] 2019 Pudukottai	Nov 2015 to Oct 2016		Water samples from two different stations in Puthukulam pond	Chromium	Station1: 0.022-**0.099** Maxi during Oct 2016 Station2: 0.023-**0.099** max during Oct 2016	0.05 (WHO)
				Nickel	Station1: **0.036-0.099** Maxi during July 2016 Station2: **0.035-0.097** max during July 2016	0.01
Kavitha V et al [21] 2019 Thiruvarur	June 2018 to August 2018	Standard method APHA 1995	Water and sediment samples S1:Achuthamangalam S2:Nannilam S3:Thirukandiswaram	Water: Arsenic	S1: **0.021±0.006** S2:**0.025±0.008** S3:**0.027±0.006**	WHO-0.01
				Cadmium	S1: <0.001 S2: 0.004±0.003 S3: 0.005±0.005	0.003
				Lead	S1: **0.827±0.041** S2: **0.839±0.047** S3: **0.955±0.007**	0.01
				Sediment: Arsenic	S1: 0.067±0.003 S2: 0.063±0.004 S3: 0.071±0.007	
				Cadmium	S1: 0.187±0.001 S2: 0.191±0.005 S3: 0.210±0.003	
				Lead	S1: 0.607±0.541 S2:0.759±0.045 S3:0.778±0.377	
Manikandan M et al [22] 2016 Nagapatinam	Monsoon Pre - monsoon, post-monsoon and summer	Atomic Absorption Spectrophotometer Perkin Elmer, model 3310	Two sediment samples Nagapattinam	Cadmium	Monsoon: 2.85±0.16 Post-monsoon: 1.83±0.24 Summer: 1.63±0.16 Pre-monsoon: 2.35±0.38	
				Lead	Monsoon: 2.66±0.50 Post-monsoon: 1.98±0.02 Summer: 1.49±0.31	

					Pre-monsoon: 1.94±0.06	
			Karaikal	Cadmium	Monsoon: 2.95±0.05 Post-monsoon: 2.49±0.30 Summer: 1.99±0.03 Pre-monsoon: 2.52±0.16	
				Lead	Monsoon: 3.25±0.27 Post-monsoon: 2.76±0.21 Summer: 1.94±0.04 Pre-monsoon: 2.56±0.48	
			Tharangambadi	Cadmium	Monsoon: 2.03±0.05 Post-monsoon: 1.22±0.17 Summer: 1.17±0.10 Pre-monsoon: 1.95±0.07	
				Lead	Monsoon: 1.94±0.05 Post-monsoon: 1.57±0.03 Summer: 1.36±0.15 Pre-monsoon: 1.52±0.08	
Sankar et al 2018 [23] Nagapatinam	Summer (May), Monsoon (August), Post-monsoon (Nov)	Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES)	96 samples was obtained each from surface water, sediment and biota Parangipettai(S 1) and Nagapattinam(S 2)	Cadmium	Water: **0.04-0.36µg/l** **S1: 0.182 µg/l** (max) **S2: 0.16µg/l** (min) Max: November	0.003mg/l
					Sediment: 0.25 to 1.26µg/g Max: August Biota: S1:P.indicus - 0.36µg/g S2:R.kanagurta - 0.26µg/g Max: August	
				Lead	Water: **0.28 – 1.39µg/l** **S1: 1.05µg/l** (max) **S2: 0.31µg/l** (min) Max: May	0.01mg/l
					Sediment: 3.47 to 10.91µg/g Max: May Biota:	

					S1: P. viridis - 5.34µg/g S2: S. guttatusin - 0.83µg/g Max: November	
Juliatmary P et al [24] 2020 Nagapattinam		Alkaline permanganate method Colorimetric method Flame photometer method	50 surface samples Industrial based agricultural area of Mayiladuthurai taluk	Nitrogen Phosphorus	54.12kg/ha 44.95kg/ha	

Table 1shows the review of articles on method of measurement of particular carcinogen and the results obtained at particular site as given by R. Bhuvaneshwari et al, VinothkannanAnbazhagan et al, Kannan D et al, Prem Nawaz M et al, Karpagam K et al, Kanmani S et al, Arulnangai R et al, MahmoodahParveen K et al, Abirami L et al, Vellaichamy K et al, Ramanathan S et al, Kavitha V et al, Manikandan M et al, Sankar et al and Juliatmary P et al.

Table 2: Percentage of cancer cases and its association with carcinogen levels in the Cauvery river basin

District	Carcinogens	Mean value obtained[a]	Normal value[b]	Cancer site	Percentage of cancer cases
THANJAVUR	Nickel	0.112	0.02	Nasal cavity and paranasal cavity & Lung	Nasal cavity - 4% Skin - 4% Stomach - 3.50% Bladder - 2.90% Liver - 2.80% Prostate - 2.50% Kidney - 2.10% Lung - 2.10%
	Chromium	0.008	0.05	Nasal cavity and paranasal cavity & Lung	
	Lead	0.266	0.01	Stomach	
	Cadmium	0.027	0.003	Lung , Prostate & Kidney	
	Arsenic	1.907	0.01	Bladder, Lung, Skin, Prostate, Kidney & Liver	
TRICHY	Cadmium	0.655	0.003	Lung , Prostate & Kidney	Prostate – 3% Kidney – 3% Stomach – 3% Lung – 2%
	Lead	0.214	0.01	Stomach	
NAGA -PATTINAM	Cadmium	0.361	0.003	Lung , Prostate & Kidney	Stomach - 2.60% Kidney – 2.3% Prostate - 1.5% Lung - 1.20%
	Lead	1.39	0.01	Stomach	
TIRUVARUR	Arsenic	0.0456	0.01	Bladder, Lung, Skin, Prostate, Kidney & Liver	Skin – 2% Stomach - 1.80% Kidney - 1.50% Liver - 1.39% Bladder – 1% Lung -1% Prostate - 0.70%
	Cadmium	0.099	0.003	Lung , Prostate & Kidney	
	Lead	0.794	0.01	Stomach	
ARIYALUR	Lead	0.01	0.01	Stomach	

	Nickel	0.02	0.02	Nasal cavity and paranasal cavity & Lung	Stomach - 1.10% Nasal cavity– 1% Lung - 0.40%
KARUR	Chromium	0.054	0.05	Nasal cavity and paranasal cavity & Lung	Nasal cavity - 2% Lung – 0.70%
PERAMBALUR	Cadmium	0.557	0.003	Lung , Prostate & Kidney	Kidney - 0.70% Lung - 0.60% Stomach - 0.50% Prostate - 0.30% Nasal cavity - 0.30%
	Chromium	0.042	0.05	Nasal cavity and paranasal cavity & Lung	
	Nickel	0.385	0.02	Nasal cavity and paranasal cavity & Lung	

Table 2 represents the spurts of cancer cases in the districts that lie along the Cauvery river basin.
Source:
[a]Mean value of carcinogens was the cumulated score of different studies described in the Table 1; Units – mg/l.
[b]Mean score was compared with WHO 2013 standard limits for drinking water; Units – mg/l.

Table 3: Quality Assessment: Newcastle Ottawa Scale

AUTHOR & YEAR	SELECTION				COMPARA--BILITY	OUTCOME	
	Representativeness of the samples	Sample size	Non-respondents	Ascertainment of the exposure		Assessment of the outcome	Statistical test
Bhuvaneshwari et al R, 2016[10]	*	*	-	**	*	**	*
VinothkannanAnbazhagan et al, 2021[11]	*	*	-	**	**	**	*
Kannan D et al, 2015[12]	*	*	-	**	**	**	*
Prem Nawaz M et al, 2017[13]	*	*	-	**	**	**	*
Karpagam K et al, 2018[14]	*	-	-	**	**	**	*
Kanmani S et al, 2013[15]	*	*	-	**	*	**	*
Arulnangai R et al, 2019[16]	*	-	-	**	*	**	*
MahmoodahParveen K et al, 2019[17]	*	-	-	*	*	**	-
Abirami L et al, 2016[18]	*	-	-	*	*	**	-
Vellaichamy K et al, 2017[19]	*	-	-	**	**	**	*
Ramanathan S et al, 2019[20]	*	-	-	*	*	*	-

Kavitha V et al, 2019[21]	*	-	-	*	*	**	-
Manikandan M et al, 2016[22]	*	-	-	*	*	*	-
Sankar et al, 2018[23]	*	*	-	**	*	**	*
Juliatmary P et al, 2020[24]	*	-	-	**	*	**	*

INTERPRETATION

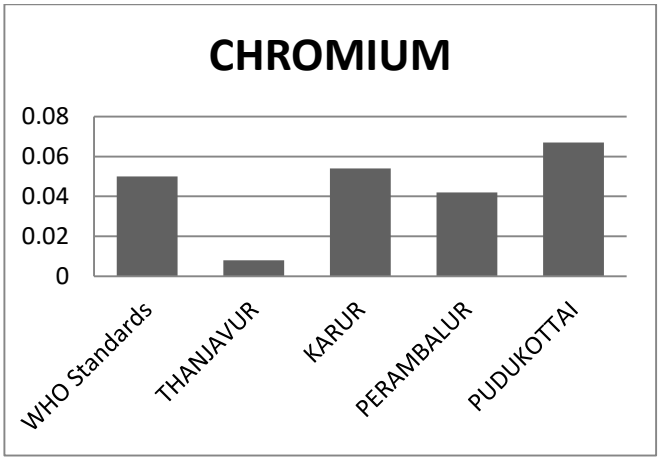
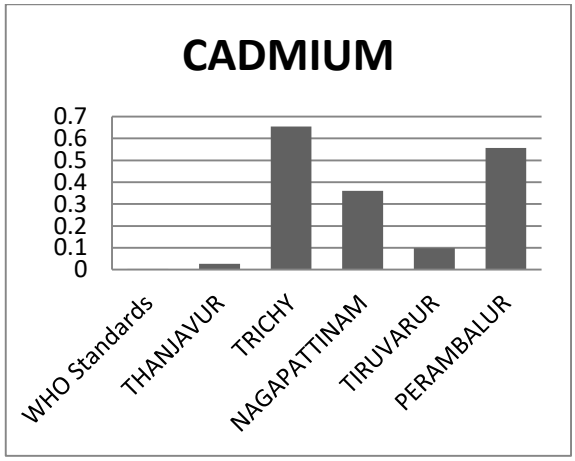


Figure: 2a



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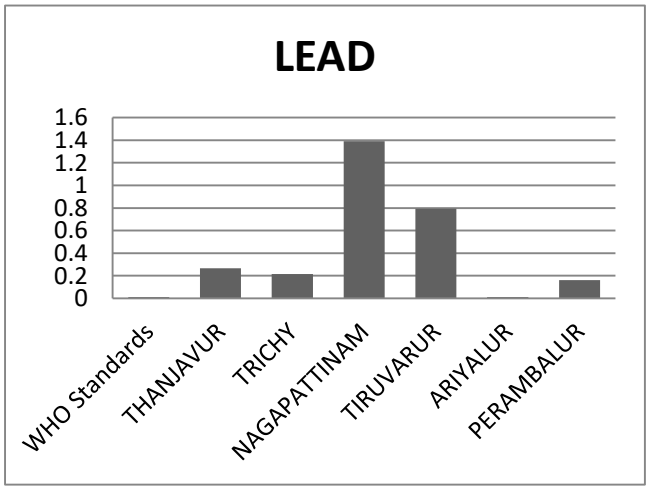

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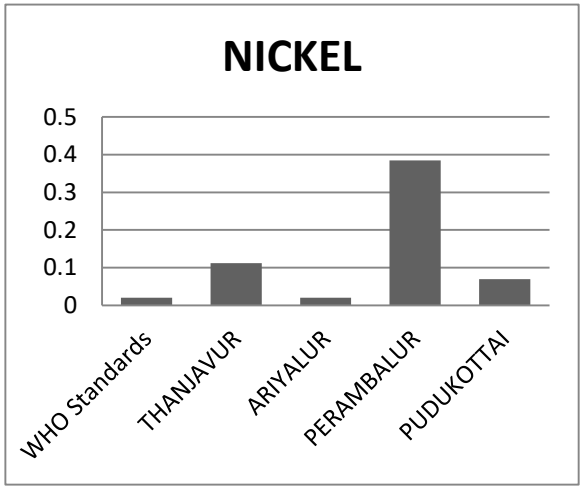


Figure: 2d

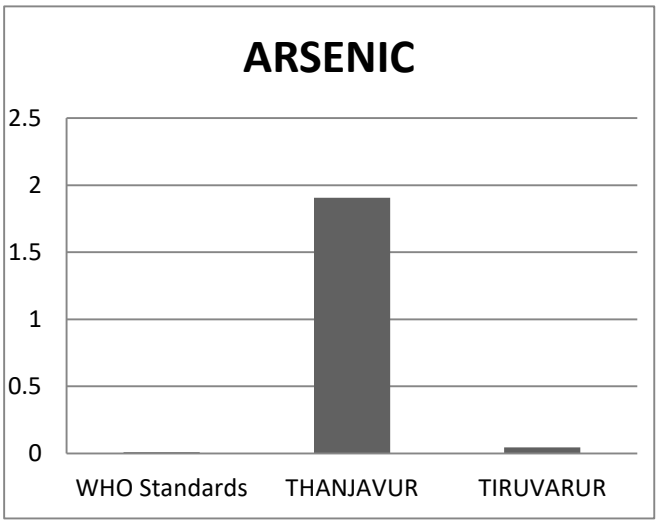


Figure: 2e

Figure 2: Graphical representation of chromium (Fig. 2a), cadmium (Fig. 2b), lead (Fig. 2c), nickel(Fig. 2d)and arsenic (Fig. 2e) concentration in districts supplied by Cauvery river compared with WHO standards.

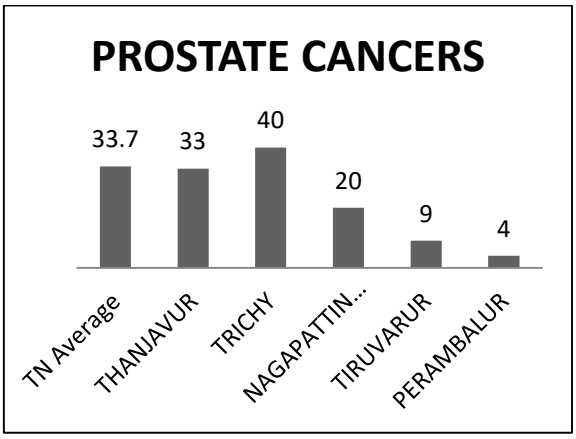
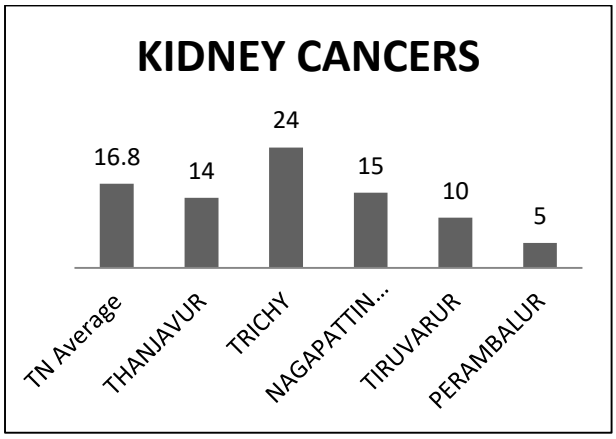


Figure: 3a



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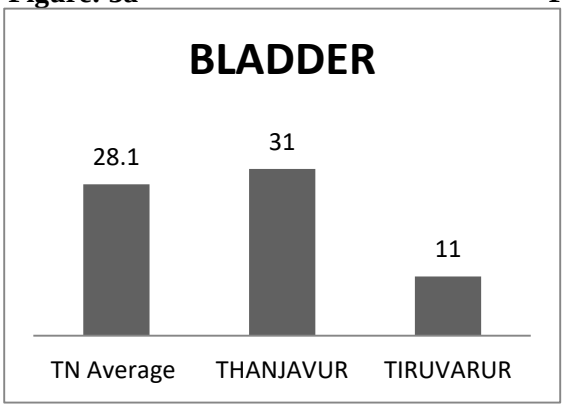

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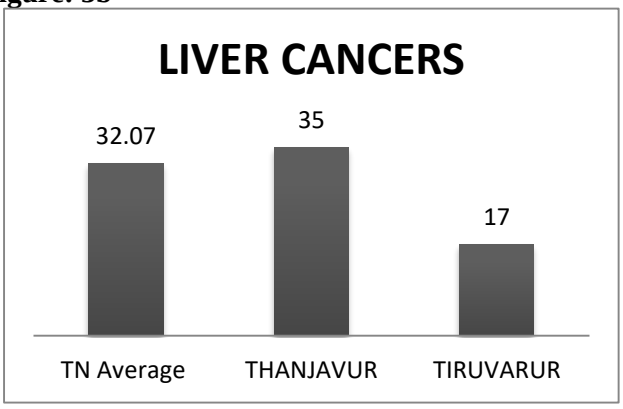

Figure: 3d

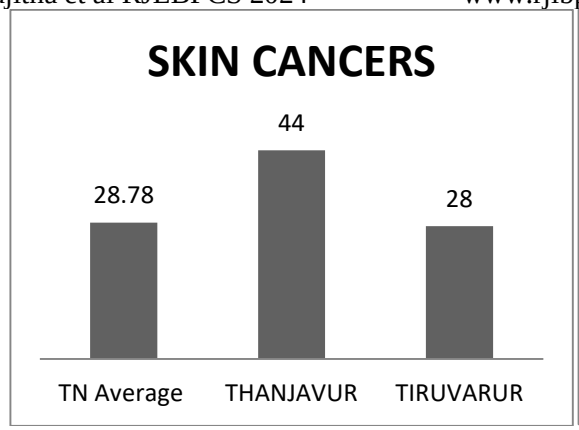

Figure: 3e

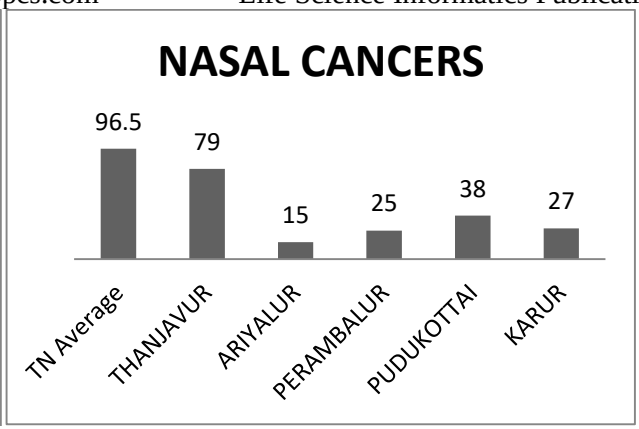

Figure: 3f

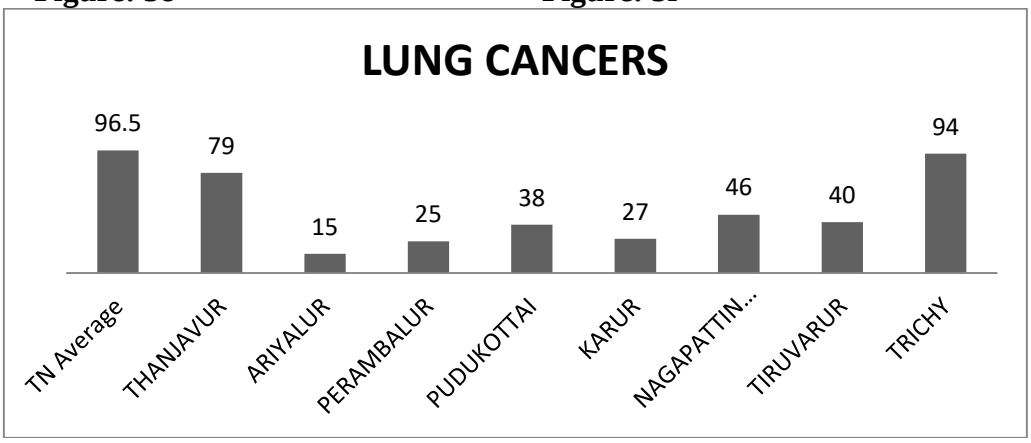

Figure: 3g

Figure 3: Graphical representation of number of prostate (Fig. 3a), kidney (Fig. 3b), bladder (Fig. 3c), liver (Fig. 3d), skin (Fig. 3e), nasal (Fig. 3f) and lung(Fig. 3g)cancer cases recorded in each district compared with Tamil Nadu Average count.

The concentration of atmospheric particulate and chemical parameters of the soil and groundwater system explains the fate of mankind. Various anthropogenic activities and misuse of natural resources determined the pervasiveness of carcinogenic agents in the environment. Heavy metal levels in the freshwater system are of major concern today because it enters into the human system through drinking water and food, causing a serious threat to health. Bioaccumulation of heavy metals in the groundwater system is due to industrial activities, discharge of municipal and domestic waste. In the present study, Cauvery and its tributaries flowing cities Thanjavur, Tiruchirapalli, Ariyalur, Karur, Perambalur, Pudukottai, Tiruvarur, Nagapattinam are seen polluted with arsenic, cadmium, chromium, nickel, lead, nitrites/nitrates and phosphates. Cadmium, a rare earth metal is naturally occurring but also toxic. It can disperse into the air, soil and water, where one may come into contact with cadmium products like batteries, pigments, metal coating and plastics. The amount of cadmium most people exposed to is likely to be higher near Factories, incinerators, cadmium-related materials landfill operators, metal smelting, electronic recycling and composting. Besides lung cancers, there is a limited evidences showing link between kidney & prostate cancers. Cadmium and arsenic is found higher than the permissible limit at all stations in the study conducted at Adirampattinam seashore, Thanjavur district by Prem Nawaz M et al, 2016 study. The high values of arsenic may be due to its wide use in the

agricultural lands which may be thrown to the river beds by runoff [13]. Similarly, Kavitha V et al, 2019 study in Tiruvarur district also found the excessive presence of arsenic in water and soil sediment samples at three different sites – Achuthamangalam, Nannilam and Thirukandiswaram. Acute poisoning of arsenic cause vomiting, oesophageal and abdominal pain and bloody rice water diarrhea [21].According to Manikandan M et al, 2016 and Sankar et al, 2018 study showed the similar results in water, sediment and biota samples collected during 2016-2018 in Nagapattinam [22, 23]. Hexavalent Chromium is used in electroplating processes, stainless-steel production, leather tanning, textile manufacturing and as a wood preservatives. Karpagam K et al, 2018 study confirmed the presence of cadmium and chromium in the crab samples collected from Varan lake, Red lake and Amni lake in Thanjavur [14]. MahmoodahParveen et al, 2019 study conducted in Karur showed chromium concentration in the groundwater samples ranging from 0.04 to 0.07mg/l. High content of chromium are mainly due to industrial effluents, tanneries, old plumbing and household sewages [17]. Hexavalent Chromium compounds have been known to cause lung cancers in humans. Ramanathan et al, 2019 study, assessed the seasonal variations of heavy metals like chromium and nickel at two different stations in Puthukulam pond, Pudukottai. Maximum concentrations of both the metals nickel and chromium at both the stations mark during July and October respectively. As a result of a diverse range of wastes, including domestic sewage, agricultural runoff, automobile waste, electroplating units, and utensil manufacturing, the levels of nickel are elevated.[20]. Similarly, Vellaichamy et al, 2017 study conducted in Pudukottai showed the presence of chromium in surface sediments and suggested anthropogenic sources of emission of chromium in the form of municipal wastes, laundry chemicals, road run-off due to tire wear etc., may be the possible reason [19]. Arulnangai et al, 2019 study assessed the comparison of concentrations of lead and nickel in water samples collected at Udayarpalayam taluk in Ariyalur district areas. High concentration of lead is mainly due to electroplating waste and lead paint wastes. Water in contact with lead piping or lead bearing joining compounds usually contains lead[16]. From Kanmani et al, 2013 study conducted in groundwater system around the open dump site in Ariyamangalam, Trichy. According to the study, the possible source of lead is from batteries and chemicals used for photograph processing, older lead-based paints and mainly due to the lead pipes disposed at the landfill. The presence of high concentration of lead in groundwater samples nearby dumping site signifies the migration of toxic substances from the leachate. Presence of has been revealed lead to stomach cancers[15]. Juliatmary P et al, 2020 study in Nagapattinam showed the similar results of elevated nitrites/phosphates where nitrites show limited evidences causing stomach cancers and phosphates leading to leukemia [24]. Although the influence of tobacco plays a critical role in the prevalence of cancer according to Sowmia et al, 2020studydirect consumption of contaminated drinking water will worsen the condition further [25]. Considering that the oral cavity reflects the entire body, oral manifestations are often elicited in cases of chronic heavy metal toxicity,

as outlined in the following table along with dietary modifications for reversal mechanisms of heavy metal concentration in the body:

Table 4: Oral manifestations of heavy metals and dietary modifications recommended for detoxification of heavy metals

Heavy metals	Oral presentations [26,27]	Recommended diet for reversal mechanism [28]
Cadmium	Bone resorption -Osteoporosis Yellowing of teeth?	Iron and zinc rich foods - Greens, Nuts & Seeds, Liver, Fish, Meat and dairy products
Chromium VI	Oral Lichenoid Reaction(ORL) Lichen Planus(LP) Erosion and discolouration of the teeth Gingivitis/ Periodontitis	Calcium and magnesium rich in Broccoli, Cabbage, Lady's finger, Bananas, Oranges and dairy products
Arsenic	Rain-drop pigmentation Hyperpigmentation Hyperkeratosis Squamous Cell Carcinoma Basal Cell Carcinoma	Vitamin A, B9, E and Selenium rich foods Papaya, Watermelon, Wheat germ, Nuts & Seeds, Carrots, Greens, Sweet potato, Broccoli, Pumpkin, Cauliflower, Spinach, Chick peas, Peas, Brown rice, Eggs, Chicken, Iiver, Fish and dairy products
Nickel	Oral Lichenoid Reaction(ORL) Lichen Planus(LP) Hypersensitivity reactions	Iron and magnesium rich foods Greens, Beans, Peas, Bananas, Nuts & Seeds, Liver and dairy products
Lead	Chronic plumbism Metallic taste Lead hue Astringency	Iron, calcium, zinc and vitamin C rich foods Nuts & Seeds, Oranges, Grapes, Watermelon, Greens, Tomato, Potato, Broccoli, Cabbage, Lady's finger, Fish, Meat, Liver and dairy products

The study is unlikely to generalize to the entire district as sample sites are limited to few zones and areas. Furthermore, there is no information on cancer prevalence at the zone level, but only at the district level. With the available and limited source of data, we could find a positive association between carcinogen levels and cancer prevalence. It is therefore necessary for the government to take immediate action upon the alarming issue.

4. CONCLUSION

This systematic review shows that there is an association between excessive presence of carcinogens and its impact of carcinogenic potential on general population. Evidences and proofs correlating with

each other makes us to realize that the human negligence has taken us this far, letting people who doesn't have any causative habits to fall for this trap and lose their lives. It's high time to raise our voice for ourselves and bring it to an immediate notice to the Government of Tamil Nadu and concerned authorities to act upon it on an emergency basis and save millions of innocent lives.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT:

The article includes references to the data that supported the findings of the study. Full text articles can be provided upon request.

REFERENCES

1. Global Cancer Observatory GLOBOCAN India, 2020, 365 India fact sheet. World Health Organisation. International Agency for Research on Cancer. https://gco.iarc.fr/today/data/factsheets/populations/356-india-fact-sheets.pdf
1. Ipsita Pati., 2022, 50% of lung cancer patients since 2012 are non-smokers: Medanta, NewspaperTimes of India, 23 Novemberhttps://timesofindia.indiatimes.com/city/gurgaon/50-of-lung-cancer-patients-since-2012-are-non-smokers-medanta/articleshow/95700609.cms
2. Indian Council of Medical Research, 2021, Profile of Cancer and Related Factors – Tamilnadu. National Cancer Registry Programme, India.https://ncdirindia.org/All_Reports/State_Factsheet_21/Factsheet/FS_Tamilnadu.pdf
3. Paramasivan, Pasupathi. An Overview of Cauvery Delta Zone in TamilNadu. International Journal of Trend in Research and Development. 2016; 3:399-403.
4. Roshan, Sindhu, Dhamodhar, Prabu, Rajmohan, Bharathwaj. Cognizance about potential cancer risks due to cone-beam computed tomography systems among dental professionals. International Journal of Health Sciences. 2022: 6:6574–6583.
5. Sujitha S, Prabu D, Dinesh Dhamodhar, Rajmohan M, Sindhu R. 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. Int J Health Sci Res. 2023; 13:1-13.

6. World Health Organisation, 2022, IARC list of carcinogens. IARC Monographs Volumes 1-132. https://monographs.iarc.who.int/list-of-classifications/
7. World Health Organisation, 2022, List of classifiacations by cancer sites with sufficient or limited evidence in humans, IARC Monographs Volumes 1-132.https://monographs.iarc.who.int/wp-content/uploads/2019/07/Classifications_by_cancer_site.pdf
8. Sampath P and Swaminathan R on behalf of the TNCRP Study Group, 2021 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.
9. Bhuvaneshwari, Paneer Selvam, Srimurali, Padmanaban, BabuRajendran. Human and Ecological Risk evaluation of Toxic Metals in the water and sediment of River Cauvery. International Journal of Scientific and Research Publications. 2016; 6:2250-3153.
10. Anbazhagan, Rajaram Rajendran, Ganeshkumar Arumugam, Arun Ganeshan. Identification of heavy metal pollution source due to idol immersion activity across the Cauvery river basin, Tamil Nadu, South India. Current science. 2021; 120:200-208.
11. Kannan, Mani. Chemical analysis of groundwater from various parts of Thanjavur district, Tamil Nadu. India. International Letters of Chemistry, Physics and Astronomy. 2015: 56:18-30.
12. Nawaz, Raja Mohamed, Ayeshamariam, Mohamed Rafi. Assessment of heavy metals in surface water of Adirampattinam seashore, Thanjavur District, Tamil Nadu, India. Fluid Mechanics: Open Access Journal. 2017; 4:1-6.
13. Karpagam, Mariappan. Heavy metals levels In three major carps (Catlacatla, Oreochromisniloticus and CyprinuscarpioVar.communis) from the lake of Thanjavur district. International Journal of Pharmaceutics and drug analysis. 2018; 6:302-306.
14. Kanmani, Gandhimathi. Investigation of physicochemical characteristics and heavy metal distribution profile in groundwater system around the open dump site. Appl Water Sci. 2013; 3:387-399.
15. Arulnangai, Mohamed Sihabudeen, Sirajudeen, AhamedSulthan. Studies on heavy metal pollution of groundwater analysis in and around – Udayarpalayam Taluk at Ariyalur district – Tamilnadu. International Journal of Pharmacy and Biological Sciences. 2019; 9:14-19.
16. Parveen, Mohamed Sihabudeen, Sirajudeen. Seasonal variation of heavy metal contamination of groundwater in and around Karur district, Tamil Nadu. International Journal of Pharmacy and Biological Sciences. 2019; 9:45-50.
17. Abirami, Mohamed Sirajudeen. A study on heavy metals contamination in brinjal of Karur, Tiruchirapalli and Thanjavur district, Tamil Nadu, India. Asian Journal of Innovative Research. 2016; 1:01-05.
18. Vellaichamy, Rajaram. Assessment of heavy metal concentration in surface sediments of Vellar

river basin of Pudukottai district, Tamilnadu, India. Journal of Computational and Theoretical Nanoscience. 2017; 14:5577-5584.

19. Ramanathan, Amsath. Seasonal variations of heavy metals in Puthukulam Pond, Pudukottai, Tamil Nadu, India. International Journal of Pharmacy and Biological sciences. 2019; 9:85-88.
20. Kavitha, Anandhan, Sumathi, Balasubramanian, BaskarSanjeevi. Analysis of selected heavy metal contamination in the Mudikondan river Nannilam,Thiruvarur district, Tamil Nadu, India. World Journal of Pharmaceutical Research. 2019; 8:1147-1157.
21. Manikandan, Paul Ravinderan. Seasonal variations of the heavy metal sediments in Nagapattinam, Karaikal and Tharangambadi coastal, Southeast coast of Tamil Nadu, India. International Journal of Modern Research and Reviews. 2016; 4:1125-1128.
22. Sankar, Sachithanandam, Thenmozhi, Sivasankar, Sai Elangovan, Yuvaraj, Marimuthu, Mageswaran, Sridhar, Ananthan. Integrated assessment of heavy metal contamination in water, sediments and marine organisms from southeast coast of India. Indian Journal of Gen Marine Sciences. 2018; 47:1274-1289.
23. Juliatmary, Arokiyaraj. Variation in soil nutrient characteristics near industrial area of Nagapattinam district in Tamil Nadu, India. Adalya Journal. 2020; 9:711-726.
24. Sowmia, Dinesh Dhamodhar, Sathiyapriya, Prabu, Rajmohan, Bharathwaj, Sindhu, Elakiya. A Systematic Review On The Prevalence Of Oral Cancer Among Tobacco And Non-Tobacco Users In Tamil Nadu. Journal of Pharmaceutical Negative Results. 2022; 13:1495-1498.
25. AbiramiArthanari, NagabhushanaDoggalli, Arun M, Smitha Ran. Oral Manifestations of Poisons in View of Forensic Odontology-A Review. Medico-legal update. 2020;20:29-35.Preeti Tomar Bhattacharya, Satya RanjanMisra, Mohsina Hussain. Nutritional Aspects of Essential Trace Elements in Oral Health and Disease: An Extensive Review. Scientifica. 2016:5464373
26. Toxicology profiles, Agency for Toxic Substances and Disease Registry. U.S. Department of Health & Human Services.3 May 2023