Impact Of Chronic Arsenic Toxicity on Human Health- A Review

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ABSTRACT

The levels of heavy metals in ground water continue to be higher than those considered acceptable by regulatory agencies in different countries across the world. One of the most important public health problems in the world is chronic arsenic poisoning, or arsenicosis, caused by drinking water that has been poisoned with arsenic. Arsenic poisoning over time has been related to a number of cancers of the skin, oral cavity, urinary bladder, kidney, and lung in addition to bone marrow depression, Blackfoot disease, cardiovascular disease, diabetes, hypertension, and a host of other ailments. In addition, arsenic causes DNA damage that has genotoxic effects. Around the world, 137 million people in 70 different nations depend on drinking water that has been drawn from severely contaminated groundwater. The two nations that have been affected the most so far are Bangladesh and West Bengal, India. The drinking water of 26 million people in nine districts of West Bengal contains levels of arsenic that are significantly higher than the WHO-acceptable limit of 10 g/l. The review focuses on the impact of chronic arsenic toxicity on public health worldwide.

Keywords: Heavy metal, chronic arsenic, arsenicosis, cancer, genotoxicity, acceptable limit.

INTRODUCTION:

Arsenic (As) poisoning is a known risk factor that could affect millions of individuals worldwide. Whereas more than 2.5 billion people rely on groundwater for drinking and other domestic uses, arsenic pollution can be caused by mining and other industrial operations as well as naturally occurring geological sources of arsenic seeping into aquifers (Shaji et al., 2021). The most common way that people are exposed to arsenic is via drinking groundwater that has been poisoned with it (Yu et al., 2018). Arsenic pollution in groundwater has been documented in more than 108 countries, with levels over the WHO's tolerable guideline of 10 g/l (Shaji et al., 2021). The amount of chronically contaminated groundwater, according to Guha Mazumder and Dasgupta, varies from 0.05 to 3.2 mg/l in numerous West Bengal districts (2011). The focus of this review endeavour will be on the long-term toxicity of groundwater in West Bengal and other parts of India that has been exposed to chronic arsenic contamination. Arsenic poisoning symptoms rarely show up immediately away. This study will reduce the risk of catching numerous diseases by increasing awareness among rural and illiterate populations and enhancing water quality.

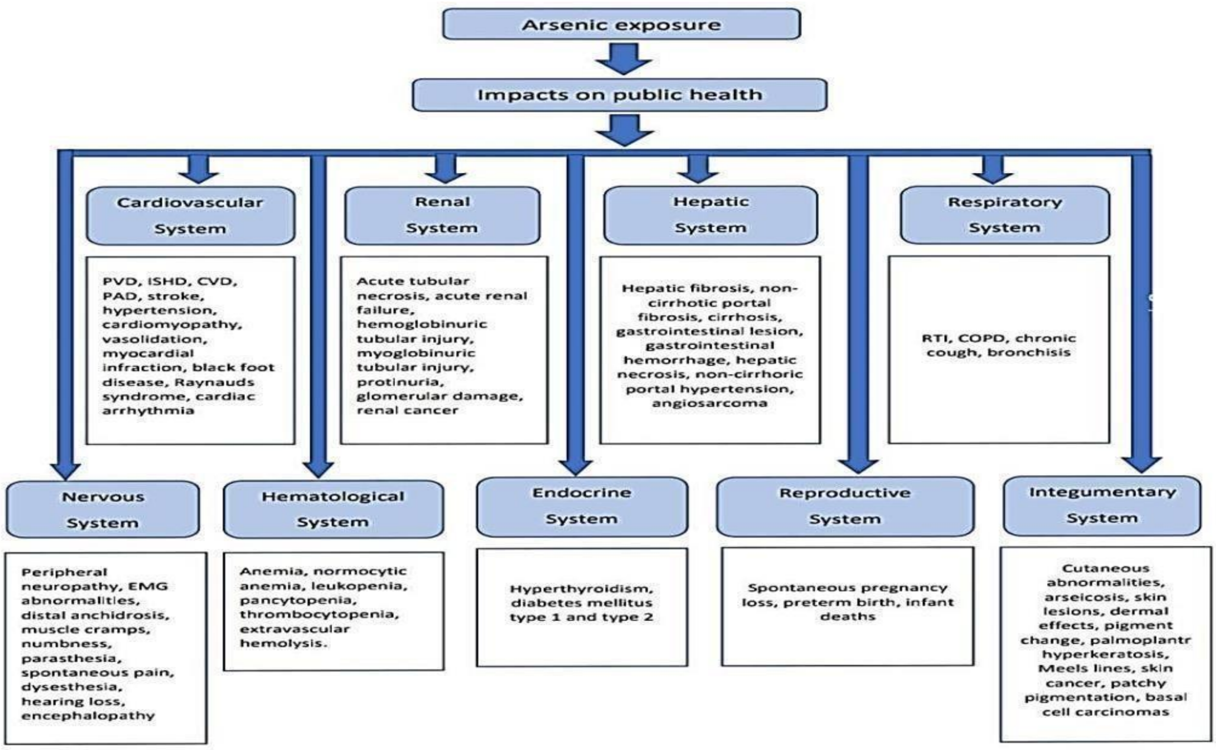
MATERIALS AND METHODS: The right information for this review article was found by searching in Pubmed, Pubmed Central, CDC, and Google for published research works on chronic arsenic contamination and the relationship between its toxicity and various diseases, including cancer. These research works took the form of original studies and review articles from all over the world. Only data that have been published were considered, and vague descriptions of exposure were excluded. Information acquired from reputable sources of publications on the subject is one of the inclusion criteria. Other languages were not included in the study.

RESULTS AND DISCUSSION:

Chronic Arsenic Toxicity:

Impact of chronic arsenic toxicity- Environmental heavy metal pollution has significantly increased during the last few decades. Arsenic is one of the most dangerous heavy metals and one of the worst environmental contaminants in the world. It is a chronic bioaccumulative carcinogen (Kaur et al., 2011). Inorganic arsenic is more hazardous even though organic arsenic molecules are less lethal (Shaji et al., 2021). Arsenate and arsenite are the two primary inorganic forms of this hazardous metalloid. Arsenite interferes with phosphate uptake and use in cells, whereas arsenate works as a phosphate analogue and affects enzymatic processes in cells. Due to the widespread presence of metalloid arsenic in the environment, people frequently come into contact with it. Arsenic can take on many different chemical forms and oxidation states and has harmful short- and long-term health effects, including cancer. Chronic exposure to inorganic arsenic has been linked to a number of malignancies, including skin, lung, kidney, and oral cavity cancers, \according to Ferreccio and Sancha (2006) and Hong et al. (2014). (Pal et al., 2017). Additionally, arsenic causes genotoxicity by altering and damaging DNA (Faita et al., 2013). Guha Mazumder and Dasgupta indicate chromosomal abnormality (Faita et al., 2013) and an elevated frequency of micronuclei in a range of cell types as two of the several genotoxic consequences of arsenic in humans (2011). Figure 1 illustrates how arsenic can have negative impacts.

Fig. 1. The effects of As poisoning on human health are depicted in a flow chart (modified from Shaji *et al*., 2021).



Spread of chronic arsenic contamination globally-Groundwater pollution with arsenic concentrations over the WHO's permissible threshold of 10 g/l has been documented in more than 108 countries (Shaji et al., 2021). The continents of Asia, Europe, South America, Africa, Australia, and North America are among those having the highest arsenic contamination levels. Elevated arsenic levels in drinking water affect a large number of individuals worldwide. Over 100 million people worldwide are expected to be exposed to arsenic due to groundwater pollution (Faita et al., 2013). 4 million people in Argentina from chronic arsenic poisoning. The amount of arsenic pollution in the water samples from the state of Buenos Aires was significantly higher than the WHO's 10 g/l cutoff point. In exposed locations, arsenicosis was 2.6% prevalent. According to multiple studies conducted in US communities, skin cancer can occur at arsenic concentrations as low as 10 g/l in some circumstances (Mayer et al., 2016). North America has one of the highest levels of arsenic contamination in the entire planet. There have also been reports of dangerous amounts of arsenic in the groundwater in other Canadian and American states. Numerous studies indicate arsenic poisoning in various foods and drinking water in Canada and the United States, according to Jankovic (2020). Chile's drinking water contained 50 g/l of arsenic. In both children and adults, Ferreccio and Sancha discovered lung and bladder cancers as chronic side effects in addition to the acute skin lesions, bronchiectasis, and premature cardiac infarction (2006). Numerous diseases, both carcinogenic and non-cancerous, were brought on by long-term As exposure, including the famed Blackfoot disease, which is exclusively found in Taiwan's high-As regions (Lan et al., 2011). The public's health in Nepal is at risk due to groundwater poisoning with arsenic, particularly in the 20 Terai districts. More than 30 million individuals, on average, reportedly drink water that has more than 50 g/L of arsenic. Figure 2 shows the arsenic contamination in several nations throughout the world.

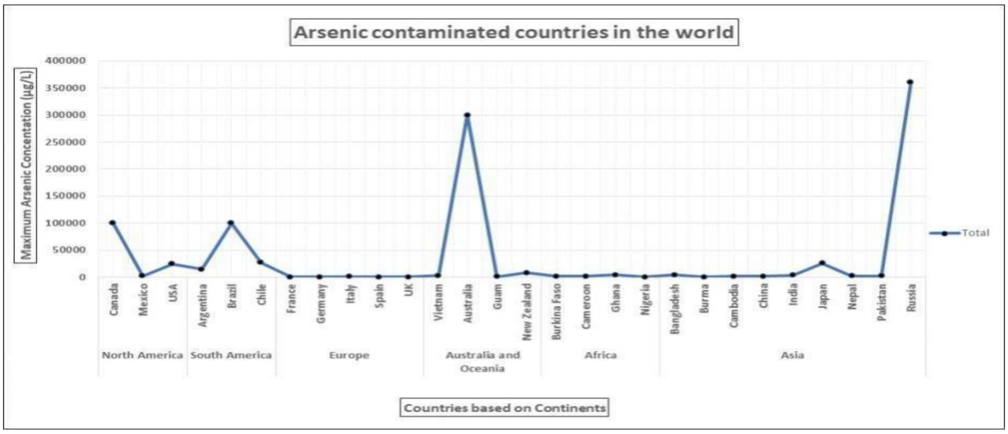


Fig. 2. Graphical representation of maximum arsenic contaminated groundwater concentrations by countries across the world,prepared from the literature data.

Spread of chronic arsenic contamination in India–India's water needs, including those of homes, industries, and irrigation systems, are largely met by groundwater. Northern and Northwestern India receive the majority of the extraction, which significantly lowers the water table in numerous places throughout the Indo-Gangetic basin (Shaji et al., 2021). Studies show that the risk of groundwater pollution with arsenic is currently present for almost 50 million people in India. Numerous scientists in India have conducted in-depth studies on the arsenic contamination of groundwater, particularly in the Ganga basin. The Ganga River basin, which makes up around 26% of India's total land area, is home to more than 500 million people (Chakraborti et al., 2018). The first case of groundwater contamination was discovered in the area near Chandigarh in north India, while the second case was discovered in West Bengal in eastern India. Figure 3 shows the level of arsenic contamination in India. However, according to our analysis, 20 Indian states (West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam, Gujarat, Haryana, Madhya Pradesh, Panjab, Arunachal Pradesh, Karnataka, Tamil Nadu, Himachal Pradesh, Telangana, Andhra Pradesh, Orissa, Nagaland, Tripura, Manipur, Chhattisgarh and Delhi, Daman and Diu, Puducherry, Jammu & Kashmir the four Union territories are presently affected (Shaji *et al*., 2021).

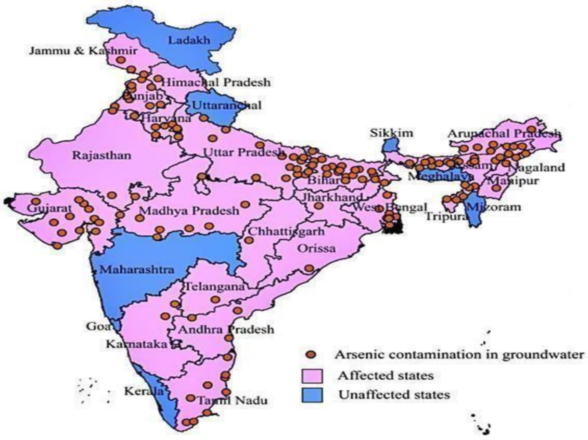
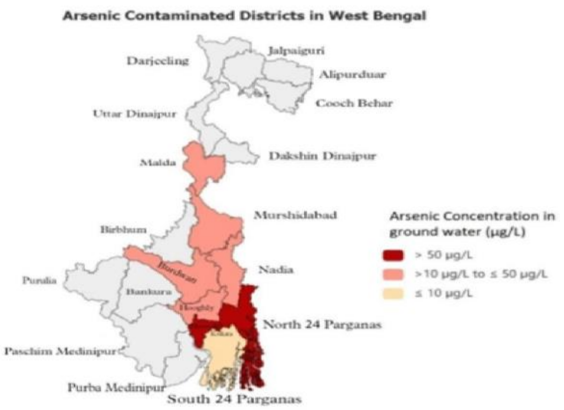


Fig. 3. Map of India showing arsenic affected areas in India (modified from Shaji *et al*., 2021)



In West Bengal, the first signs of groundwater poisoning with arsenic were discovered in 1978, and the 2001 census shows that

16.66 million people in eight districts are at danger. The abandoned meander belt in West Bengal is mostly to blame for areas where the groundwater is tainted with arsenic. Arsenic comes from the earth. Significant quantities of arsenic have been found in the groundwater in the districts of Nadia, Howrah, North 24 Parganas, Hooghly, Burdwan, and Kolkata. The Burdwan region had the highest amounts of groundwater arsenic, followed by Kolkata (Shaji et al., 2021). In six West Bengal districts, the level of chronic arsenic contamination in the water ranges from 0.05 to 3.2 mg/l. Figure 4 shows the level of arsenic contamination in several West Bengal districts.

Fig. 4. Map of West Bengal prepared from data of literature regarding arsenic affected districts

CONCLUSION: Many nations throughout the world have been plagued by persistent arsenic poisoning; in particular, Bangladesh and the Indian state of West Bengal are affected areas. Many individuals drink untreated groundwater. As a result, whereas the effects of acute arsenic toxicity can be seen almost immediately, those of chronic arsenic toxicity may go unnoticed for a long time and culminate in a variety of illnesses, including cancer and genotoxic effects. To that end, this study will present a societal message for the benefit of people's good nature. In order to properly treat groundwater, control arsenic leaching, and raise awareness among the public about using contaminated groundwater, appropriate measures must be adopted.

FUTURE SCOPE: Although traditional methods are used often, they have a variety of drawbacks. The majority of the time, a pre-oxidation phase utilizing chemical oxidants like ozone, chlorine, or hydrogen peroxide is necessary. Sludge and harmful byproducts are created during redox reactions as well as other treatments including precipitation and coagulation/filtration. Other reported issues with arsenic removal technologies include limited efficacy (lime softening and alumina adsorption), need for pH adjustment in coagulation, need for reagent regeneration in adsorption technique, membrane fouling in reverse osmosis, and interference from suspended solids, dissolved solids, and other inorganic ions in the ion exchange process. The greatest alternative and most affordable arsenic removal technique may be bioremediation, which uses naturally occurring organisms alone or in conjunction with dead biomass/biomass residues. Although a number of microbes are reported to remediate the arsenic from ground water already. It is necessary to look for other efficient microbes for the detoxification and degradation of arsenic which are still undefined. Understanding their genetics and biochemistry will result in developing appropriate bioremediation strategies, thus, preserving the chronic impacts of arsenic. More eco-friendly and cost-effective ground water treatment technologies must be used.

Conflict of Interest: There is no conflict of interest declared by the authors.

Author Contributions: Acquisition and interpretation of data is done by Rupesh Dutta Banik, Uparna Dutta, Sneha Sahani, Shreya Sahaand Subhankar Paul. Conception, design and revising of the article are done by Dr. Pritha Pal and Dr. Sibashish Baksi.

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