Study Of Extent of Global Uranium Contamination in Groundwater

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ABSTRACT: Uranium exposure can result in health risks in both natural and anthropogenic contexts, due to its chemotoxicity and radiotoxicity. The former is anticipated to play a larger role in natural uranium exposure, whilst the latter is more significant in enriched uranium exposure. The largest consumer of groundwater worldwide is India. India is responsible for 85% of the world's freshwater supply and 60% of irrigated agriculture. Uranium is absorbed into the body through contaminated food or uranium-affected water, offering a health danger to humans who may be exposed to high quantities of uranium through their drinking water. The health effects of uranium exposure include leukaemia, prostate cancer, breast cancer, colorectal cancer, lung cancer, kidney cancer, and bladder cancer. Evidence also suggests that drinking water contaminated with uranium might result in chronic renal disease, bone malformations, and liver damage. Uranium in drinking water must not exceed a WHO standard of 30 g/L. Uranium pollution is highest in China, the United States, Germany, Spain, Korea, Myanmar, Mongolia, Burundi, and other nations worldwide. In 151 districts across 18 states in India, high quantities of uranium have been found in ground water. This review focuses on impact of this metal contamination worldwide.

Keywords: *Uranium contamination, health risk, chemotoxicity, radiotoxicity, India, world*

INTRODUCTION:

Geological deposits and geochemical processes have led to the predominance of uranium (U) in the natural environment, which may be quantified as either a radionuclide in radioactivity (Bq) or chemicals in mass (Vodyanitskii 2011; Bjorklund et al. 2020). (g). Low amounts of uranium, a naturally occurring radioactive metal, are scattered throughout the earth's crust. Uranium is obtained by a number of human-made processes, such as mining, milling, mineral sands, and ore; its ground water may result from the fabrication of fertilisers. It is economically produced from uranium-bearing minerals like uraninite and is found in soil, rocks, granites, and water. The hexavalent state is particularly relevant in water due to its solubility because the tetravalent state is almost insoluble in water. The two most important organs to be harmed by uranium exposure are the kidneys and lungs since it is toxic both chemically and radiologically (ATSDR, 1990, 1999; WHO, 1998). 80% of all human sickness, according to the World Health Organization, is caused by deteriorating drinking water quality. Normal uranium intake from the air and water is relatively low, however excessive uranium intake from drinking water is harmful to human health. Most sources of drinking water contain radioactive contaminants in quantities safe for human consumption. In several parts of the world, including India, elevated quantities of uranium have been found in drinking water. Uranium standards for drinking water have been set at 30 micrograms per litre by the USEPA and WHO. The Atomic Energy Regulatory Board has established the upper limit for uranium in drinking water at 60 micrograms per litre. Bureau of India standards do not provide information about the uranium level. Alpha rays with a high ionisation strength are released by uranium nuclides and are taken in in higher concentrations. According to estimates, only 15% of ingested uranium comes through food, whereas 85% comes from drinking water (Cothern and Lappenbusch 1983). A dose of roughly 0.1 mg/kg of body weight of soluble natural uranium damages the kidneys chemically temporarily (Tanner 1980). There is no established threshold for the nephrotoxic effects of uranium in drinking water (Kurttio et al.2005). The purpose of the study is to gather data on uranium contamination of ground water in affected areas around the world, including India.

MATERIALS AND METHODS:

Searching Pubmed, Pubmed Central, CDC, and Google for published research papers on chronic arsenic poisoning and the connection between its toxicity and numerous disorders, including cancer, yielded the pertinent data for this review study. These research projects take the shape of original studies and international reviews. Vulgar descriptions of exposure were disregarded in favour of only published data. One of the inclusion criteria is data obtained from reliable sources of publications on the issue. The study did not cover any other languages.

RESULTS AND DISCUSSION:

Uranium contamination:

Uranium salt, which generates ions with oxidation states of +4(UO2 and U4+) and +6(UO3 and UO22+), is the most soluble radionuclide (Banks et al. 1995). The uranyl ion, which is soluble in groundwater, is produced when uranium forms an aerobic bond with oxygen. Whereas almost all natural streams include the lithophile element uranium, its concentration in groundwater depends on the lithology, geomorphology, and other geological factors of the area (Sridhar Babu et al.2008). Worldwide, uranium pollution poses a serious threat to the public's health. Major causes of uranium pollution, whether natural or human-made, include mining, phosphate fertilisers, nuclear power plants, and military operations. According to information from the Department of Atomic Energy, a high uranium content in drinking water may have negative effects on people's health. Health research conducted elsewhere in the world imply that kidney damage may be related to elevated uranium levels in drinking water. The influence of uranium exposure on human health is demonstrated by the fact that drinking water contaminated with uranium can result in chronic kidney illness, bone and liver deformities, and other health problems. The allowed limit for uranium (U) in drinking water was set by the World Health Organization (WHO) at 30 micrograms per litre (ppb). The kidneys and lungs, two of the most significant target organs, are affected chemically and radioactively by the buildup of U in the human body. U is most frequently ingested through drinking water, which accounts for 85% of all U absorbed; the remaining 15% is ingested through food. The published literature on this topic from 2000 to 2019 was summarised based on the Web of Science database, the most recent understanding of the health effects of uranium pollution, notwithstanding its radioactive or chemical hazards. The two most frequent sources of uranium contamination are mining (41.14%) and groundwater (39.67%), followed by fertiliser (7.57%), nuclear facilities (7.25%), and the military (4.36%). In the first two of these situations, natural human uranium exposure occurs primarily through water and food consumption (UNSCEAR, 2016; WHO, 2001). The buildup and retention of uranium in tissues or organs (such as the kidney, liver, and bone) might then continue for days to years (ATSDR, 2013), with unpredictable severe implications on health. According to epidemiological and laboratory investigations, uranium poisoning primarily affects the kidney (36.22 percent), bone (19.48 percent), liver (17.58 percent), reproductive system (13.90 percent), lung (7.24 percent), and neurological system (5.58 percent). The study found that uranium has no role in animals' typical biochemical reactions or metabolic processes (Ansoborlo et al. 2006). Oxidative stress (33.86%), protein interaction (21.52%), metabolic problem (13.39%), cell death (13.25%), genetic damage (11.42%), and inflammation (6.56%) are all possible effects of excess uranium (Lin 2020, Asic et al.2017, Gao et al. 2019, Asghari et al. 2015, Shaki et al. 2019, Shaki et al. 2019). Even Nevertheless, research into the toxicological mechanism of uranium is still in its early phases, but interest is growing. The metal induced health problems is depicted in Figure 1.

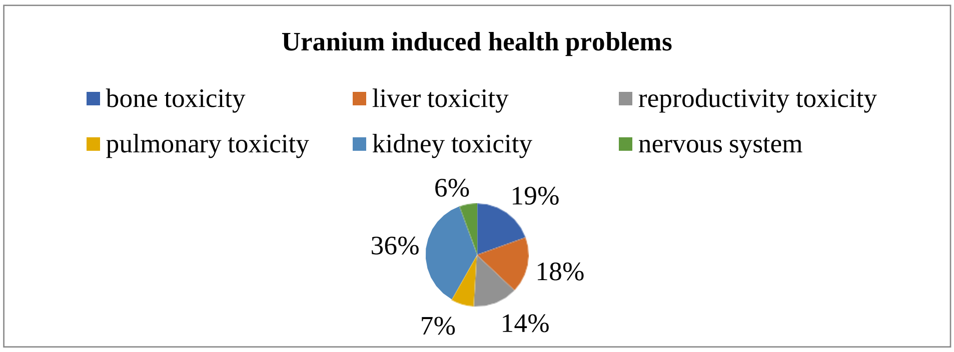

Fig. 1. Pie chart showing that uranium induced health problems

Uranium contamination worldwide- Groundwater has been found to have a wide range of uranium amounts, with pH and hazardous conditions having a significant impact (Coyte and Vengosh 2020, Seder-Colomina et al. 2018). Uranium contamination in groundwater is a growing concern for global health due to geologic processes (Jakhu et al. 2016, Guo et al. 2018, Birke et al. 2010, Wu et al. 2014, Coyte et al. 2018, Nolan and Weber 2015, Nriagu et al. 2012, Post et al. 2017, Steffanowski and Banning 2017, Navarro et al. 2016, Bacquart et al. To ensure the safety of drinking water, the World Health Organization's (WHO) drinking water standard has previously undergone many updates (Ansoborlo et al. 2015). The World Health Organization (WHO) has undergone several changes in the past (Ansoborlo et al. 2015). Based on chemotoxicity rather than radiotoxicity, the World Health Organization (WHO) and the United States Environmental Protection Agency (US EPA) have recommended that the uranium concentration in drinking water not exceed 30 microg/L. The local population in locations with uranium contamination generally consumes uranium-contaminated food or water (WHO 2001). Germany's tap and bottled water uranium contents were found to be between 0.0005 and 16 microg/L (mean of 0.17 and 0.00115 and 0.073 microg/L, respectively) (Birke et al. 2010). A concentration of more than 2 microg/L was found in more than 10% of bottle-tested water, making it unsuitable for use in infant food production. The Nambe region of northern New Mexico, United States, had the greatest concentration of uranium- contaminated well water, which served as the main supply of drinking water for the local population. This concentration was 1200 microg/L. (Hakonson-Hayes et al. 2002). Also, data from two significant U.S. aquifers, the High Plains and Central Valley aquifers, revealed that these regions had the highest uranium contents, which were, respectively, 2674 microg/L and 5400 microg/L. (Nolan and Weber 2015). Additionally, it was calculated that the combined surface area of these two aquifers' groundwater was contaminated beyond WHO and US EPA safety criteria, and that 1.9 million people lived within one kilometre of the contaminated groundwater. A study of high-level uranium sites in Korea found that 160 of 4140 wells, the bulk of which were located in the plutonic bedrock region, had groundwater uranium content that was higher than the WHO standard (Shin et al. 2016). In the Hetao sedimentary basin in northwest China, where there are numerous wells that provide drinking water, uranium contamination of groundwater is frequent (Wu et al. 2014, Guo et al. 2018). For instance, the Hetao basin's groundwater had a uranium concentration that varied from 0.23 to 246 microg/L. (Wu et al. 2014, Guo et al. 2018). Uranium values in the Ridaura basin in Spain range from 0.258 to 152 micrograms per litre, making it a contaminated area (Steffanowski and Banning 2017). Uranium concentrations ranging from 0-3610 micrograms per litre have an impact on Korea (Magdo et al. 2007). Myingyan City, Mandalay Division, central Burna, with a range of 1 to 45 (microgram per litre), is the affected area in the case of Myanmar (Navarro et al. 2016). With a range of 0.01 to 57, Ulaanbaatar in Mongolia is the area most affected (Nolan and Weber 2015). The affected region in Burundi is Kirundo, with a range of 0.238 to 734 (Nriagu et al. 2012). Kosovo (0.012-166 micrograms per litre; Berisha and Goessler 2013), Korea (0.002-402.3 micrograms per litre; Kim et al. 2004), and Finland have all been reported to have higher uranium amounts (0.002–6000 microgram per litre). The global scenario of uranium contamination is depicted in Figure 2.

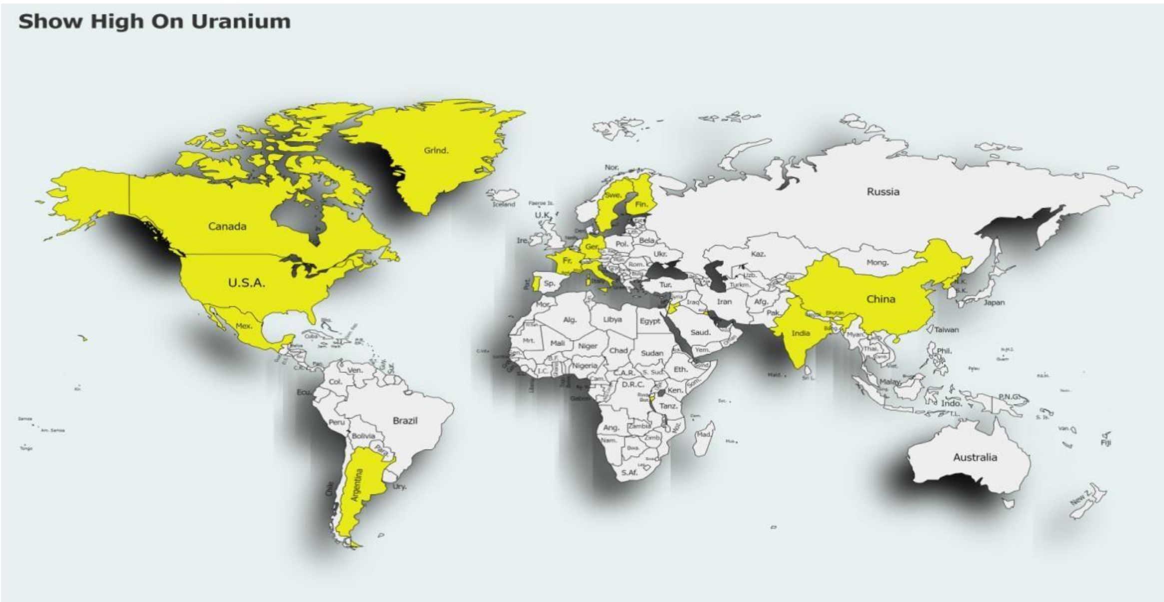

Fig. 2. Global map showing uranium contamination worldwide

Uranium Contamination in India- The WHO limits the amount of uranium in drinking water to 30 micro mega per litre. The states with the highest percentage of wells with uranium concentrations above 30 micro mega per litre are Rajasthan (7.2%), Andhra Pradesh (4.9%), Uttar Pradesh (4.4%), Punjab (24.2%), Delhi (11.7%), Haryana (19.6%), and Telangana (10.1%). A radiologically based limit for uranium in drinking water has been established by the Atomic Energy Regulatory Board (AERB) at 60 mg/liter (ppb) [AERB, DAE (2004)]. . A radiologically based limit for uranium in drinking water has been established by the Atomic Energy Regulatory Board (AERB) at 60 mg/liter (ppb). The states that are most affected are Punjab (60 percent of wells have levels above 60 ppb), Haryana (4.4 percent), Uttar Pradesh (0.4 percent), Jharkhand (0.25%), Madhya Pradesh (0.6 percent), Karnataka (0.7 percent), Tamil Nadu (0.9 percent), Chhattisgarh (1.1 percent), Andhra Pradesh (2.0 percent), Rajasthan (1.2 percent), and Telangana (2.6 percent). Other states with uranium pollution exceeding the 30 microgram per litre criterion include Gujarat (0.9%), Madhya Pradesh (1.3%), Tamil Nadu (1.6%), Jharkhand (1.5%), and Chhattisgarh (1.3%). Karnataka (1.9%),
Madhya Pradesh (1.3%), Himachal Pradesh (0.8%), Maharashtra (0.3 %), Odisha (0.4 %), West Bengal (0.1 %), Bihar (1.7
%) and Tamil Nadu (1.6%) are also affected. Drinking water with a uranium content of more than 30 microg/L is not advised [WHO (World Health Organization) 2011] because it could damage internal organs like the kidney (Zielinski et al. 1998). The Indian scenario of uranium contamination is depicted in Figure 3.

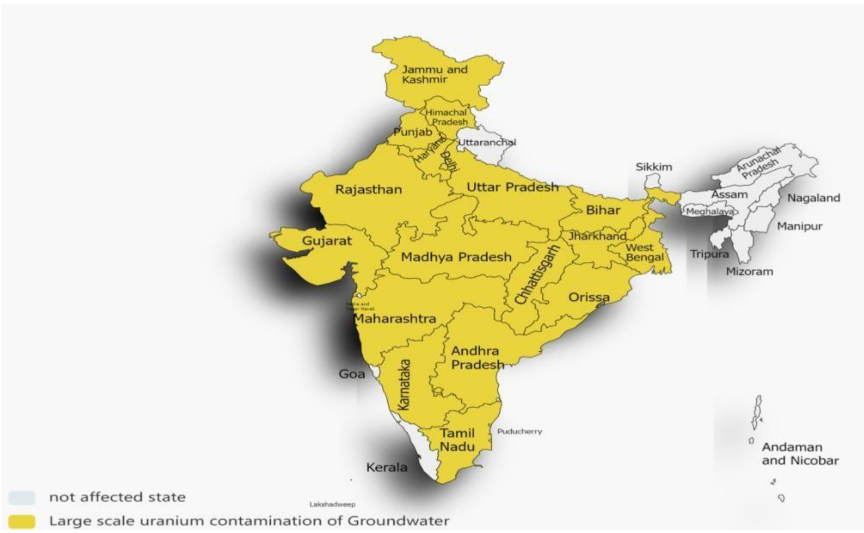

Fig. 3. Map of India showing that large scales uranium contamination of groundwater in India

CONCLUSION: One of our most important sources of irrigation water is ground water, and it is vulnerable to pollution. Many people consume untreated groundwater. Studies show that uranium in drinking water promotes nephritis. The immediate side effects include dizziness, headaches, low-grade fever, and vomiting. Yet long-term exposure can also lead to renal impairment, liver, bone, and lung cancer, among other problems. As a result, the results of the uranium experiment could predict long-term effects and the emergence of a number of diseases, including cancer. According to the research, contamination of ground water can result in low-quality drinking water, a loss of water supply, a damaged surface water system, high remediation costs, high costs for alternative water supplies, and a possible health risk. Point-of-use water filtration devices are the greatest way to lower uranium levels in drinking water if they are greater than the allowed threshold. In water, the uranium compounds that result from uranium reactions with other elements and substances dissolve to varying degrees. The mobility and toxicity of a uranium compound depend on how easily it dissolves in water. The review intends to spread goodwill among people by sending them a social message that effective groundwater treatment can control the metal contamination in groundwater.

FUTURE SCOPE: Even while traditional approaches are frequently employed, they have a number of disadvantages. A pre- oxidation phase using chemical oxidants such ozone, chlorine, or hydrogen peroxide is typically required. Redox reactions, as well as other processes like precipitation and coagulation/filtration, produce sludge and hazardous byproducts. Other reported problems with arsenic removal technologies include their limited efficacy (lime softening and alumina adsorption), the requirement for pH adjustment in coagulation, the requirement 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. Bioremediation, which makes use of living organisms alone or in combination with dead biomass/biomass residues, is perhaps the best alternative and most cost-effective method of removing arsenic from the environment. It is vital to look for additional effective microorganisms for the metal's still-unknown detoxification and breakdown. The development of appropriate bioremediation techniques will come from an understanding of their genetic make-up and biochemistry, protecting the long-term effects of uranium. We need to use more ground water treatment methods that are both economical and environmentally benign.

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

Author Contributions: Acquisition and interpretation of data is done by Madhusmita Padhi and Moumita Mukherjee. Conception, design and revising of the article are done by Dr. Pritha Pal and Dr. Sibashish Baksi.

ACKNOWLEDGEMENT: I would like to express my special thanks of gratitude to the higher dignitaries of Swami

Vivekananda University for allowing to carry out the study.

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