

EFFECT OF ARSENIC INGESTION ON MENTAL HEALTH: AN ANALYTICAL STUDY IN CHILDREN OF DIFFERENT VILLAGES OF BIHAR PLAINS

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Abstract

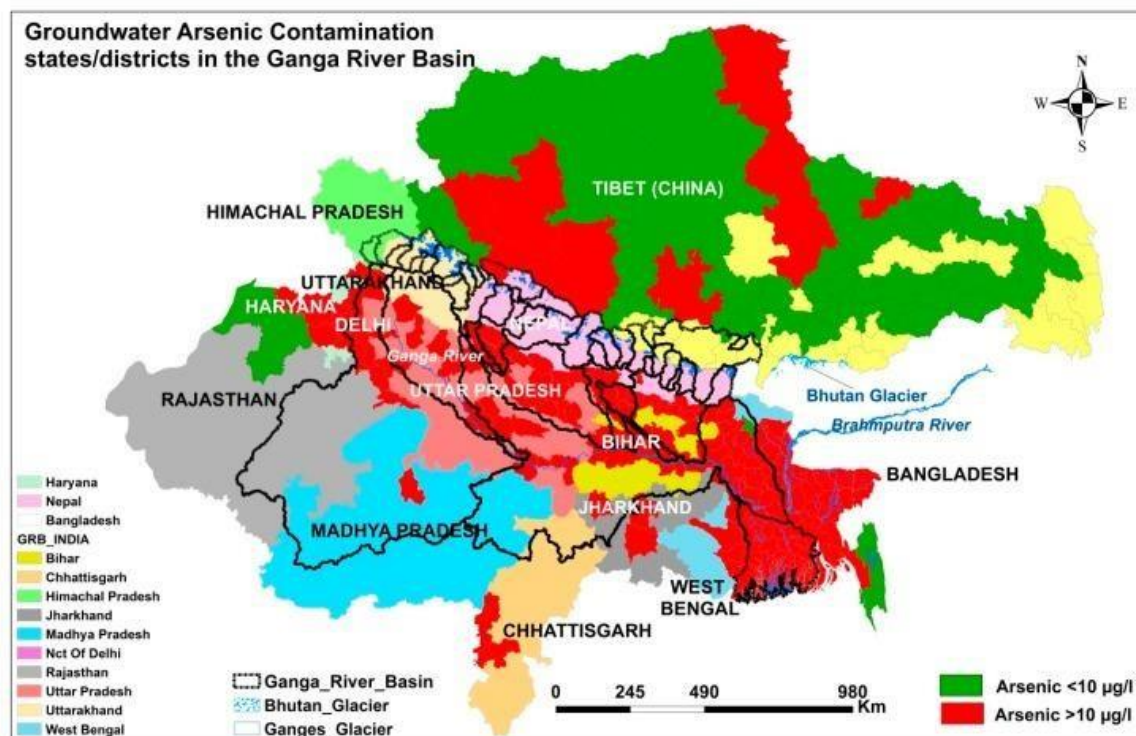
Bihar is one of the major arsenic-affected states of India. In arsenic-affected districts of Bihar, we got information on various problems i.e, not only physical harm but also so many types of mental illness. Unfortunately, the consequences of arsenic exposure on mental health have not been adequately studied. The present research aims to measure children's mental health in arsenic-affected districts of Bihar. 500 school children from 20 blocks were selected as samples for the study. Different Psychological tests were administered for the purpose of the study. The result revealed that in arsenic-affected districts of Bihar mental development was not according to the standardized level of development. Mental retardation and different developmental disabilities were found in children of the arsenic-affected district of Bihar.

Keywords: Arsenic, Mental health, development, children, Bihar

Statement of the problem- Arsenic toxicity has become a human health threat worldwide. In South Asia, arsenic contamination in groundwater in the Ganga- Brahmaputra fluvial plains in India and Padma-Meghna fluvial plains in Bangladesh has been found to have a huge impact on human health and its consequences have been reported as the world's biggest natural groundwater calamities. Millions of people in Bihar, India, are showing symptoms of arsenic poisoning, which can be linked to cancer, due to the consumption of contaminated drinking water. The state of Bihar, in eastern India, is one of the country's most impoverished states. More than 10 million people in the state are estimated to be threatened with arsenic poisoning or arsenicosis from contaminated groundwater.

Introduction- The Ganga River basin (GRB) is a part of the Ganga-Brahmaputra- Meghna (GBM) river basin, draining 1.08 million km² in Tibet, Nepal, India, and Bangladesh; it covers nearly 26% of India's land mass and is home to a population of over 500 million. Currently available scientific literature reveals that the Ganga is considered to be one of the world's most polluted rivers, containing a number of toxins including arsenic, cadmium, chromium, copper, lead, and mercury, as well as pesticides and pathogenic microbes nearly 3000 times greater than the safe limit

prescribed by the World Health Organization (WHO). In India, West Bengal, Jharkhand, Bihar, Uttar Pradesh in the flood plains of the Ganga, Assam and Manipur in the flood plains of the Brahmaputra and Imphal rivers and Rajnandgaon village in Chhattisgarh state have been reported to be affected by arsenic contamination in groundwater (Ghosh and Singh,).



Arsenic (As) is an odourless and tasteless metalloid widely distributed in the earth's crust. Arsenic in drinking water is absorbed through the intestine into the bloodstream through which it reaches the various organs. The human body normally gets rid of smaller amounts of arsenic through urine. However, if there are large amounts of arsenic, the remaining arsenic accumulates inside the body and can lead to adverse health effects. Arsenic causes or increases the risk of numerous illnesses. It leads to skin damage including keratosis and skin cancer, internal cancers such as that of the lung and bladder, and diseases of the vascular system. Arsenicosis is the medical word for arsenic poisoning, which occurs due to the accumulation of large amounts of arsenic in the body. The guideline value or maximum contaminant level (MCL) for arsenic in drinking water is 10 ppb (according to WHO) followed by most of the developed countries.

In developing countries including India and Bangladesh, 50 ppb is considered as the accepted level for arsenic in drinking water.

Exposure to arsenic leads to an accumulation of arsenic in tissues such as skin, hair, and nails, resulting in various clinical symptoms such as hyperpigmentation and keratosis. There is also an increased risk of skin, internal organs, and lung cancers. Cardiovascular disease and neuropathy have been linked to arsenic consumption. Verbal IQ and long-term memory can also be affected, and arsenic can suppress hormone regulation and hormone-mediated gene transcription.



Bihar

Bihar is one of the least developing states of India both in terms of per capita income and human development index. In the last few decades, pollution of water levels has increased due to excessive exploitation of groundwater resources for irrigation and drinking purposes, rapid increase in industrialization and urbanization. The groundwater level is falling in many parts due to excess draws leading to contamination problems.

with nitrate, fluoride, arsenic and other chemicals; this also contributes to contaminating potable water sources.

Bihar and a few other states of India face a severe problem due to the arsenic menace in groundwater. Groundwater is the main source of drinking water and it constitutes more than 80 per cent of drinking sources in rural Bihar. Around 40 percent districts of Bihar have reported arsenic in its groundwater. This comprises more than 67 blocks from 15 districts and covers more than 1600 habitations across the state where arsenic contamination in groundwater exceeds the Bureau of Indian Standard (BIS) limits for safe drinking water of 50 parts per billion (ppb) and more. If we consider the WHO limit of 10 ppb, the coverage area will be much more and the population which is facing the danger of arsenic hazard will be more than the BIS standard limit. It is estimated that more than 13.85 million people could be under the threat of contamination levels above 10 ppb/l, out of which more than 6.96 million people could be above 50 ppb/l, against the total population of these areas is around 50 million (Ministry of Water Resources, 2010). The actual problem of arsenic menace among the population will be more than the estimate due to the increase in the affected area after every new survey.



Out of seven states, two states of India namely Bihar and West Bengal are worst affected by arsenic contamination in their groundwater. Altogether more than 40 percent of the people from Bihar and West Bengal are affected by arsenic contamination in groundwater which causes serious threats to the people of the state in health and other hazards which act as threats to the socio-economic status of the affected people.

Table 3 presents the arsenic contamination problem in Bihar.

Table 3: Arsenic in Groundwater of Bihar (> 50 ppb/l)

District	Total blocks	Total affected blocks	Total surveyed habitation	Total affected habitation	Maximum concentration in ppb	Minimum concentration in ppb
Begusarai	18	4	174	84		
Bhagalpur	16	4	216	159		
Bhojpur	14	4	316	231	1630	BDL
Buxur	11	4	512	385	1400	BDL
Darbhanga	18	1	29	5	218	BDL
Katihar	16	5	112	26		
Khagaria	7	4	376	246		
Lakhisarai	7	3	320	204		
Munger	9	4	178	118		
Patna	23	4	218	65	1810	BDL
Samastipur	20	4	248	154	626	3
Saran	20	4	74	37	374	BDL
vaishali	16	5	173	76		
Total	195	50	2946	1590		

source: Public Health Engineering Department, Govt. of Bihar (2012)

Chronic arsenic exposure can cause many diseases, including various physical and psychological harms. Although the physical problems caused by arsenic toxicity are well reported in literature, unfortunately, the consequences of arsenic effect on mental health are not adequately studied (**Kapaz, Peterson, Liber, Bhattacharya, 2006**). In India, a cross-sectional study on 351 children (5-15 y.o.) exposed to an average of 147 $\mu\text{g/L}$ arsenic in water throughout development and childhood found an association between arsenic exposure and poor performance in several measures focusing on vocabulary, math skills, memory, and overall cognition; however, confidence intervals and the age range of participants in this study were broad (**Vonet al, 2007**). In India, over 1.5 million people have been exposed to high levels of

arsenic with more than 200,000 cases of arsenicosis. Cross-sectional analysis of over 1169 arsenicosis patients between the ages of 18-65 y.o. revealed that 19 % of patients developed some type of psychiatric disorder, compared to an average 7 % prevalence of mental disorders in India.

There are three possible channels through which unsafe arsenic levels in drinking water may affect mental health: physiological, social, and psychological. The physiological channel can occur due to two reasons: first, drinking arsenic-contaminated water may affect certain brain functions and in turn directly increase the probability of depression (Martinez et al., 2008). Second, individuals affected by arsenicosis may actually feel sick, which has been shown to be related to lower mental health (Dolan et al., 2008). Arsenic may affect individuals socially if arsenicosis patients suffer from discrimination and social exclusion. There is some evidence showing that arsenicosis is sometimes believed to be contagious and that victims are socially stigmatized (George et al., 2013; Hassan et al., 2005; Brinkel et al., 2009). Suffering from arsenicosis symptoms should therefore lead to a decrease in mental health. A third channel, which is somewhat connected to the other two but refers to a different mechanism, is the psychological channel. Individuals may start worrying about their health, future or family (Schwartz and Melech, 2000) when they or one of their family members have arsenicosis symptoms, or when they drink out of a red or unlabeled TW.4 Again arsenicosis symptoms would lead to lower mental health.

The arsenic problem also has a major effect on the socio-economic structure. The socio-economic problems can be mainly categorized into three classes: agricultural problems, health problems and other problems (Thakur et al. 2013). Excess presence of contaminated water leads to decreased agricultural productivity and soil fertility and enters into the food chain, creating health problems. Brammer (2008) suggested that in India, Nepal, and Bangladesh, arsenic contaminated water used for irrigation enters into the food chain. All these three problems lead to both social and economic problems. While skin lesions, bladder, cancer, and mortality are few of the resulting health problems, social ignorance, depression, and suicidal tendency are among the few social problems. The presence of arsenic in water or the environment does not preclude the presence of other elements; in fact, it is probable that a number of metals (Pb, Mn, Cd, Hg) are

comorbid in individuals with arsenic exposure in the studies provided here. Reports on developmental exposures to heavy metal mixtures suggest that combined exposure is associated with a greater risk for cognitive dysfunction, including behaviour and impaired neurological (CNS) development (**Rai, 2010**). The incidence of mental retardation is highly correlated with the presence of soil metals in rural areas (As, Cu, Pb, Mn, Hg), and the probability of intellectual disability in children increases as the concentration of arsenic and lead in the soil increases (**Mcdermot, 2011**).

Purpose of the study—The purpose of the present research was to measure the mental health of children in arsenic-affected districts of Bihar, and also to find out what other psychological problems they are facing currently. It was an attempt to study the mental health of arsenic-affected children, i.e. those children who have already developed physical symptoms of arsenic.

Hypotheses—The main hypotheses of the present research were as follows:-

- (a) Arsenic-affected children will be low on different dimensions on Mental health battery.
- (b) The effect of arsenic will be found on the attention capacity of the children.
- (c) Learning process in children will be affected by the effect of arsenic.
- (d) Mood disorders will be found in children living in arsenic-affected areas.
- (e) Arsenic effect will be seen in the memory, reading and visual perception of the children.

Methodology—

(A) Sample—500 school children from 20 blocks were selected as a sample for the study. They were in the age group of 10-15 years. The accidental cum purposive sampling technique has been used in the study. The sample has been taken from different arsenic-affected districts of Bihar.

(B) Tools—For the measurement of the mental health of students of minority and majority groups, MENTAL HEALTH BATTERY was used. This inventory

was developed by Dr. Arun Kumar Singh and Dr. Apana Sen Gupta (2000). The scale consists of 130 items which measure six dimensions of mental health—Emotional Stability (15 items), Overall Adjustment (40 items), Autonomy (15 items), Security Insecurity (15 items), Self Concept (15 items) and Intelligence (30 items). Scoring has been done with the help of the scoring key. A high score means better mental health. The reliability and validity of the scale are 0.87 and 0.61 respectively.

Apart from this, a personal data sheet was prepared to collect information about the cognitive problems of children in arsenic-affected areas. These cognitive problems included attention deficit, hyperactivity, learning deficits, mood disorder, memory deterioration, reading deficit, visual perception etc.

(C) Data collection procedure— The subjects were requested to respond honestly and genuinely on the items of the two questionnaires. Scoring has been made on the basis of answers given by the subjects. Data was obtained by analyzing the responses of the subjects.

Results - The results of the present study have been presented in tabular form with two tables- Table A and Table B.

Table- A

Scores of children on mental health battery

S. NO	Dimensions	Mean Scores	Description
1	Emotional Stability	8.32	Low
2	Overall Adjustment	15.62	Average
3	Autonomy	9.33	Low
4	Security Insecurity	10.48	Low
5	Self Concept	8.31	Low
6	Intelligence	11.15	Low

Table A presents the mean scores of arsenic-affected children on the six dimensions of the mental health battery. From the table, we can see that children have shown low mental health status. Of all the six dimensions, five dimensions have low scores. This is an alarming situation. It means that Children are emotionally unstable, and insecure, and have low autonomy, low self-concept and low intelligence. This confirms the first hypothesis of the study. We found that suffering from an arsenicosis symptom, even more so than other illnesses, is strongly positively related to mental health. The arsenic-affected people have skin diseases, cancer, and other physical problems which destruct their face and body image. They are socially ignored and hence they feel insecure. This obstructs their social life and they got mentally disturbed.

Table-B

Prevalence of cognitive problems among children of arsenic-affected areas.

S. N.	Cognitive problems	Total reports	Percentage
1	Attention deficit	290/500	58
2	Hyperactivity	221/500	44.2
3	Learning deficits	302/500	60.4
4	Mood disorder	248/500	49.6
5	Memory deterioration	316/500	63.2
6	Reading deficit	341/500	68.2
7	Visual perception	223/500	44.6

Table B shows the percentage of children facing different cognitive problems. It can be seen from the table that about 68.2% of children reported that they have a reading deficit. Also, 63.2% have memory deterioration. Learning deficits are prone in 60.4% of subjects. This supports the earlier research that reported poorer scores in arsenic-exposed children on measures of language and vocabulary and a modest association with hyperactive behaviour using the attention deficit hyperactive disorder (ADHD) index (**Roy et al, 2011**). Evidence presented suggests that chronic ingestion of arsenic alters a number of intelligence measures and induces learning deficits and mood disorders like depression. Researchers concluded that arsenic exposure was associated with a 0.4 decrease in IQ in exposed children (**Rodriguez-Barranco M,**

et al, 2013). These results confirm the second, third, fourth and fifth hypotheses of the present study.

Conclusion—Conclusively we can say that arsenic has a negative effect, physically as well as psychologically. It can produce many cognitive problems in the affected people. Chronic moderate exposure to arsenic, more so than high acute exposure, may induce greater harm to intellectual function in children. Access to safe and clean drinking water and sanitation are basic human needs. They are fundamentally linked to the health and well-being of the people. The majority of the people facing arsenic in their drinking water is from the poor socio-economic background. They are either not aware or if aware are forced to take drinking from the same source due to a lack of alternative sources of water. However, in Indian society, arsenicosis patients are able to maintain their traditions, kinship, and caste relations to cope with stress of the disease. Similar to observations of the general population, anxiety and depression were the most common psychiatric disorders in arsenicosis patients; however, lower SES, the diseases associated with arsenic poisoning, body image, and low self-esteem are predisposing factors of psychological issues in this population. A lot of broad research is needed in this field before it will become a major epidemic issue.

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