

Review Article

Effect of Drinking Arsenic Contaminated Water in Children

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Objective: Chronic arsenic toxicity due to drinking of arsenic contaminated water is a major environmental health hazard throughout the world including India. Though lot of information is available on health effects due to chronic arsenic toxicity in adults, knowledge of such effect on children is scanty. A review of available literature has been made to highlight the problem in children. **Review Methods:** Scientific publication in journals, monograph, thesis and proceedings of conferences on arsenic in regard to epidemiological, clinical and psychometric studies were reviewed. **Results:** Skin abnormalities including pigmentation change and keratosis are the diagnostic signs of chronic arsenic toxicity in adults. Incidence of skin manifestations vary between 1.9-37.1% in various arsenic exposed children populations in different regions of the world. Occurrence of chronic lung disease including pulmonary interstitial fibrosis was described in arsenic exposed children in Chile. Affection of intellectual function is also reported from Thailand, Bangladesh and India. **Conclusion:** Chronic arsenic toxicity due to drinking of arsenic contaminated water causes significant morbidity in children in different parts of the world.

Key words: Arsenicosis, Children.

Many aquifers in various parts of the world have been found to be contaminated with arsenic. Of these the most noteworthy occurrences are in large areas of India, Bangladesh, Taiwan and Northern China. Other Asian countries affected are Lao PDR, Cambodia, Myanmar, Pakistan, Nepal, Vietnam. Other countries having reports of significant arsenic contamination of ground water are Hungary, Mexico, USA, Chile and Argentina. In India over and above West Bengal, other states affected are

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Bihar, Uttar Pradesh, Jharkhand and Assam(1). There are sufficient evidence from human studies that chronic ingestion of inorganic arsenic causes cutaneous and systemic manifestations and skin, bladder and lung cancer in adults(2).

Skin abnormalities such as pigmentation changes and keratosis have long been known to be hallmark signs of chronic arsenic exposure in adults. These lesions are the most common health effect found in populations exposed to arsenic-contaminated drinking water. Pigmentation and keratoses caused by arsenic are quite distinctive. The hyperpigmentation is marked by raindrop-shaped discolored spots, diffuse dark brown spots or diffuse darkening of the skin on the limbs and trunk. Spotty depigmentation (Leucomelanosis) also occur in Arsenicosis. Simple keratosis usually appears as bilateral thickening of the palms and soles, while in nodular keratosis, small protrusions appear in the hands, feet, or the legs. Skin lesions pose an important public health problem because advanced forms of keratosis are painful, and the consequent disfigurement can lead to social isolation in the villages. In contrast to cancer which take decades to develop, these skin lesions are generally observed 5-10 years after exposure commences. Although limited epidemiological data exist, other reported clinical manifestations resulting from ingestion of arsenic-contaminated drinking water in adults include weakness, conjunctival congestion, hepatomegaly, portal hypertension, lung disease, polyneuropathy, solid edema of limbs and anemia(2,3).

Initial report of non-malignant pulmonary effect of chronic ingestion of arsenic by drinking arsenic contaminated water was available from studies in children in Chile as early as 1970. Rosenberg conducted autopsies on five children manifesting characteristic features of chronic arsenic toxicity, including pigmentation and/or keratosis. Lung tissue was examined in four of the five children, with abnormalities found in each and two having pulmonary interstitial fibrosis with mild bronchiectasis(4). Arsenical skin lesions were reported in 144 school children in Antofagasta, Chile during a

cross-sectional survey in 1976. The investigators further reported that chronic cough was complained of by 38.8% of children with skin lesion compared to 3.1% of children with normal skin(5).

Except from Chile, not much information was available previously in regard to the toxic effect of chronic arsenic exposure among children. Recent report of affection of children due to drinking of arsenic contaminated water was available from epidemiological studies carried out in S-24 Parganas, West Bengal, India. It was reported that pigmentation and keratosis were observed among boys and girls (age <9 yrs), who were exposed to arsenic above 50 $\mu\text{g/L}$, though less compared to adults. Nine (1.7%) out of 536 girls and 12 (1.9%) out of 613 boys below the age of 9 years had pigmentation due to exposure of high level of arsenic in water. The number of subjects with keratosis were 1 (0.2%) and 3 (0.48%) in girls and boys respectively(6). In another study in West Bengal, India 114 (3.7%) out of 6695 children below 11 years had evidences of arsenical skin disease. In Bangladesh, 298 (6.11%) out of 4877 children below 11 years were reported to have arsenical skin lesion due to drinking of arsenic contaminated water(7). However, the incidence of Arsenicosis in children was found to be much higher (12.2%) in Inner Mongolia, China when studied in a population of 728 subjects below 19 years who were exposed to arsenic(8). In a recent study carried out in Cambodia, much higher incidence of arsenic related skin lesion was also observed in children who were drinking arsenic contaminated water(9). Ten out of 27 (37.04%) children below 16 years of age were found to show evidences of arsenical skin lesions. From the reports available in the literature it appears that children are similarly affected as adults due to chronic arsenic exposure, though the incidence of arsenic related skin manifestation due to drinking of arsenic contaminated water varies in different countries.

Study report on children's intellectual function in the arsenic exposed region of Thailand was available for review(10). Chronic arsenic exposure assessed by hair concentrations was related to developmental retardation as judged by IQ measured by using the Wechsler Intelligence Scale test for children. Multiple classification analysis

was conducted with data from 529 children aged 6-9 years who had lived in Ronpiboon district since birth. The percentage of children in the average IQ group decreased remarkably from 56.8 to 40.0 as the arsenic level increased. After adjusting for confounders they observed a statistically significant relationship that arsenic could explain 14% of variance in children's IQ. The extent of arsenic exposure was difficult to assess. Hair concentrations were found to have an average of 2.42 mg/kg (range: 0.48-26.94 mg/kg) of arsenic, whereas normal was quoted as less than 1 mg/kg.

Another study was conducted on the effect of water arsenic exposure and children's intellectual function in Araihasar, Bangladesh(11). It was found that exposure to arsenic from drinking water was associated with reduced intellectual function in WISC III for children, in a dose response manner after adjustment for socio-demographic covariates and water Mn. Children with water arsenic levels >50 $\mu\text{g/L}$ achieved significantly lower performance and full-scale scores than did children with water arsenic level <50 $\mu\text{g/L}$. The association was generally stronger for well water arsenic than for urinary arsenic.

A cross-sectional study of intellectual development was done in West Bengal on 351 children aged 5-15 years in families selected from a surveyed source population of 7683 people(12) in West Bengal, India. Intellectual function was assessed based on 6 subsets from the Weschsler Intelligence Scale for children (WISC), the total Sentence recall test, the Colored Progressive Matrices (CPM) test and a Pegboard test. Information on socio-demographic factors was collected and height and weight were measured. Arsenic level in urine samples collected from the participants and water samples consumed by them were measured by AAS. Urinary arsenic concentrations stratified into tertiles showed an inverse trend with the vocabulary test scores, the object assembly test scores and the picture completion test scores, adjusted for potential confounders. This corresponds to a relative reduction of the mean scores related to exposure in the upper tertile in the vocabulary tests of 12.6%, in the object assembly test of 20.6% and in the picture completion test of 12.4%. Reduction in intellectual function scores, particularly the vocabulary and

What this Review Adds

- Chronic arsenic toxicity due to drinking of arsenic contaminated water causes significant morbidity in children characterized by skin pigmentation, keratosis and chronic lung disease.

picture completion test scores, were associated with increased urine arsenic concentrations, but not with various measures of water concentrations.

Arsenicosis has socio-economic effect on children. Children affected by pigmentation and/or keratosis due to chronic arsenic toxicity discourage them from attending school for fear of ridicule. Very often when a family member, especially an earning male member develops Arsenicosis, his treatment takes precedence over other expenses like children's schooling, which may be abandoned if the family cannot afford both. Children also may have to contribute to the family income, thus depriving them of education. Arsenicosis may force changes in responsibilities within and outside the home for victim as well as the rest of the family. The burden of the disease and its treatment, as well as the impact on households and their coping strategies, which vary with the victim's occupation and earning capacity.

Funding : None.

Competing interest : None.

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