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MINIREVIEW

Arsenicosis and malnutrition

Kunal Kanti Majumdar

Professor, Department of Community Medicine, KPC Medical College & Hospital, Jadavpur, Kolkata, India

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Arsenic exposure through drinking water is a major health problem affecting many countries in the World, viz., Bangladesh, India, Argentina, Mongolia, China, Chili, Thailand, Taiwan, Mexico, and some parts of USA.[1–4] Prolonged exposure of arsenic of 5–90 µg/kg body weight/day results in arsenicosis,[5] characterized by hyper- and hypo-pigmentation, keratosis, various systemic manifestations like weakness, anemia, chronic lung disease, peripheral neuropathy, liver fibrosis, gangrene of limbs, and cancers of skin, lungs and urinary bladder.[6–8] Studies on populations of Taiwan, India, and Argentina exposed to arsenic through drinking water have suggested that malnutrition increases the risk of arsenic-induced diseases.[9–13] Several human studies have identified associations between malnutrition and arsenic-induced skin lesions, skin cancer, and cardiovascular effects.[12,14,15] Literature surveys indicate arsenic resistance and its relation with nutritional status.[16–19] Laboratory experiments have demonstrated that specific micronutrients can modify arsenic metabolism and toxicity.[13] Inhabitants of Taiwan and the Antofagasta region in northern Chile with severe health effects due to ingestion of high arsenic contaminated drinking water were reported to have a poor nutritional status.[20]

Inorganic arsenic is metabolized to monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA), and this methylation facilitates urinary arsenic excretion, which is dependent on availability of S-adenosylmethionine (SAM). The methyl group from SAM may be derived from dietary components such as methionine, choline, folate, and other nutrients.[21,22] Dietary protein, iron, zinc, and niacin are associated with urinary excretion of MMA and DMA.[23] Previous studies suggest that persons with more complete methylation have a lower risk of adverse arsenic-related health outcomes.[24] Diet poor in methionine in protein is likely to decrease the ability to methylate arsenic and increase the arsenic toxicity.[25] Folate and cobalamin (vitamin B12) have been suggested to play an important role in the detoxification of ingested arsenic.[26] Studies carried out in experimental animals have shown that severe protein deficiencies can impair arsenic methylation and excretion.[22] Vitamin C reduces the toxicity of arsenic.[27]

Intake of carbohydrate, protein, animal protein, fat, vitamins, and minerals was estimated from a diet survey by 24-hour recall method in arsenic exposed study population of south 24 parganas and it was found in that study that deficiencies of some nutrients like animal protein, calcium, fiber, folate, and vitamin C may increase the risk of arsenic-induced skin lesions.[28] Some researchers have postulated that deficiencies in some nutrients such as beta-carotene, methionine, and zinc may increase susceptibility to arsenic-induced health effects.[13] Experimental animals with a low dietary intake of methionine, choline, and protein were found to have lowered methylation of inorganic arsenic.[22]

Nutrition surveys in eight states of India conducted by the National Nutrition Bureau of India revealed calorie consumption less than the RDA of energy (male—2875 and female—2225 kcal/day).[29] Studies in Murshidabad district of West Bengal revealed that in more than 50% of the household surveyed families with poor nutrition suffer more from arsenic toxicity.[27] Other studies also revealed that undernourishment was found to increase the risk of skin lesions and skin cancer in arsenic-exposed populations.[9,11,15] In Western States like Alaska, studies revealed that populations consuming high concentrations of arsenic from their drinking water often did not shown arsenical skin lesions .The reason may be their nutritional status.[30] Experimental research in animals has also found that low protein and amino acids in diets increase risks of arsenic related health effects.[12,22,31] The study conducted among residents of California where arsenic level in the drinking water supplies had been near 100 µg/l suggests that low intakes of dietary protein, iron, zinc and niacin lead to decreased production of DMA and increased level of MMA in arsenic exposed individuals.[32] Studies showed that consumption of high levels of niacin (vitamin B3) was associated with arsenic methylation.[33] There are studies indicating that consumption of a diet rich in riboflavin, pyridoxin, vitamin A, C, and E can significantly reduce the harmful effects of developments of skin lesions.[26] Other nutrients like niacin, iron, calcium, protein, and thiamin were also reported to be protective against arsenic toxicity.[34] Inadequate intake of folate, methionine, cysteine, vitamin B6 and B12, calories and proteins are associated with arsenic related health effects in humans.[12,22,34–36] It was experimentally proved that low zinc concentrations were found in blood and urine of arsenic effected patients.[37]

A cross-sectional study was conducted in Chakdah and Haringhata block of Nadia district of West Bengal to determine the dietary intake of nutrients and its correlation with manifestations of arsenicosis.

The study revealed that low socioeconomic status along with less dietary intake of calorie, protein and micronutrients may have a definite role in increasing the risk of development arsenicosis. It was found that there was significant difference in intake of protein along with micronutrients like thiamine, riboflavin, niacin, zinc, and choline in the diet of cases compared to exposed controls in both the sexes, indicating the probable role of above nutrients in development of diseases.[38]

Based on the above findings all patients living in arsenic endemic area should be advised to consume a variety of green leafy vegetables, locally available pulses and fruits rich in antioxidant and other micronutrients along with low-cost animal protein like egg, fish to decrease the susceptibility from arsenic-related health effects.

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Address for Correspondence:
Dr Kunal Kanti Majumdar,
Professor, Department of Community Medicine,
KPC Medical College & Hospital, Jadavpur, Kolkata, India.
E-mail: kunalmajumdar1@gmail.com, **Phone:** +91 9830401906.

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