


Chapter 4

Arsenic Exposures, Poisoning, and Threat to Human Health: Arsenic Affecting Human Health

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ABSTRACT

Arsenic (As) is a naturally occurring metalloid which induces high toxicity to both human and animal health. Although As has some applications in industrial, medicinal and agricultural fields, the increasing concentrations of As in drinking water sources had made it a potential threat to living organisms. Inorganic As is naturally present in groundwater and is adsorbed by plants and crops through the irrigation system. This leads to its accumulation in crops and translocation to humans and animals through food. Increased levels of As can cause various health disorders through acute and chronic exposures such as gastrointestinal, hepatic, respiratory, cardiovascular, integumentary, renal, neurological, and reproductive disorders including stillbirth and infant mortality. Arsenic is also capable of inducing epigenetic changes, thereby causing gene mutations. This chapter focuses on the possible sources of As, leading to environmental contamination and followed by its hazardous effects which pave the way to various human health manifestations.

INTRODUCTION

The earth's crust is naturally comprised of approximately 4.0×10^{16} kg of arsenic (As) (Jang et al., 2016; Bhattacharya et al., 2002). In the environment, As is released either by natural processes or anthropogenic actions and once released it cannot be degraded or destroyed. Hence, it circulates in the environment and further gets easy access to plants and crops through groundwater system and finally reaches human body. Inorganic forms of As such as trivalent Arsenite [As (III)] and pentavalent Arsenate [As (V)] are the most extensive and toxic forms present in groundwater than organic As. However, the food contains both organic and inorganic As (Naujokas et al., 2013). Inorganic As (As III and As V) gets dissolved in groundwater and pumped into sub-surface soils through the irrigation system. Since, groundwater is a major source of drinking water; the population in different parts of the world are exposed to high levels of As mainly through contaminated groundwater. The most As affected places documented till now include Chile, Hungary, Mexico, U.S.A, Vietnam, Argentina, Bangladesh, and India with maximum exposure in states of West Bengal (McCarty et al., 2011; Ghosh et al., 2017; 2018a, 2018b). The increasing acute and chronic effects of As on human health have resulted in the classification of As as a class I carcinogen by the International Agency of Research on Cancer (IARC; Hong et al., 2014).

Pyrite minerals are one of the major natural sources of As in environment, whereas, anthropogenic sources include agricultural chemicals such as pesticides, insecticides, and herbicides; mining, manufacturing industries, coal burning, copper chromate arsenic-treated wood and wood preservatives (Ravenscroft et al., 2011; Naujokas et al., 2013; Jiang et al., 2013). Thus, As contamination is an equally challenging threat to both human health and sustainable farming (Brammer, 2008).

Constant usage of As-contaminated groundwater for drinking and irrigation purposes has led to several health manifestations in human body, generally termed as arsenicosis (Pimparkar & Bhawe, 2010). This includes intestinal, renal, lung and bladder disorders, dermal effects and cancer in various organs. Arsenic toxicity also causes neurological dysfunction, cardiovascular diseases, and immunity-related disorders (Figure 1). Arsenic ingestion through water and food causes reproductive problems in men and women, with various maternity related issues in women such as stillbirth, early abortions, and premature birth. Notably, reports suggest that children from various As affected places may suffer from malnutrition, massive weight loss and finally death (Shankar et al., 2014; Jang et al., 2016).

This chapter aims at describing the various sources of As exposure which aids in understanding the role of human behaviour and activities in increasing global As issues. In addition, it highlights the acute and chronic health manifestations caused by As toxicity.

BACKGROUND: ARSENIC EXPOSURE

Arsenic Exposure Through Drinking Water

Water is an essential product for the sustainability of life and functioning of the global ecosystem. Ground or surface water supplies are sources of fresh water used for human activities. Other than surface water, groundwater is utilized as an important source for drinking purpose in many places around the world and As has been found in dissolved form or particulate form in many groundwater aquifers across the globe. The maximum contaminant level of As in potable water established by World Health Organisa-

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