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Review

Human health risks and socio-economic perspectives of arsenic exposure in Bangladesh: A scoping review

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ABSTRACT

Arsenic contamination of drinking water, which can occur naturally or because of human activities such as mining, is the single most important public health issue in Bangladesh. Fifty out of the 64 districts in the country have arsenic concentration of groundwater exceeding 50 μg L^{-1}, the Bangladeshi threshold, affecting 35–77 million people or 21–48% of the total population. Chronic arsenic exposure through drinking water and other dietary sources is an important public health issue worldwide affecting hundreds of millions of people. Consequently, arsenic poisoning has attracted the attention of researchers and has been profiled extensively in the literature. Most of the literature has focused on characterising arsenic poisoning and factors associated with it. However, studies examining the socio-economic aspects of chronic exposure of arsenic through either drinking water or foods remain underexplored. The objectives of this paper are (i) to review arsenic exposure pathways to humans; (ii) to summarise public health impacts of chronic arsenic exposure; and (iii) to examine socio-economic implications and consequences of arsenicosis with a focus on Bangladesh. This scoping review evaluates the contributions of different exposure pathways by analysing arsenic concentrations in dietary and non-dietary sources. The socio-economic consequences of arsenicosis disease in Bangladesh are discussed in this review by considering food habits, nutritional status, socio-economic conditions, and socio-cultural behaviours of the people of the country. The pathways of arsenic exposure in Bangladesh include drinking water, various plant foods and non-dietary sources such as soil. Arsenic affected people are often abandoned by the society, lose their jobs and get divorced and are forced to live a sub-standard life. The fragile public health system in Bangladesh has been burdened by the management of thousands of arsenicosis victims in Bangladesh.

1. Introduction

Arsenic is ubiquitous in the earth's crust, although generally constitutes less than 1% of most rocks, coals, and soils (Alam et al., 2002). Although the occurrence of arsenic in the environment is mainly from minerals and geogenic sources, human activities resulted in extensive soil and water contaminations in many parts of the world (Smith et al., 1998).

Groundwater contamination with high level of arsenic is an important environmental and public health issue in South and South-East Asian countries (Chakraborti et al., 2015). It is the single most important public health problem in Bangladesh, with between 35 and 77 million of its population being at risk of arsenic poisoning from arsenic-contaminated drinking water (Edmunds et al., 2015). In 2000, the World Health Organization (WHO) stated that Bangladesh has been experiencing "the largest mass poisoning of arsenic of population in history" (Smith et al., 2000).

The rural people of Bangladesh have mainly depended on surface water to meet drinking water needs. Such surface water has often been contaminated by pathogen. However, from the 1960's hand-pumped tube wells were widely introduced in the rural areas of Bangladesh especially by government and non-government agencies to provide pathogen-free drinking water. This practice accelerated significantly from the 1980s onwards as the installation of tube wells became relatively cheap and the technology became easily available (Edmunds et al., 2015). This led to a significant increase in the access of underground drinking water from the shallow alluvial aquifers (Smedley and Kinniburgh, 2002) (Fig. 1).

Chronic arsenic poisoning was first identified in West Bengal of India in the 1980s; however, the first diagnosis of arsenic poisoning in

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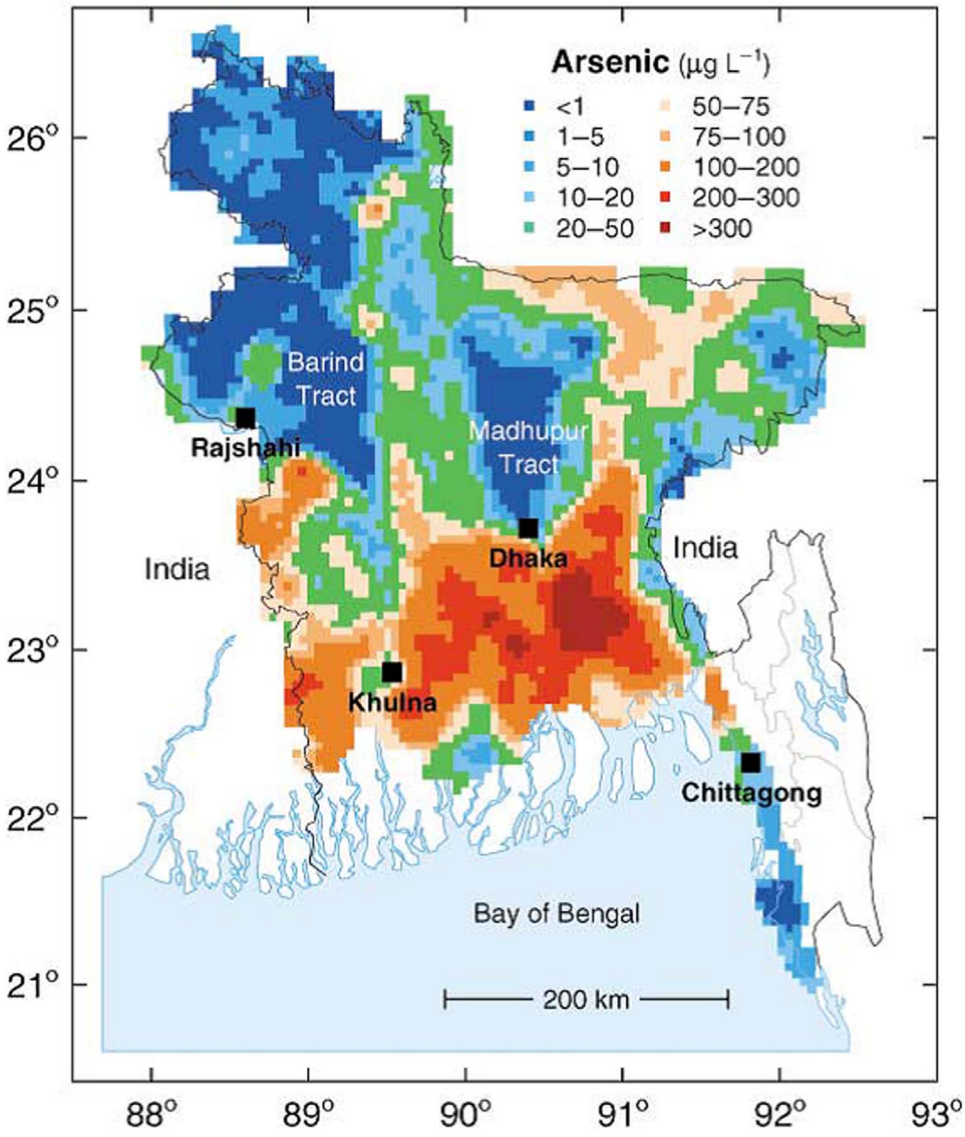

Fig. 1. Map showing the distribution of arsenic in groundwater of Bangladesh, adopted from Smedley and Kinniburgh (2002) with permission.

Bangladesh was made in 1993. It was reported that more than a quarter of shallow (< 150 m deep) tube wells in Bangladesh contained at least 50 mg L^{-1} arsenic. The worst-affected area is the South-East region of the country, where more than 90% of the tube wells were arsenic-affected (Smedley and Kinniburgh, 2002).

Although groundwater is the main source of drinking water, it is also an important source of irrigation water in south and south-east Asian countries (Meharg and Rahman, 2003). Underground water has been used extensively, particularly during the dry season, for rice cultivation in Bangladesh (Meharg and Rahman, 2003). The background levels of arsenic in paddy-growing soils in Bangladesh range from 4 to 8 mg kg^{-1}; however, up to 83 mg kg^{-1} of arsenic was found in paddy-growing soils that was irrigated with arsenic-contaminated groundwater (Williams et al., 2006). High level of arsenic in paddy-growing soils from contaminated irrigation water has resulted in arsenic uptake in rice grain (Rahman and Hasegawa, 2011; Williams et al., 2006) and vegetables (Alam et al., 2003; Rahman et al., 2013) that raised concern of potential human health risk in the country. The possibility of arsenic exposure to the people of the countries where arsenic contamination has not been occured can be an important concern with the expansion of global food trade (Rahman et al., 2014).

Widespread human exposure of arsenic from drinking water and food and associated carcinogenic and non-carcinogenic effects have been matters of growing concerns during the past three decades (Chatterjee et al., 2010; Rahman et al., 2009). Besides the public health impacts of arsenicosis, arsenic contamination may create widespread socio-economic consequences for the victims and their families in Bangladesh; however, this issue has received little attention from the point of view of social risk and hazards. Therefore, the purpose of this review is to fill in this knowledge gap with special reference to Bangladesh. The specific objectives of this paper are to:

- Discuss dietary and non-dietary pathways of arsenic exposure.
- Identify the socio-economic consequences of chronic arsenic exposure in Bangladesh considering food habits, nutritional status, socio-economic conditions, and socio-cultural behaviours of the population of the country.
- Identify the social risk and social hazards of arsenicosis.

2. Methodology

A scoping review has been conducted following the framework outlined by Arksey and O'Malley (2005) and Levac et al. (2010). The framework outlined five steps that we implemented in this study: Identifying the research question; identifying relevant studies; selecting previous studies; charting the data; and collating, summarizing and