



Mercury exposure and Alzheimer's disease in India - An imminent threat?



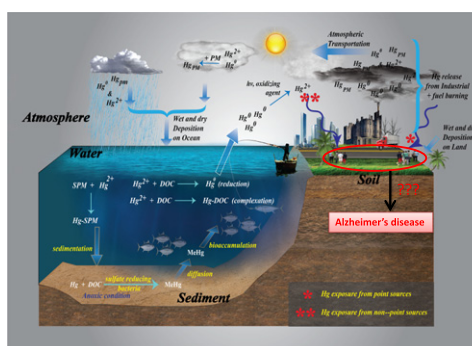
Parthasarathi Chakraborty

Geological Oceanography Division, CSIR-National Institute of Oceanography, Dona Paula, Goa 403004, India

HIGHLIGHTS

- Long-term exposures to Hg are a risk to human health in India.
- Research is needed to understand the link between Hg and Alzheimer's disease
- Decreased Hg pollution is needed for sustainable development in India.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 23 January 2017

Received in revised form 20 February 2017

Accepted 20 February 2017

Available online 3 March 2017

Editor: D. Barcelo

ABSTRACT

India is an industrial giant with one of the fastest growing major economies in the world. Primary energy consumption in India is third after China and the USA. Greater energy production brings the burden of increasing emissions of mercury (Hg). India ranks second for Hg emissions. Rising atmospheric Hg release, high Hg evasion processes, and increasing monomethylmercury (highly neurotoxin) accumulations in marine food products increase the potential for human and ecosystem Hg exposure. Hg has been identified to increase the risk of getting Alzheimer's disease (AD). There are increasing reports of AD and dementia in different age groups in India. The relationship between increasing Hg exposure and increasing neurodegenerative disorder in India is not known. This commentary points to the need for better understanding of the relationship between Hg release and AD in India, and other countries, and how to protect human health and the environment from the adverse effects of Hg.

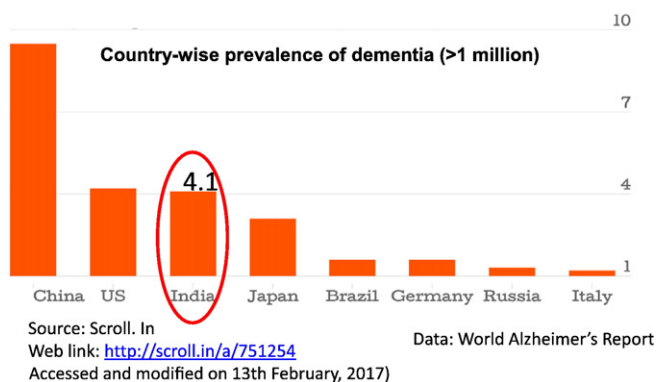
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1. Commentary

India is an industrial giant with one of the fastest growing major economies in the world. Economic and industrial growth of a country always improves health care systems, but at the same time, they bring an

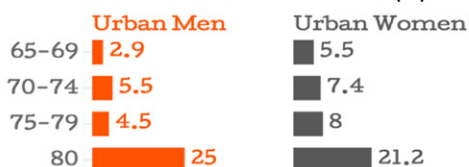
unexpected rise in the number of diseases and illnesses related to increased prosperity. One of the major concerns in developing countries like India is Alzheimer's disease (AD) (Duthey, 2004), a common neurodegenerative disorder that leads to dementia and death (Goedert and Spillantini, 2006; Hardy et al., 1998). In 2008, the World Health Organization (WHO) declared dementia as a priority condition through the Mental Health Gap Action Program (http://www.who.int/mental_health/publications/dementia_report_2012/en/).

E-mail address: pchak@nio.org.



(a)

Prevalence of dementia in India (%)



(b)

Fig. 1. (a) Country wise prevalence of dementia. There are 4.1 million dementia patients in India, just behind the 4.2 million in the US and the more than 9 million in China (b) prevalence of dementia in different age group in India.

As of 2015, there were an estimated 46.8 million people with dementia worldwide (Prati et al., 2014). This number will increase to an estimated 75.6 million in 2030 and 135.5 million in 2050 (<http://www.who.int/mediacentre/factsheets/fs362/en/>). Much of this increase will be in the developing countries like India and China. Today ~58% of the people with dementia live in developing countries, but by 2050

this will rise to ~68% (<https://www.alz.co.uk/research/statistics>). Almost 4.1 million people are living with dementia in India (<http://www.who.int/mediacentre/factsheets/fs362/en/>). According to the latest World Alzheimer's Report, India has the third-largest population of dementia patients in the world (<http://scroll.in/a/751254>, <https://www.alz.co.uk/research/statistics>) with 4.1 million in India, 4.2 million in the USA, and more than 9 million in China (See Fig. 1a). Fig. 1b shows the prevalence of dementia in different age groups in India (%).

Long-term exposure to Hg has been reported to produce Alzheimer's like symptoms (Mutter et al., 2004, 2007). Some autopsy studies have found increased Hg concentration in brain tissues of AD patients (Mutter et al., 2010; Nakagawa, 1995). It has been reported that inorganic Hg levels of 0.02 ng Hg/g (2 μl 0.1 μMolar Hg in 2 ml substrate) can lead to total destruction of intracellular microtubuli and degeneration of axons (Leong et al., 2001). Inorganic Hg levels of 36 ng Hg/g (0.18 μMol Hg) has been found to increase oxidative stress as a prerequisite for further cell damage (Olivieri et al., 2000, 2002). The average Hg load in brain tissues of individuals with Alzheimer's disease has been found to vary from 20 to 178 ng Hg/g; in some cases the load has been found to exceed up to 236–698 ng Hg/g. In 15% of the human brain samples, the Hg load has been reported above 100 ng Hg/g (Ehmann et al., 1985; Thompson et al., 1987; Saxe et al., 1999). The average Hg load in the pituitary gland has been found 400 ng Hg/g (Cornett et al., 1998). These levels are again above the established toxic levels.

Inorganic Hg damages nervous system and produces pathological changes similar to AD (Mutter et al., 2010; Haley, 2007). Hg exposure helps to form “neurofibrillar tangles” inside brain cells that are one of the two diagnostic markers for Alzheimer's disease (<http://articles.mercola.com/sites/articles/archive/2001/04/07/alzheimers-mercury.aspx>). Low level inorganic Hg exposure damages nerve cell (like AD). Whereas, other metals (zinc, aluminium, copper, cadmium, manganese, iron, and chromium) aggravate the toxic effects of Hg inside nerve cell (Thompson et al., 1987; Deibel et al., 1996; Haley, 2007). Markesbery (1997) has reported that increasing Hg exposure can generate free radical and produce oxidative stress in brains. However, several studies have also mentioned that Hg may not increase the risk of getting AD (Cornett et al., 1998). The increasing rate of Hg emission,

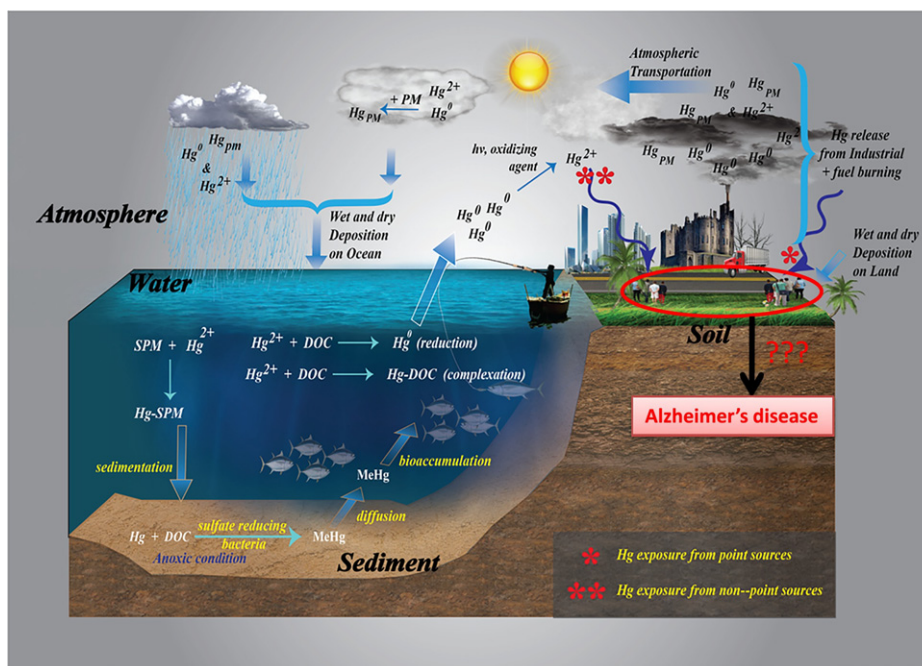


Fig. 2. Anthropogenic perturbation on Hg cycling: Increasing trend of atmospheric Hg release, Hg evasion processes, and monomethylmercury (highly neurotoxin) accumulation in marine food products increase the chances of Hg exposure. Is Hg exposure increasing and leading to Alzheimer's disease in India?

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