

ARSENIC EXPOSURE THROUGH DRINKING WATER AND ITS EFFECT ON PREGNANCY OUTCOME IN BENGALI WOMEN

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Twelve districts of the state of West Bengal, India are affected by arsenic (As) and millions of individuals are consuming As-contaminated groundwater. The probable adverse effects of As on pregnancy outcome (stillbirth and miscarriage) are yet to be properly studied. The present investigation is an attempt to understand the effects of As exposure on the pregnancy outcome in Bengali women exposed to As through drinking water and residing in different villages in North 24 Parganas District of West Bengal. The results show a significantly higher rate of stillbirths and miscarriages than those in the unexposed population.

KEY WORDS: *groundwater, miscarriage, stillbirth, toxic elements, West Bengal*

Arsenic (As) has been recognised as a human toxicant for over 2000 years. Numerous studies have shown that As has an adverse effect on humans. The element is genotoxic, alters DNA methylation, and adversely affects cell proliferation. It also inhibits certain enzymes and causes tumour, cancer, dermatosis, and arsenicosis. Animal research has demonstrated that As significantly affects developing embryos in avian and mammalian species. This element can readily transfer to the foetus and shows developmental toxicity in animal embryo cultures. It has been recognized as a reproductive toxicant in humans (1).

One of the main routes of As exposure in humans is through drinking water. The primary source of this drinking water is groundwater, which is contaminated with As. Various studies have shown concern that drinking As-contaminated water is a major worldwide public problem (2). In India, one of the most affected regions is the Ganges Delta Plain, and the state of West Bengal in particular (3). Millions of people

are affected. The number of affected districts in West Bengal has steadily increased over the years, starting from six in 1994 to twelve districts in 2006, counting. One of the most affected districts is North 24 Parganas. The groundwater As levels in the area are significantly higher than the Indian National drinking water standard of $50 \mu\text{g L}^{-1}$ and the provisional limit of $10 \mu\text{g L}^{-1}$ recommended by the World Health Organization (WHO).

Exposure to As through drinking water may involve the risk of negative pregnancy outcome (stillbirth and miscarriage). But this is yet to be proved conclusively. There are but a few studies on the effects of groundwater As contamination on human reproduction, including a review which was published a decade ago (4). There is, however, growing evidence to suggest that exposure to high concentrations of As during pregnancy increases the risk of stillbirth.

As one of the major routes of As exposure in West Bengal is groundwater, there is an immediate need to address the issues related to As exposure through

groundwater and effects on pregnancy outcome in this area.

It would be worthwhile to assess the role of As in the incidence of stillbirths and miscarriages among women exposed to As. The hypothesis that is being tested here is that women exposed to As through drinking water have a higher incidence of miscarriages and stillbirths than those unexposed to As.

SUBJECTS AND METHODS

The data on pregnancy outcome were collected from 240 married women residing in four As-affected villages (Shimulpur, Kamdebkati, Raghampur, and Chandalhati, n=60 per village) located in North 24 Parganas district of the state of West Bengal, India. In these villages there was a number of people suffering from As-related symptoms. All these villages are included in a community-based project to mitigate groundwater As exposure. This project has been conducted by a non-governmental social organisation called Save the Environment, Calcutta in collaboration with All India Institute of Hygiene and Public Health and India-Canada Environment Facility. There is also a specialised clinic to monitor As exposure in the area.

All the women belong to the Bengali Population which consist of the Bengali Hindu Caste and the Bengali Muslims who are genetically identical (5). To obtain information on pregnancy outcome, we used a structured interview. The responses were compared with those by 60 control married women from a village called Babla-Gobindapur, located in the nearby district of Nadia. Women from both the As-exposed villages and the control village were randomly selected and made for about one third of the total married female population of each village. Women were further

matched for age, socioeconomic status, family size and age at marriage.

Most of the tube wells, which supply drinking water to the residents of the four As-exposed villages have been reported for As water contamination which is significantly higher than the Indian National drinking water standard and the WHO recommended provisional limit. The concentrations of As was determined using standardized field kits recommended by the WHO. The number of stillbirths and miscarriages over the period 1995-2005 were obtained from the study subjects. Chi-square test was used to compare pregnancy outcomes (stillbirths and miscarriages) between the exposed and control subjects.

RESULTS

Our results show that the exposed women (villages Shimulpur, Kamdebkati, Raghampur, and Chandalhati) had a higher number of stillbirths and miscarriages than controls (village Babla-Gobindapur). The results are shown in detail in Table 1.

Table 2 shows the chi-square values for both stillbirths and miscarriages in all villages. The differences between each As-exposed village and the control village turned out to be statistically significant ($p < 0.05$; d.f.: 1) for all outcomes save for miscarriage between Chandalhati and Babla-Gobindapur.

DISCUSSION

It has been reported that exposures to toxic elements such as lead and methylmercury could have significant adverse effects on pregnancy (6, 7). However, only a limited number of studies have investigated stillbirths and miscarriages among pregnant women exposed

Table 1 Village-wise break-up showing the number of tube wells, number of As-affected tube wells, As levels, number of women investigated, and the number of stillbirths and miscarriages

Name of village	Number of tube-wells	Number of As-affected tube-wells	Level of As in water / mg L ⁻¹	Number of women investigated	Number of stillbirths	Number of miscarriages
Shimulpur	262	251	0.01-0.54	60	6	18
Kamdebkati	268	239	0.01-0.60	60	7	18
Raghampur	95	59	0.01-0.08	60	10	17
Chandalhati	136	119	0.01-0.60	60	11	22
Babla-Gobindapur (control)	180	0	<0.01	60	5	8

Table 2 Results of the chi-square tests to estimate statistical differences in stillbirths and miscarriages between women from the exposed and control villages

Exposed village vs. control village	Stillbirths	Miscarriages
	chi-square	chi-square
Shimulpur vs. Babla-Gobindapur	0.08*	3.18*
Kamdebkati vs. Babla-Gobindapur	0.30*	3.18*
Raghabpur vs. Babla-Gobindapur	1.48*	2.69*
Chandalhati vs. Babla-Gobindapur	1.99*	5.27

* statistically significant difference ($p < 0.05$)

to As through groundwater. Our study suggests that such exposure produces adverse effects on pregnancy outcome, as the incidences of stillbirths and miscarriages significantly differ between the exposed and the control groups. A recent similar study done in West Bengal has suggested that high As exposure through groundwater increases the risk of stillbirth, but not of miscarriage (8). On the other hand, a study in Bangladesh (9) has reported higher incidence of stillbirths and miscarriages in pregnant women exposed to As through groundwater than in normal controls. Our results confirm the findings reported in other similar studies as well (10-12).

Exposure to As causes placental dysmorphogenesis and defective placental vasculogenesis, resulting in placental insufficiency and subsequent miscarriage. This has well been documented in mice, and may apply for humans (13-14). Attention must be paid to comparative pharmacokinetics and metabolism, likely exposure scenarios, and possible mechanisms of action of As. This however calls for more rigorously controlled studies. Ideally, these studies should be longitudinal to understand the effect of continuous increase in As content in groundwater on pregnancy outcome.

CONCLUSION

In conclusion, further research is clearly needed, particularly on the potential toxicity of As. Current studies reasonably argue that As has a potential to adversely affect human reproduction.

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Sažetak

IZLOŽENOST ARSENU U PITKOJ VODI I NJEGOV UTJECAJ NA ISHOD TRUDNOĆE U ŽENA IZ ZAPADNOG BENGALA, INDIJA

Arsenu (As) iz podzemnih voda izloženi su milijuni ljudi koji žive u dvanaest administrativnih jedinica Zapadnoga Bengala u Indiji. Njegovo štetno djelovanje na ishod trudnoće (mrtvorodenja i spontane pobačaje) tek treba kvalitetno dokumentirati. Istražen je utjecaj izloženosti arsenu na ishod trudnoće u bengalskih žena koje su mu bile izložene putem pitke vode, a stanovnice su različitih sela u administrativnoj jedinici North 24 Parganas savezne države Zapadni Bengal. Rezultati istraživanja pokazali su značajno veću učestalost mrtvorodenja i spontanih pobačaja u žena izloženih arsenu u odnosu na neizloženu skupinu.

KLJUČNE RIJEČI: *podzemne vode, mrtvorodenje, spontani pobačaj, toksični elementi*

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