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International Journal of Health Research, June 2009; 2(2): 183-188 (e2211p79-84)



Available at http://www.ijhr.org

**Original Research Article**

*Open Access*
Online Journal

# Prevalence of Arsenicosis in Ramgram Municipality, Nawalparasi, Nepal

**Received:** 23-Jan-09 **Revised:** 02-Apr-09 **Accepted:** 01-May-09

## Abstract

**Purpose:** To determine the prevalence of arsenicosis in Ramgram Municipality, Nawalparasi, Nepal.
**Methods:** This descriptive cross-sectional study was conducted from 26th June, 2007 to 28th July, 2007, among households exposed to 50 ppb to 350 ppb of arsenic concentrations in drinking water using questionnaire, direct observation and interview. WHO Algorithm Chart, 2005 was applied in identifying subjects with symptoms of arsenicosis. Arsenic contents in hair and nail samples were determined by atomic absorption spectrometer.
**Results:** Out of 866 subjects studied, 28 (3.2%) showed the symptoms of arsenicosis. The prevalence was 4.5% (17/379) in males and 2.3% (11/487) in females. Those with the highest prevalence of symptoms of arsenicosis was found among subjects that had melanosis on trunks, keratosis on palm and feet account for 71.4%, 11.1% and 7.4%, respectively. The two hair and three nail samples from 5 subjects with arsenicosis showed concentrations of arsenic > 2 mg/kg.
**Conclusion:** Arsenicosis is prevalent in Ramgram Municipality. Distribution of free anti-arsenicosis drugs and regular maintenance of arsenic biosand filters are recommended.

**Keywords:** Arsenic; Drinking water; Arsenicosis; Nepal.

**Hom J Adhikari[1]***

**Tirth R Ghimire[2]**

[1]Earth System Science and Policy Department, University of North Dakota, USA.

[2]Centre for Biophotonics, Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, Scotland.

***For correspondence:**

*Postal Address:* 4149 Campus Drive, Box 9011, Clifford Hall Room 270, Grand Forks, ND 58202-9011.

*Tel:* 701-777-9309

*Email:* homjyoti@yahoo.co.uk

## Introduction

Arsenic poisoning (arsenicosis) usually occurs on exposure to arsenic over a prolonged period; generally 5 to 20 years [1]. The first physical changes are usually observed on the skin. Manifestation of these changes typically takes place with the appearance of small black or white marks (melanosis), then thickening of the skin on the palms and the feet (keratosis), followed by skin lesions and eventually skin cancer in a sequential development. Late phenol-menon is internal cancer which usually takes more than 10 years to develop. In advanced stages of arsenocosis, patients appear like leprosy patients due to the development of gangrene over the body. The early symptoms of arsenicosis (eg. melanosis) appears to be reversible and/or can be arrested if exposure to arsenic is avoided [2,3]. Although chronic arsenic toxicity produces varied non-malignant manifestations as well as cancer of skin and different internal organs, dermal manifestations such as hyperpigmentation and hyperkeratosis are diagnostics of chronic condition [4]. Arsenical hyper-keratosis appears predominantly on the palms and the plantar aspect of the feet, although involvement of the dorsum of the extremities and the trunk have also been described. An indurated, grit-like advance to form raised, punctuated, 2-4 mm wart-like keratosis are readily visible [5].

A history of arsenic exposure through inhalation or ingestion is helpful in corroborating a diagnosis of arsenicosis. Spotty rain-drop pigmentation of the skin, distributed bilaterally and symmetrically over trunks and limbs, is the best diagnostic feature of arsenical hyperpigmentation. The duration of the patient's arsenic exposure with the date of onset of symptoms does not follow a particular time frame. Hence, a history of chronic arsenic exposure for more than 6 months is essential for diagnosis of arsenic-related skin manifestation [4].

Nawalparasi is one of the 20 Terai Districts of Nepal where the water from shallow tube-wells is one of the major sources of drinking water. About 31,930 such wells, including private tube-wells, have been installed by different agencies. Out of these, presence of arsenic in only 3.4% of them had been undertaken and 18% of the tube-wells were found to have arsenic concentrations above the national standard of 50 ppb [6]. A small health survey conducted by Nepal Red Cross Society (NRCS) which covered 20 contaminated tube-wells has shown the prevalence of arsenicosis in the district as 3.33% (unpublished). Since this latter study was based on only 20 contaminated tube-wells dug by NRCS, its findings could not be generalized. Moreover, there were indications of possible poisoning of some inhabitants in the area by the presence of arsenic in their drinking water due to the arsenicosis-like skin lesions observed in some subjects. Therefore this study was undertaken to determine the prevalence of arsenicosis in Ramgram Municipality, Nawalparasi.

## Methods

This is a descriptive cross-sectional study conducted in the study area to assess the existing water use and to find out the arsenicosis symptoms among the human population of Ramgram Municipality, Nawalparasi.

This study is based on the survey of DWSS, 2006 [7]. In a descriptive cross-sectional study conducted in Ramgram Municipality, Nawalparasi, 104 households exposed to 50 ppb or more of arsenic concentrations in their drinking water were selected on the basis of blanket testing data of DWSS [7].

### *Interview*

In each of the households, the household head and other members were interviewed using a structured questionnaire. The questionnaire contained questions regarding the sources of drinking water, socio-

economic conditions of the households, and perception of arsenic contamination of drinking water. All the questions were asked in Nepali (the local dialect) since most villagers neither spoke nor understood English.

### *Physical examination*

This was carried out in each of the 104 households at the time of interview. Out of the 866 subjects in all the households involved in this study, only 689 were physically examined as they were the only ones available in the households at the time of visit. The type of skin changes along with the duration and sides of the observed lesions were recorded. Diagnosis was confirmed if a patient with keratosis and hyperpigmentation was found to have been drinking water with a high arsenic content over a period of years. The diagnosis of arsenicosis patient was based upon the WHO Algorithm [8].

### *Hair and nail samples collection and analysis*

Hair (about 5 cm) and nail (about 2 cm) samples from 3 and 2 subjects, respectively, who were confirmed to have developed arsenicosis were collected. After collection, the hair were washed with arsenic-free water. Similarly, the subjects were asked to wash their hands with arsenic-free water then dried prior to collection of their nails.

The nail and hair samples were washed with few drops of biodegradable detergent (Extran Merck, MA 03 - phosphate free) and rinsed with distilled water, and finally with acetone. It was then dried in an oven at a temperature of 50-60 $^{o}$C and stored in a polythene bag prior to laboratory analaysis. After weighing, the nails were kept in a 25 ml beaker and 8-10 ml of concentrated $HNO_3$ was added. The beaker was placed on a hot plate around 60-80 $^{o}$C 48-78 hr until the color turned from deep brown to pale yellow. When the volume of liquid was reduced to about 1 ml, it was filtered through multipore membrane (0.45 M) filter, washed with distilled water and made up to 5 ml. Arsenic content was then determined using atomic absorption spectrometer. It was assumed that arsenic concentration of >1 mg/kg of dry hair and >1.5 mg/kg of nail was indicative of exposure to an unsafe dose of arsenic within the preceding 11 months [8].

### *Ethical considerations*

Before data collection, the purpose and the procedure of this study were explained to the household head or key informant and other interested family members. Participation of the subjects in all kinds of data collection was voluntary. Confidentiality of information was maintained.

## Results

### *Characteristics of the respondents*

The distribution of subjects in this study is provided in Table 1. Majority of the subjects were less than 41 years old.

**Table 1:** Age and sex distribution of subjects

| Age (yrs) | Males (%) | Females (%) | Total (%) |
|---|---|---|---|
| ≤20 | 117 (30.9) | 125 (25.7) | 242 (27.9) |
| 21-40 | 101 (26.6) | 233 (47.8) | 334 (38.6) |
| 41-60 | 74 (19.5) | 82 (16.8) | 156 (18.0) |
| ≥61 | 87 (23.0) | 47 (9.7) | 134 (15.5) |
| Total | 379 | 487 | 866 (100) |

### *Prevalence of arsenicosis symptoms*

Out of 866 populations studied, 28 (3.2%) showed the symptoms of arsenicosis. This was made up of 4.5% of the males and 2.3% of the females. The highest prevalence was found among those who were 41-60 years (Table 2). Out of 28 subjects with symptoms of arsenicosis, 14, 11 and 3 of them exhibited mild, moderate or severe symptoms, respectively.

Arsenic concentrations in the range of 2.2-7.8 mg/kg and 3.4-7.8 mg/kg were found in the hair and nails, respectively (Table 3). The hair sample from a 4 year old female who

had melanosis symptoms on trunk had the highest concentration of arsenic.

**Table 2:** Prevalence of arsenicosis symptoms

| Age (yrs) | Males (%) | Females (%) | Total (%) |
|---|---|---|---|
| ≤20 | 1 (0.9) | 1 (0.8) | 2 (0.8) |
| 21-40 | 7 (6.9) | 5 (2.1) | 12 (3.6) |
| 41-60 | 9 (12.2) | 2 (2.4) | 11 (7.1) |
| ≥61 | 0 (0.0) | 3 (6.4) | 3 (2.2) |
| Total | 17 (4.5) | 11 (2.3) | 28 (3.2) |

The interview revealed that some (9) of the subjects with arsenicosis symptoms had been consuming the arsenic contaminated water for 16-20 years. Most of them (85.7%) were agriculture workers or farmers. Although as many as 82.1% of them had the knowledge about arsenic and its sources, they did not know its effects on skin. While one of the subjects was interested in being trained by the government on knowledge of arsenic, many of them (53.6%) recommended the provision of arsenic biosand filters for inhabitants of the District and distribution of free anti-arsenicosis drugs for those with arsenicosis. Regular health checkup and training on recognising of arsenicosis symptoms were also recommended by 7.1% of the subjects.

## Discussion

The prevalence of arsenicosis has been reported in earlier studies [9-22]. The prevalence of 3.2% in our present study is higher than that reported from Nepal (1.3%) [9], Parsa district (1.8%) [10], Rautahat district (1.8-2.1%) [11,12], Nawalparasi, Bara, Parsa and Rautahat (<1%) [13] and lower than those reported from Santpur VDC, Rautahat (15.3%) [14], Terai region of Nepal (5.1%) [15], 6.9% [7] and Nawalparasi district (5.1%) [6], 8.9% [16]. Various factors that can influence susceptibility to arsenicosis have been identified. These include nutritional status, addiction, dose response, socio-economic status, different methylating capacity among individuals and population groups [8,14,18-21].

The development of arsenicosis in the subjects studied appears to be age-related. Those aged 21-60 years appear to have higher prevalence than younger people. Possible reason for this could include length of exposure as this could be age-related. In addition, the use of arsenic biosand filters in the community to reduce the concentration of arsenic in their drinking water started only recently. There are indications that after 60 years, arsenicosis is related to chronicity, defective immune system and doses as earlier reported [9,23-26].

Attempts to reduce the level of arsenic in the drinking water has led to the use of arsenic biosand filter such as Kanchan Filter in many homes. Unfortunately, proper use of the measures has not been fully archieved. There were indications that damaged arsenic biosand filter or filters that were not very good were being used in some homes. The request for training by some of the people is thus very relevant. As most of the people were living under very poor conditions, the need for the government to consider regular health check-up and distribution of free anti-arsenicosis drugs to the community becomes important.

**Table 3:** Concentration of arsenic in hair and nails in some subjects

| Sex | Age (yr) | Samples | Symptoms | arsenic (mg/kg) |
|---|---|---|---|---|
| Female | 4 | Hair | Melanosis | 7.8 |
| Male | 58 | Nail | Keratosis | 3.4 |
| Male | 29 | Nail | Keratosis | 4.8 |
| Male | 55 | Hair | Melanosis+ keratosis | 2.2 |
| Male | 59 | Nail | Melanosis | 6.7 |

**Conclusion**

There is high prevalence of arsenicosis in Ramgram Municipality. Although biosand filters are already being used in the area, it does appear that they are not properly used in some homes. Knowledge of arsenic is also poor in some homes. The need for adequate training and monitoring of the inhabitants of the community for blood levels of arsenic is essential.

## Acknowledgements

We acknowledge the Executive Board of Nepal Health Research Council (NHRC) for providing research grant for this study. Also, we are grateful to all those who participated in the study.

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