A NEW PUBLIC HEALTH ISSUE: CONTAMINATION WITH ARSENIC OF PRIVATE WATER SOURCES

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ABSTRACT – A new public health issue: contamination with arsenic of private water sources. Known since the early '40s, the natural contamination with arsenic of depth water in Bihor and Arad areas continues to incite interest, especially since the rural localities still use depth water as the main source of drinking water. Arsenic concentrations measured in the water sources in the area range between 0-176 μg/L, and it is estimated that over 45,000 people are exposed via drinking water to arsenic concentrations above 10 μg/L. The present study proposed the measurement of arsenic concentrations from old public sources and individual private water sources from recent wells located in five localities in Arad County, samples being collected during 2010-2011. The results showed that public water sources declared or not non-potable contain arsenic above the maximum allowable concentration of 10 μg/L. Individual water sources recently drilled as an alternative for the population to the lack of access to safe water from public water systems, presented high concentrations of arsenic in most cases, even higher than the concentrations of the public sources declared by authorities as non-potable. In the absence of informing and counseling the population regarding the natural uneven distribution of arsenic in the depth water and its potential carcinogenicity, human exposure continues and it is even more intense. The significance of the problem in terms of public health becomes even more important as for the private water sources quality is not monitored by the authorities according to law, water analysis being performed on request and for a fee.

Keywords: arsenic, drinking water, private water sources

1. INTRODUCTION

Arsenic is ubiquitous in the environment. Well water contaminated with arsenic from natural sources has been reported to be the cause of arsenic toxicity throughout the world, including areas as Argentina, Chile, Taiwan, United States, Mexico, Inner-Mongolia, Germany, United Kingdom, Slovakia and Hungary. It is known that large numbers of people have been exposed to arsenic via water consumption but information about arsenic levels in groundwater in Europe is still scarce.

Exposure to As in drinking water has been associated with the development of skin and internal cancers and noncarcinogenic effects such as

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diabetes, peripheral neuropathy and cardiovascular diseases (Abernathy 1999, Martinez 2011, Fernandez 2012). Maternal exposure to high concentrations of inorganic arsenic in naturally contaminated drinking groundwater sources has been associated with an increased risk for spontaneous pregnancy loss. (Bloom 2010)

Because of these severe health effects, the natural and anthropogenic occurrence of arsenic in drinking water has been recognized as a major public health issue in several regions of the world over the past three decades.

In Romania, several areas have been affected by natural arsenic contamination, other areas being contaminated from anthropogenic sources (non-ferrous industry). In Northwestern Transylvania (Bihor and Arad Counties), drinking water contains arsenic as a result of the geochemical characteristics of the land. The population in this region obtain their drinking water from the naturally contaminated sources. The release of arsenic, a potent human carcinogen, from the bedrock into groundwater is a growing public health concern because groundwater is increasingly used as a source of drinking water (Gurzau&Gurzau, 2001). A cross-sectional study to assess the arsenic exposure of human populations via drinking water performed in the Western part of Bihor and Arad Counties in 1995 showed a range of arsenic concentrations from 0 to 176 μg/L, 37.2% of the settlements exceeded 10 μg As/L. An increased prevalence of reported morbidity for cutaneous disorders, peripheral neuropathy and cardiovascular diseases was noticed in the area, but not a relationship between arsenic exposure via drinking water and skin, lung, and kidney cancers (Gurzau&Gurzau, 2001). The monomethylarsonous acid (MMA(III) was detected for the first time in the urine of some humans exposed to inorganic arsenic in their drinking water (2.8, 29, 84, or 161 μg As/L) from Arad County area (Aposhian, 2000)

According to the World Health Organization guidelines and the European Union legislation, starting with 2004 Romania switched the arsenic standard for drinking water from 50 to 10 μg/L.

Our study presents the magnitude of arsenic groundwater contamination in Arad County, Romania, based on measurements of arsenic in old public water sources and new individual, private sources located in 5 rural localities.

2. MATERIALS AND METHODS

During 2002-2004, public underground water sources from Pilu, Sepreus, Apateu and other 64 localities from Arad County have been investigated from the arsenic contamination point of view in the frame of ASHRAM project (Arsenic Health Risk Assessment and Molecular Epidemiology). In this paper we present some of the results regarding the arsenic contamination of 1-3 water samples from each locality.

The water sampling for public and new private underground water sources has been performed during 2010-2011 in Pilu, Varsand, Sepreus, Zerind and Apateu villages. A number of 37 samples were collected, including tap water.

Water was sampled in 50 ml high purity polyethylene containers, preserved with 100 µl concentrated nitric acid and stored at < 4°C temperature. The total arsenic concentration was measured by Hydride Generation-Atomic Absorption Spectrometry using a Varian 100 device (Environmental Health Center Lab Cluj-Napoca).

3. RESULTS AND DISCUSSIONS

ASHRAM study performed between 2002-2004 revealed that 11 (16.4 %) out of the 67 investigated localities have one or more public water sources exceeding the maximum admitted concentration of arsenic for drinking water of 10 µg/L (fig. 1). As a consequence, in these 11 localities almost 41,000 people are exposed to high levels of arsenic via drinking water. Part of the underground water sources was centrally supplying some of the investigated localities.

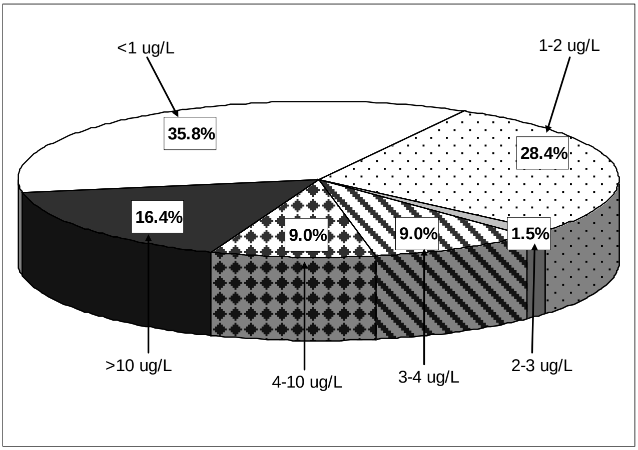

Fig. 1. The arsenic concentration in water samples (2002-2004)

In Figure 2 it is represented the geographical distribution of the arsenic concentration in the analyzed water samples, the highest values being measured in the Northern and Western parts of the county, in Apateu (46.36 µg/L), Zerind (61.20 µg/L), Pilu (69.90 µg/L) and Sepreus (179.98 µg/L) localities.

According to the legislation previous to 2004, only 4 (5.97 %) of the investigated localities (Apateu, Sepreus, Pilu and Zerind) had public water sources exceeding the arsenic concentration of 50 µg/L. The policy concerning the public water supply presumes switching them off. Drinking water consumption from public networks was still limited by the population preferences for private and public old water sources (drills, wells, artesians – one of them older than 150 years) despite the high arsenic contamination, the consumption being motivated by “the good taste of water”, accessibility (free of charge) and the peoples perception of “no diseases related to water consumption”. After reducing the maximum admitted concentration of arsenic to 10 µg/L the number of improper water sources increased.

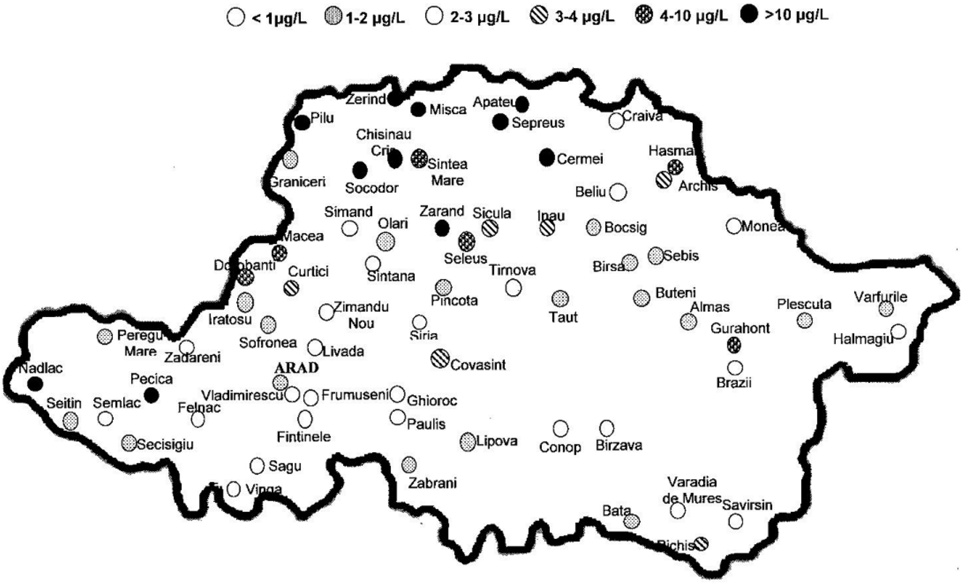

Fig. 2. The geographical distribution of arsenic contamination of water in Arad County (2002-2004)

Part of the underground water sources was closed due to different reasons, not only because of the arsenic concentration. There are still in function public underground water sources (e.g. artesian) containing arsenic over 10 µg/L even if officially the water was declared non-potable.

As an alternative to unsafe and insufficient water from public network and community wells, part of the population drilled their own wells, expecting they reach good quality water. The national surveillance of drinking water quality is focused only on public water sources, the private ones being tested only by request of the owner and with charge.

Table 1. The investigated localities and type of water analyzed for arsenic (2010-2011)

	Private well	**Community well**	**Tap water**
Pilu	20	5	0
Varsand	3	1	0
Apateu	0	1	1
Sepreus	0	3	1
Zerind	0	1	1
Total	**23**	**11**	**3**

The 2010-2011 sampling sessions summarized a number of 37 samples from private and community wells and tap water located in 5 localities from Arad County. There were 23 samples from private wells (Table 1).

The arsenic concentration in water from private wells ranged from 15.8 to 132.41 µg/L, while in public sources it ranged between 15.29-157.81 µg/L. The arsenic concentration exceeded the MAC in all 37 water samples.

In this regard 15% sample contain 15-17 µg/L of arsenic, 20% contain 26-29 µg/L of arsenic, 45% contain 41-46 µg/L of arsenic, 10% contain 41-46 µg/L of arsenic and other 10% contain 110-133 µg/L of arsenic (Fig. 3).

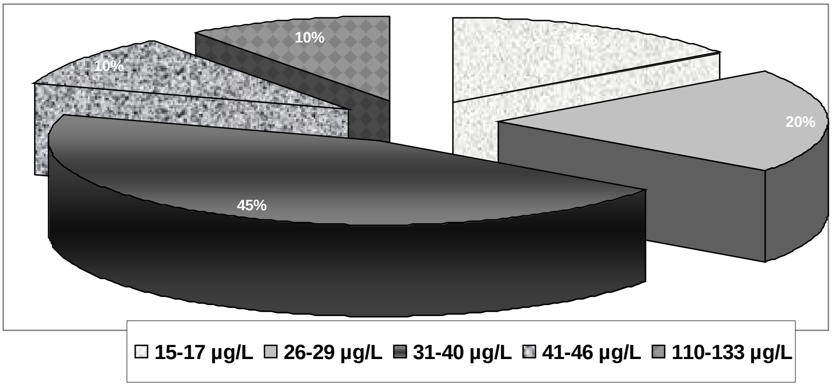

Fig. 3. The percentage of water sources by arsenic concentrations (2010-2011)

The average concentrations of arsenic in water in relation with the locality and type of analyzed water are presented in Table 2. The highest arsenic contamination of water was identified in the community wells or tap water in Sepreus, Varsand and Apateu. It must be mentioned the case of Apateu where both analyzed public water sources contain very high arsenic concentrations. The actual measurements of arsenic are above or below the arsenic concentrations measured between 2002-2004 in other water sources in these villages.

Table 2. The average concentration of arsenic in water samples (2010-2011)

	Private well	Community well	Tap water
Pilu	40.21	27.8	
Varsand	34.94	79.42	
Apateu		78.86	84.66
Sepreus		90.64	32.14
Zerind		23.69	

Figure 4 shows the arsenic average concentration in new private water sources in comparison to the community water sources. Most of the investigated private new well water sources are located in Pilu, where the highest arsenic concentration of arsenic (110.87 and 132.41 µg/L) was measured out of all analyzed samples between 2010-2011. The average concentration of arsenic in this type of water sources is much higher than in community wells, which are still in function and people use the water for drinking and cooking. It must be mentioned that the local authorities notified the population that the water is not safe. On the other hand, the magnitude of arsenic concentration in community wells in Varsand is higher in comparison to the private wells.

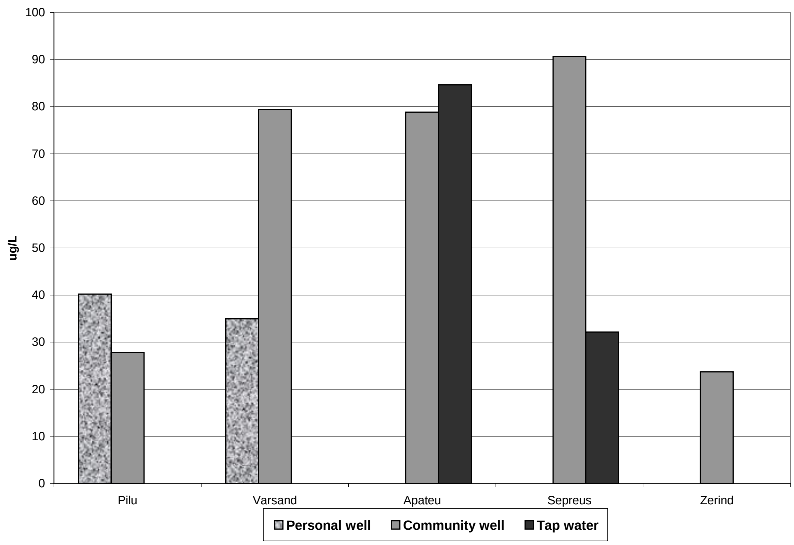

Fig. 4. Arsenic concentration in private and community water sources (2010-2011)

Natural arsenic pollution of groundwater and surface water affects more than 140 million people in at least 70 countries worldwide which are chronically exposed to high levels of arsenic and elevated risks of numerous adverse health effects; several studies demonstrated genetic polymorphisms that influence susceptibility to these and other disease states through their modulation of As metabolism (Chowdhury, 2000; Ravencroft 2007 and 2008; Lindberg 2007, McClintock, 2011). While the arsenic contamination of water has been mentioned since 1885 (Ravencroft 2007), the arsenic contamination of groundwater in the Western part of Romania dates back since the 1940's.

The results that we presented in relation to the water contamination with arsenic in Arad County (2002-2004) were part of the ASHRAM project which evaluated the gene-environment interactions in the assessment of cancer risk from arsenic intake in three European populations: from Hungary, Romania, and Slovakia.

Several studies focused to assess the current exposure to arsenic via drinking water in these European countries by measuring inorganic arsenic and methylated arsenic metabolites in urine. Significantly higher concentrations of arsenic were found in both water and urine samples from the Hungarian counties than from the Slovakian and Romanian counties and a significant correlation was observed between arsenic in water and arsenic in urine (Lindberg 2006). There is a wide variation in the susceptibility of arsenic to health effects, which, in part, may be due to differences in arsenic metabolism. The M287T (T-->C) polymorphism in the AS3MT gene, the A222V (C-->T) polymorphism in the MTHFR gene, body mass index, and sex are major factors that influence arsenic metabolism in this population, with a median of 8.0 µg/L arsenic in urine (Lindberg 2007). The exposure indices were all log-normally distributed and the mean and median lifetime average concentrations were 14.7 and 13.3 µg/L in Hungary, 3.8 and 0.7 µg/L in Romania and 1.9 and 0.8 µg/L in Slovakia, respectively. Overall, 25% of the population had average concentrations over 10 µg/L and 8% with exposure over 50 µg/L (Hough 2010).

4. CONCLUSIONS

The geographical distribution of arsenic in the drinking water from Arad County is spotty, with a mixture of high and low arsenic concentrations in contiguous areas.

Individual water sources recently drilled as an alternative for the population to the lack of access to safe water from public water systems, presented high concentrations of arsenic in most cases, even higher than the concentrations of the public sources declared by authorities as non-potable.

In the absence of informing and counseling the population regarding the natural uneven distribution of arsenic in the depth water and its potential carcinogenicity, human exposure continues and it is even more intense. Moreover, previous studies performed in the area highlighted a susceptibility to health effects and the fact that arsenic methylation capacity may have a role in the development of arsenic-induced cancers.

The significance of the problem in terms of public health becomes even more important as for the private water sources quality is not monitored by the authorities according to law, water analysis being performed on request and for a fee.

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