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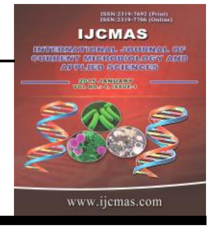

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Original Research Article

Non Carcinogen Risk Assessment Lead in Tap Drinking Water in Adult's Age Group; Minab city, Iran

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A B S T R A C T

The presence of heavy metals such as lead in drinking water sources due to the toxicity and bioaccumulation can be hazardous to human health. Long-term intake of lead in drinking water can cause chronic effects such as headache, abdominal pain and brain and kidney damage in humans. In this cross-sectional study that was conducted in Minab City, 100 tap drinking water samples from 10 areas during the month of December of 2014 were collected. Measuring lead concentrations by flame atomic absorption spectrophotometry device, AA8000 model was done. Then, non-carcinogenic risk of adults was calculated by the equations presented by the EPA. The mean and range of lead concentrations in December is 9.54±2.07 µg/land ND-13.5 µg/land in January is 6.4±2.3 µg/land ND-12.3 µg/l, respectively. Highest and lowest concentrations of lead in December are in city center and Al mahdi areas and in January, it relates to Valiasr and Azadegan areas, respectively. In December, CDI for the lead is 0.00027 µg/kg-day and 0.00074 HQ and in January, CDI for the lead is 0.00018 µg/kg-day and also HQ is 0.0005 respectively. The mean concentration of lead in tap drinking water is lower than the WHO and EPA standard level. As the HQ for lead is less than 1, it can be thus said that adult population in Minab city are in safe area in terms of non-carcinogenic risk of the lead in drinking water.

Keywords

Lead concentration, Tap water, Non-carcinogenic risk, Adult's age group

Introduction

Heavy metals are considered as important component of environmental pollutants Due to the biological accumulation, toxicity and environmental sustainability (Pekey *et al.*, 2004). In recent years, the presence of heavy metals such as arsenic, cadmium, mercury, lead, nickel and chromium in drinking water has become an international environmental and health concerns (Dogaru *et al.*, 2009, Ghaderpoor *et al.*, 2009; Wang *et al.*, 2011). The presence of heavy metals in water can be caused by natural processes (erosion or sediment) or from human activity (discharge of sewage, industrial and agricultural activities) (Demirak *et al.*, 2006; Muhammad *et al.*, 2010).

Entry of heavy metals in water resources will not only have a negative impact on living organisms and water ecosystems, but will also reduce the quality of water for drinking or irrigation purposes (Krishna *et al.*, 2009). Some heavy metals such as cadmium, chromium, manganese and lead in high concentrations can be highly toxic to humans (Ouyang *et al.*, 2002). Epidemiological studies show that there is a significant relationship between tooth decay, heart disease, kidney disorders, neurological disorders and cancers with heavy metals (Babaji *et al.*, 2004, Sahmoun *et al.*, 2005, Soupioni *et al.*, 2006).

Lead is a highly toxic and carcinogenic element which can cause chronic effects such as headache, abdominal pain, cerebral and renal damage (Mortada *et al.*, 2001, Järup, 2003). Children are very sensitive to the toxic effects of lead and exposure to high concentrations of it can cause acute effects such as behavioral disorders, memory loss, decreased learning and long-term cause of anemia (Järup, 2003). Considering the importance and role of metals on human health, several studies have been carried out in water at various locations. For example, a study conducted in Tehran, which the concentration of copper and lead in drinking water samples were measured, showed that copper concentration is in an optimal level, but lead concentration is slightly higher than the standard level (Ghaemi *et al.*, 2005). In Ahwaz, concentrations of cadmium, lead and mercury in drinking water were also measured by atomic absorption spectrophotometry, which in all samples, cadmium concentration (0.0012 mg/l) is lower than the WHO standard level (0.02 mg/l), but the lead concentration (0.02 mg/l) was higher than the standard level (Albaji *et al.*, 2013). The widespread use of pesticides and fertilizers by farmers and agricultural water supply wells in the vicinity of the town of Minab and lack of urban wastewater collection system raised the possibility of contamination of tap drinking water in the city with heavy metals. With regard to the health significance of heavy metals in drinking water sources, it is tried in this study to measure the lead concentration of tap drinking water and non-carcinogenic risks (infectious diseases, heart, kidney etc.) in adults of lead concentrations in tap drinking water is calculated and evaluated by the current equations.

Materials and Methods

Study area

Minab city is located in the southeastern province and at a distance of 100 km from the city of Bandar Abbas (Center of Hormozgan Province) in the geographical coordinates of 27°11´53" Nand54°22´7"E (Figure 1). Height of this city is 27 meters above sea level and has a warm and humid climate (Hassan *et al.*, 2011). City's drinking water for Residents is supplied from groundwater sources (three deep 300 meter wells). The city is one of the largest manufacturer of agriculture products in the province, hence the use of pesticides and chemical fertilizers are widely done even in the vicinity of the city's drinking water supply wells. On the other hand, the city lacks urban wastewater collection system and residents of the city use absorbed wells for sewage disposal (municipal and industrial) that can contaminate groundwater and tap water.

Samples collection

In this cross-sectional study conducted in the months of November and December 2014, in order to get a good mean of lead concentrations of heavy metals in drinking water in Minab according to its size, population and industry, the city was divided into ten areas namely Azadegan, Ahmadabad, Valiasr, city center, Pakoh, Shaykh abbad, 95 Dastgah, Al mahdi, Zohaki and Solghan (Figure 1). For comparison the mean concentration of heavy metals in the months of December and January, samples collection in two temporal stages in the middle of December and January months was done. At each stage of the region, 5 samples of tap drinking water were collected. Hence, a total of 50 samples in the first stage (December) and 50 samples in the second stage (December) of the whole city was collected.

Measuring the lead concentration

According to water chemistry sampling instructions, tap water samples during the first and second stage was transferred into polyethylene bottles washed with 20% nitric acid and distilled water. Also, 1 ml of nitric acid (65%) per liter of water sample to deliver PH<2 (for heavy metals in water) was added to the sample. Then the samples were transferred to the laboratory device analysis at Faculty of hormozgan University of Medical Sciences at 4 °C. In the laboratory, to concentrate, water samples were filtered through Whatman glass microfiber filter (GF/C) (Muhammad *et al.*, 2011, Albaji *et al.*, 2013). Lead concentrations in condensed samples were measured by flame atomic absorption spectrophotometry[1] (Model AA8000) in µg/l (ppm).

Chronic daily intake (CDI)

Heavy metals enter the body by different routes such as skin contact and inhalation and mouth (food and drink), but the arrival of heavy metals through the oral route is much higher (Patrick, 1994; Muhammad *et al.*, 2011). To calculate the amount of CDI through drinking water, the following equation was used:

Equation 1

$$CDI = C \times DI/BW$$

C; concentration of heavy metals in the water in terms of µg/l, DI; daily water consumption (l/d), BW; body weight (72 kg) (Muhammad *et al.*, 2010, Agency October, 2004).Since there was no information on the exact amount of water used and the mean body weight of the residents in Minab city, hence the information provided by the EPA is used.

Hazard quotient indices (HQ)

The risk contribution for non-carcinogenic risks assessment is calculated by the following equation:

Equation 2

$$HQ = CDI/RfD$$

[1] FAAS

Reference dose of oral toxicity (RFD) for the lead is 0.36 kg-d/mg (Forum, 2005). A community is in safe area when HQ for heavy metal is less than 1 (Khan *et al.*, 2008).

Statistical analysis

The difference in the mean concentration of lead in drinking water in December and January and in various locations in Minab city was performed by One Way ANOVA test in SPSS16 software. Error of 5% (α =5) was considered as significant level.

Results and Discussion

The mean and range of lead concentrations in the months of December is 9.54±2.07 µg/l and ND-13.5 µg/l, respectively. The mean concentration of lead in Azadegan, Ahmedabad, Valiasr, city center, Pakoh, Shaykh abbad, 95 Dastgah, Al Mahdi, Zohaki and soleghan is 11.5, 9.6, 11.6, 11.8, 9.6, 8.6, 11.2, 5.8, 6.8 and 8.9 µg/l (Table 1).

The mean and range of concentrations of lead in December is 6.4±2.3 µg/l and ND-12.3 µg/l, respectively. Also the mean concentration of lead in Azadegan, Ahmedabad, Valiasr, city center, Pakoh, Shaykh abbad, 95 Dastgah, Al Mahdi, Zohaki and soleghan is 3.6, 4.6, 11.6, 8.6, 7.9, 5.6, 5.6, 6.8, 4.6 and 5.8µg/l, respectively (Table 2).

WHO and EPA standards for the lead is 10 and 15 µg/l (Chigbo *et al.*, 1982, Wade, al. 2003, Muhammad *et al.*, 2011, santé 2011).Hence,ratio the lead concentration to the WHO standard is 95% and for the EPA standard is 63%. Lead concentrations in December are close to the standards of WHO and EPA, but it is observed lower than them. In December, the number of samples above the WHO standard for lead is 16 (Azadegah, Ahmad abbad, Valiasr, City center and 95 Dastgah). Also, all samples collected in December (n=50) are lower than the EPA standard. As in December, the concentration of lead in December was close to the standards of WHO and EPA, but observed lower than them. In December the number of samples above the WHO standard for the lead is 5 (Valiasr). As well as the month of December, all samples collected in December (n=50) are also lower than the EPA standard. The mean concentration of lead in our study (in December and January) was higher than the one in the study conducted by Ghaderpoor et.al in the field of lead concentrations in drinking water in Tehran (3.18±3.44 µg/l) (Ghaderpoor *et al.*, 2009). Lead concentration in the study conducted by Miranzadehet.al (10.5±0.12µg/l) was higher than that of our study (Miranzadeh *et al.*, 2010) . Also, the concentration of lead in drinking water in the study conducted by Fiket *et al.* (2007) was lower than the lead in our study Residents. But in the study conducted by Albaji *et al.* (2013) the lead concentration of drinking water in Ahwaz was higher than the one in our study. This difference in the concentration of lead in different places may be due to differences in the water sources (surface or groundwater), the kind of water infiltration or existing possible contaminations (Ahmed Baig *et al.*, 2010) .

In December, the concentration of lead in Azadegan, Valiasr, azadegan and 95 Dastgah and in December in the Valiasr area was higher than WHO and EPA standard level. According to One-Way ANOVA statistical analysis, the mean concentration of lead in December for the Azadegan (p value = 0.03), Shaykh Abbad (p value =0.04), city center (p value = 0.01) and 95 Dastgah (p value =0.03) compared with December has a significant difference (p value <0.05) (Figure 2). As in our study, non-carcinogenic risk in the study done by Muhammad *et al.,* (2011) Lim *et al.,* (2012) and Rajaei *et al.* (2012) non-carcinogenic risk was less than 1. But non-carcinogenic risk in the study conducted by Naveedullah et.al (HQ=0.664) was observed much higher than the one in our study. This huge difference with our results is due to greater concentration of lead in drinking water (30.82±22.16 µg/l) (Naveedullah *et al.*, 2014).

In conclusion, the mean concentration of lead in tap drinking water in December and January is lower than the WHO and EPA standard level. The mean concentration of lead in high-density areas (City center, Pakoh and Valiasr) is much higher than other areas. As the HQ for lead is less than 1, it can be thus said that consumer population of tap drinking water in Minab is in a safe area in terms of non-carcinogenic hazard of lead.

Table.1 The mean concentration of lead in 10 regions at Minab city in December 2014 (µg/l)

Region	
Azadegan	
Mean	**11.5**
Rang	**ND-13.3**
SD[2]	**4.35**
Ahmad abbad	
Mean	**9.6**
Rang	**8.8-11.1**
SD	**1.3**
Valiasr	
Mean	**11.6**
Rang	**10.1-13.6**
SD	**0.4**
City center	
Mean	**11.8**
Rang	**ND-13.5**
SD	**6.7**
Pakoh	
Mean	**9.6**
Rang	**8.8-9.8**
SD	**0.3**
Shaykh abbad	
Mean	**8.6**
Rang	**ND-10.6**
SD	**3.7**
95-Dasgah	
Mean	**11.2**
Rang	**10.1-13.6**
SD	**0.79**
Al Mahdi	
Mean	**5.8**
Rang	**5.4-6.1**
SD	**0.7**
Zohki	
Mean	**6.8**
Rang	**ND-7.6**
SD	**3.4**
Soleghan	
Mean	**8.9**
Rang	**7.7-9.6**
SD	**0.8**
Mean	**9.54**
SD	**2.07**

2 Standard Deviation

Table.2 The mean concentration of lead in 10 regions of Minab in January 2014(μg/l)

Region	
Azadegan	
Mean	3.6
Rang	ND-4.1
SD	1.8
Ahmad abbad	
Mean	4.6
Rang	4-5.3
SD	1
Valiasr	
Mean	11.6
Rang	ND-12.3
SD	3.5
City center	
Mean	8.6
Rang	7.3-9
SD	1.3
Pakoh	
Mean	7.9
Rang	7.3-8.3
SD	1.6
Shaykh abbad	
Mean	5.6
Rang	ND-6.3
SD	2.8
95-Dasgah	
Mean	5.6
Rang	5.3-7
SD	1.9
Al Mahdi	
Mean	6.8
Rang	5.9-7.3
SD	2.3
Zohki	
Mean	4.6
Rang	ND-5
SD	2.6
Soleghan	
Mean	5.8
Rang	3.2-6.6
SD	3.6
Mean	6.4
SD	2.3

Table.3 CDI and the of non-carcinogenicity risk (HQ) of lead in tap drinking water in December and January 2014

December		January	
[3]CDI	HQ	CDI	HQ
0.00027	0.00074	0.00018	0.0005

In December; CDI for lead is 0.00027 and HQ is 0.00074 and in January; CDIfor the lead is 0.00018 μg/kg-day and HQ is 0. 0005, respectively.

[3] Unit CDI is μg/kg-day

Figure.1 Collection areas of water samples, Minab city in Hormozgan Province, Iran

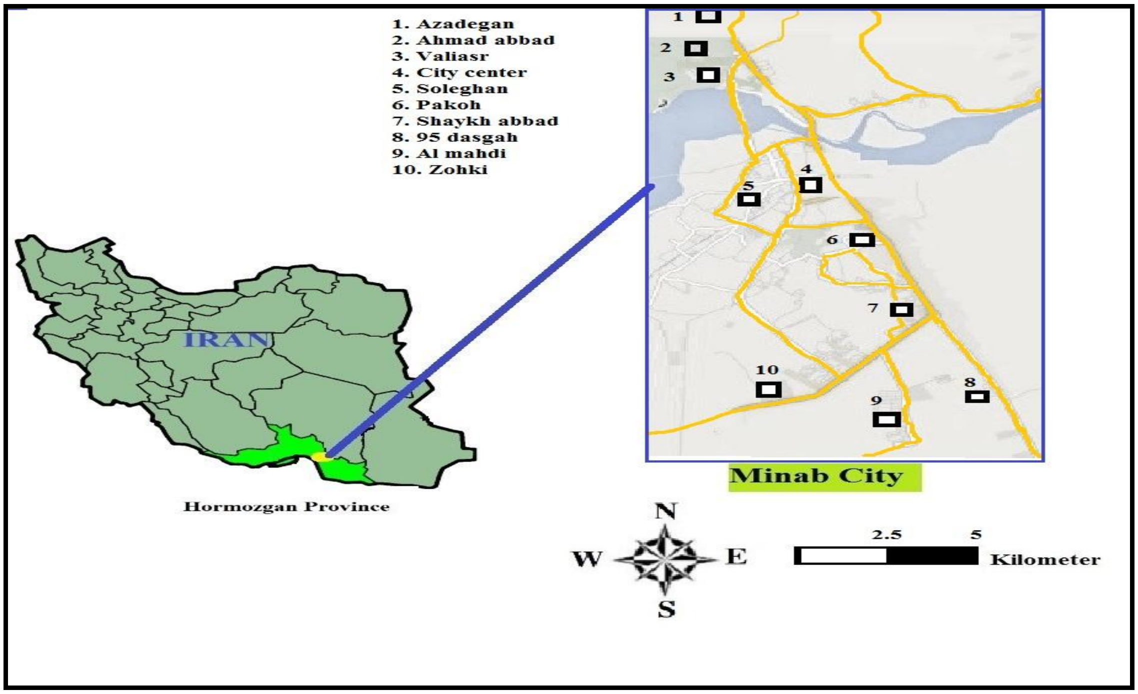
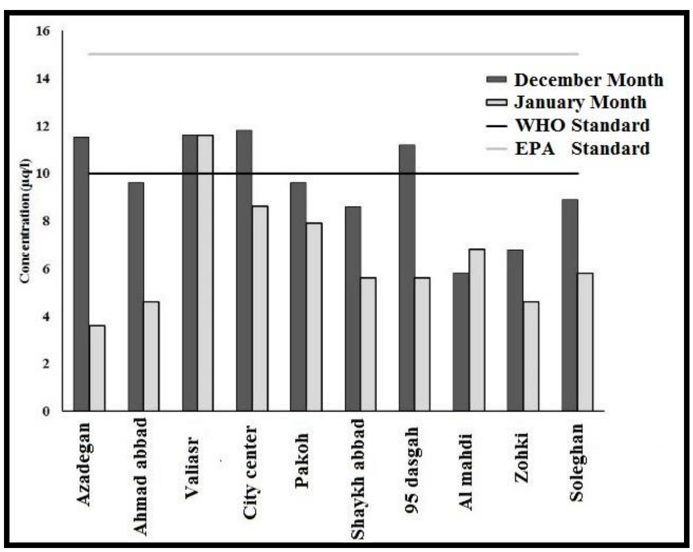


Figure.2 Comparing the concentration of lead in different areas of Minab city with WHO and EPA standards



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