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Lead in Drinking Water in Slovenian Kindergartens and Schools

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Abstract. The purpose of the work is to determine how high are the concentrations of lead in drinking water in older Slovenian kindergartens and primary schools and to demonstrate that lead can also migrate from newer materials used for the construction of water distribution networks. To determine the concentrations of lead in drinking water, it is needed to take 250 ml of drinking water that stood in the pipes from 8 to 18hours. It is also applied a method for determining the migration from different materials. An old lead pipe is utilized, as well as new materials (PEX-Al-PEX, copper, galvanized pipes and stainless steel pipes). Sampling showed that 6 samples of 39 had levels of lead higher than 10 μg/l, two of them highly exceeded that level. Negative correlation between the level of pH and concentration of lead in drinking water is moderate. Implementation of lead migration from various types of pipes demonstrated the migration from galvanized pipes in all simulants. Furthermore, the migration of lead from galvanized pipes is dependent on water temperature. The migration was confirmed from the lead pipe as expected. Study points to a problem with elevated concentrations of lead in drinking water faced by older kindergartens and primary schools in Slovenia. All concentrations of lead after flushing the pipes were below the 10 μg/l, which shows that the most effective action to lower the concentrations of lead is flushing the water pipes. For the purposes of national monitoring of drinking water is necessary to apply a better method for determining lead levels in drinking water namely the sampling of water that stood in the pipes at least 8 to 18 hours. This study has demonstrated the migration of lead from galvanized pipes. This material is also installed in 54 % of kindergartens and primary schools that participated in the study.

Keywords: lead, drinking water, water supply system, children, exposure

Introduction

Exposure to lead from the environment is an important public health problem. In the early ages of a child's life, it may cause permanent neurological and psychological changes. The International Agency for Research on Cancer has determined that inorganic lead is probably carcinogenic to humans (Group 2A) (International Agency for Research on Cancer, 2006).

Lead is most often found in water when water comes into contact with public or domestic water supply systems that contain lead pipes, taps, solder or other plumbing components. Lead in small quantities is also found in newer materials which are used for building water supply networks, and came into use in the early 80's of the 20th century. These materials include brass, ceramics and PVC (Al-Malack, 2001; Centers for Disease Control and Prevention, 2004; Drev, 2005; Golja, 2005; Vilarinho et al., 2004). The period between 1960 and 1970 should not be ignored as well, when the asbestos-cement pipes were in use - some studies have reported that the cement pipes may contain lead (Guo, 1997).

The Member States of the European Union have to comply with the Drinking Water Directive (98/83/EU) (1998), which sets an interim standard for lead in drinking water of 25 μg/l and a standard of 10 μg/l that will become a legal requirement from December 2013. EPA recommends that childcare facilities take action if samples show lead levels greater than 20 μg/l (US EPA, 2005).

The purpose of the work is to determine concentration levels of lead in drinking water in older Slovenian kindergartens and primary schools and to demonstrate that lead, in addition to its migration from lead pipes and lead parts of the water supply network, can also migrate from newer materials, namely brass, ceramics and PVC.

Materials and Methods

To determine the concentrations of lead in drinking water in kindergartens or schools, a sample of 250 ml of drinking water that stood in the pipes from 8 to 18 hours is required. The first draw sample has to be taken from the kitchen where food and drinks are prepared. After the first sample, a follow-up (flush) sample has to be taken. Before that, the water has to run for 30 seconds (Skipton et al., 2006). In the laboratory, ICP-MS method was used to determine the concentration of lead in water samples.

In addition to determining the levels of lead in drinking water in kindergartens and schools, the method for determining the migration from different materials used for the construction of water distribution networks is applied. An old lead pipe is utilized, which has already been installed in the facility, as well as new materials that have not been used (PEX-Al-PEX, copper, galvanized pipes and stainless steel pipes).

All samples of pipes were filled with different solutions: drinking water without preparation, drinking water with pH 6.5 and deionized water, and left for 18 hours in an incubator at a temperature of 23 ° C. The test was repeated with drinking water without preparation at a temperature of 80 ° C, in order to see whether the temperature has any effect on migration. After that, the determination of lead in solutions followed.

Results and Discussion

Study was conducted in 2010. Thirty-nine (39) old kindergartens and schools were selected; most institutions were built prior to 1980. An analysis of the samples showed that 6 samples out of 39 had levels of lead higher than 10 μg/l, three samples had lead concentration at the level 10 μg/l, and two concentrations in samples highly exceeded that (Figure 1). Negative correlation between the level of pH and concentration of lead in drinking water was moderate and confirmed the assumption that lower pH water results in higher concentration (WHO, 2011)

Implementation of lead migration from various types of pipes demonstrated the migration from galvanized pipes in all simulants: in drinking water without preparation at 23 ° C and 80 ° C, in drinking water with pH 6.5 and in deionized water (Figure 2). The migration tests also demonstrated that the migration of lead from galvanized pipes is dependent on water temperature. The migration of lead was confirmed from the lead pipe as expected.

The exposure to lead in drinking water for a 6-year-old child, who weighs app. 20 kg and drinks 1.2 liters of water per day, has been calculated, assuming that the proportion of the input of lead through drinking water is 50 %. In case that the child drinks the water with the highest measured concentration of lead in our study (i.e. 42 mg / l), the exposure is 17.64 mg / kg body weight, which exceeds the old PTWI for lead in drinking water which was 12.5 mg / kg body weight (WHO, 2011).

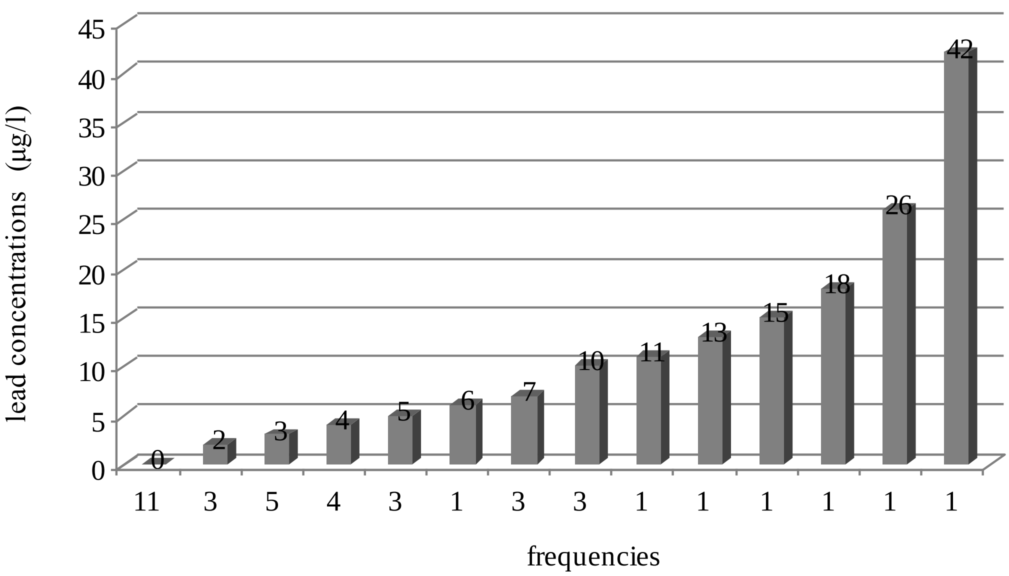

Fig.1 Frequency distribution of lead concentrations measured in selected kindergartens and schools in Slovenia

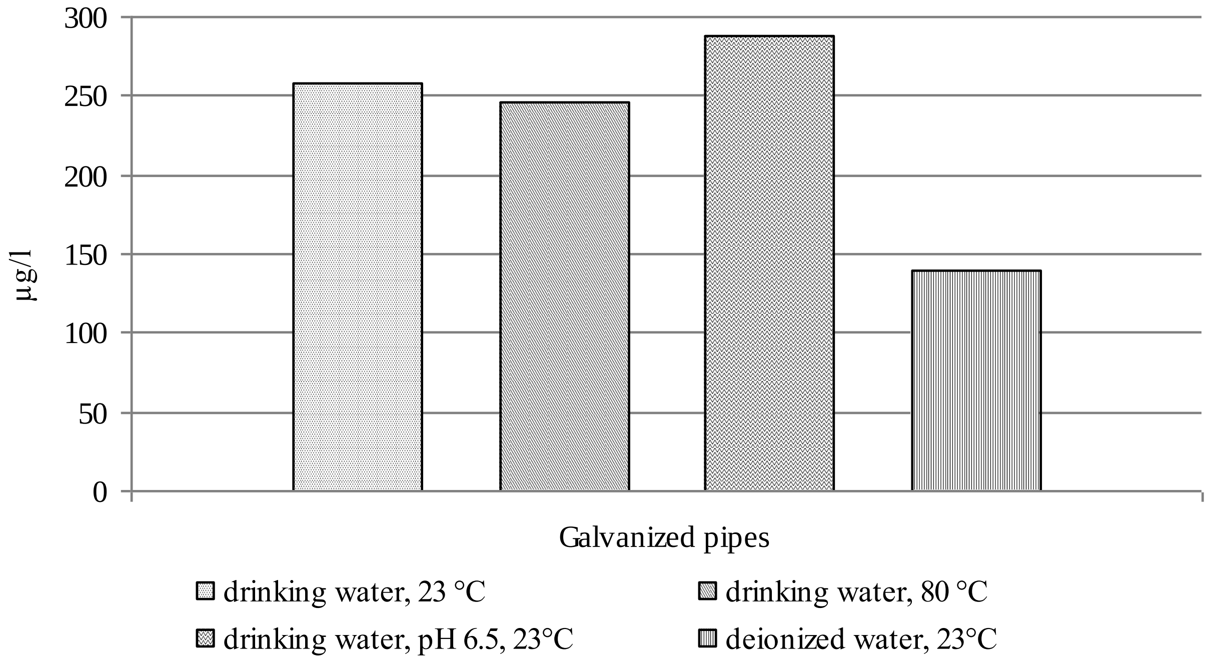

Fig.2 The migration of lead from galvanized pipes filled with different solutions

Conclusion

The study exposes the problem of elevated concentrations of lead in drinking water found in older kindergartens and primary schools. All concentrations of lead after flushing the pipes were below 10 μg/l, which shows that the most effective and expeditious action to lower the concentrations of lead in drinking water is flushing the water pipes for a few minutes. A collection of samples will be repeated in summer because water temperatures can get higher even by 10 ° C and the concentrations of lead in drinking water can be doubled (Gray, 2008). For the purposes of national monitoring of drinking water it is necessary to apply a new method for determining lead levels in drinking water, for example: sampling of water that stood in the pipes for at least 8 to 18 hours.

This study has demonstrated the migration of lead from galvanized pipes in all simulants. It is important to add that in our study 54 % institutions had galvanized pipes in the water supply network and 11 % had lead pipes installed in the network. Consequently, the probability to find lead in their drinking water was even higher.

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