

## Significant decrease of blood lead levels in lead-exposed workers due to effective preventive measures.

Los F.<sup>1</sup>, Kotackova L.<sup>1</sup>, Zima T.<sup>1</sup>

Institute of Clinical Biochemistry and Laboratory Diagnostics, 1<sup>st</sup> Medical Faculty, Charles University, Prague, Czech Republic

### SUMMARY

**Objective:** Monitoring trends in blood lead concentrations (plumbemia) of lead-exposed workers during years 2005 - 2012. Determining the effectiveness of preventive measures on reducing lead exposure (decreasing plumbemia) was investigated.

**Design:** Observation prospective study

**Material and Methods:** The study was performed on 236 workers of a battery industry factory in period 2005 – 2012. Workers were divided into 4 groups based on their initial plumbemia in the year 2005 (< 200 µg/l, 200 – 299 µg/l, 300 – 399 µg/l, ≥ 400 µg/l). Plumbemia was measured using graphite furnace atomic absorption spectrometry. Paired t-test was used for statistic interpretation.

**Results:** The most significant decrease in plumbemia between years 2005 – 2012 was measured in the group of workers with initial plumbemia ≥ 400 µg/l (average decrease to 37 % by the year 2012,  $t(63) = 29.105$ ,  $p < 0.001$ ). Significant decreases were measured also in other groups of workers with initial plumbemia 300 – 399 µg/l (average decrease to 41 %,  $t(70) = 32.704$ ,  $p < 0.001$ ), 200 – 299 µg/l (average decrease to 42 %,  $t(67) = 34.208$ ,  $p < 0.001$ ) and under 200 µg/l (average decrease to 51 %,  $t(32) = 11.663$ ,  $p < 0.001$ ).

**Conclusion:** In all groups of lead-exposed workers we found significant decrease in plumbemia during years 2005 – 2012. Our data show that applied preventive measures are highly effective in decreasing plumbemia.

**Key words:** plumbemia, atomic absorption spectrometry.

### SOUHRN

**Los F., Kotackova L., Zima T.: Významné snížení plumbémie při dodržování preventivních opatření u pracovníků vystavených zvýšené zátěži olovem**

**Cíl studie:** Sledování trendů koncentrací olova v krvi (plumbémie) u pracovníků vystavených zvýšené zátěži olovem během let 2005 - 2012. Hlavním účelem studie bylo posoudit efektivnost zavedených preventivních opatření na snížení expozice olovem (snížení plumbémie).

**Typ studie:** Observační prospektivní studie

**Materiál a metody:** Do studie bylo zařazeno 236 pracovníků bateriového průmyslu. Podle vstupních hodnot plumbémií z roku 2005 jsme pracovníky rozdělili do čtyř skupin (< 200 µg/l, 200 – 299 µg/l, 300 – 399 µg/l, ≥ 400 µg/l). Plumbémie byla stanovena metodou bezplamenové atomové absorpční spektrometrie. Pro statistické vyhodnocení byl použit párový t-test.

**Výsledky:** Nejvýznamnější pokles v plumbémii mezi lety 2005 – 2012 byl zaznamenán ve skupině pracovníků s nejvyšší vstupní hodnotou plumbémie ≥ 400 µg/l (průměrný pokles na 37 % k roku 2012,  $t(63) = 29.105$ ,  $p < 0.001$ ). Významné poklesy byly zjištěny i u všech ostatních skupin pracovníků – se vstupní hodnotou plumbémie 300 – 399 µg/l (průměrný pokles na 41 %,  $t(70) = 32.704$ ,  $p < 0.001$ ), 200 – 299 µg/l (průměrný pokles na 42 %,  $t(67) = 34.208$ ,  $p < 0.001$ ) a pod 200 µg/l (průměrný pokles na 51 %,  $t(32) = 11.663$ ,  $p < 0.001$ ).

**Závěr:** U všech skupin pracovníků vystavených zvýšené zátěži olovem jsme sledovali významné snížení plumbémie během let 2005 – 2012. Tato studie ukazuje, že zavedená preventivní opatření jsou vysoce efektivní.

**Klíčová slova:** plumbémie, atomová absorpční spektrometrie.

## Introduction

Lead can have an adverse effect on human organism as it affects the synthesis of heme, has neurotoxic and nephrotoxic effects and can possibly reduce fertility. Lead is accumulated in bones and some of the organs and is released from these pools during stress of organism. Monitoring of lead blood concentration (plumbemia), which reflects the total lead level in the organism, is therefore very important, especially for persons with higher lead exposition [1- 3]. The maximal permitted value of plumbemia in lead-exposed workers is 400 µg/l [4]. Plumbemia of all such workers is periodically monitored. Preventive measures are taken to keep plumbemia within ranges defined

by law. We studied the effect of preventive action on plumbemia of lead-exposed workers from battery industry.

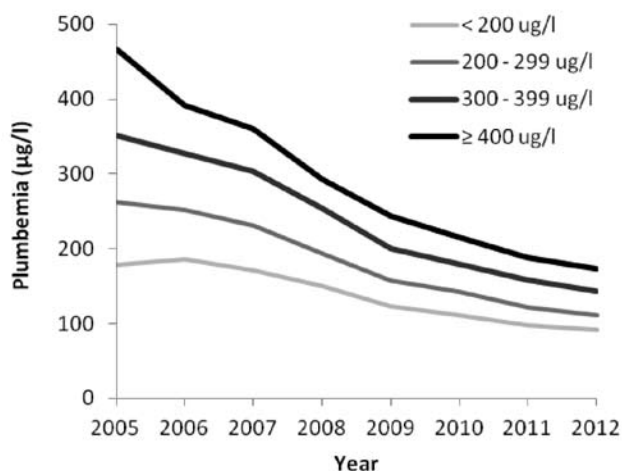
## Material and methods

The study group comprises 236 workers of a battery industry factory (Johnson Controls). Their average annual plumbemia was measured during years 2005 – 2012 and all of the workers were controlled at least once every year. We expected the largest decrease in plumbemia in cases of workers with high initial plumbemia. Therefore we divided the workers into 4 groups based on their initial plumbemia in the year 2005:

< 200 µg/l (33 subjects), 200 – 299 µg/l (68 subjects), 300 – 399 µg/l (71 subjects), ≥ 400 µg/l (64 subjects). In these groups we assessed the average percentage decrease in plumbemia by the year 2012 (comparing the year 2005 and 2012). The decrease in plumbemia was used to determine the effectiveness of preventive measures on reducing lead exposure. Plumbemia was measured using graphite furnace atomic absorption spectrometry using Varian 220 FS with GTA 110 device. Used method has coefficient of variation 8.44 % and expanded uncertainty 18.6 %. Plumbemia was measured in whole blood samples collected in special containers for trace element analysis. Paired t-test was used for statistic interpretation.

## Results

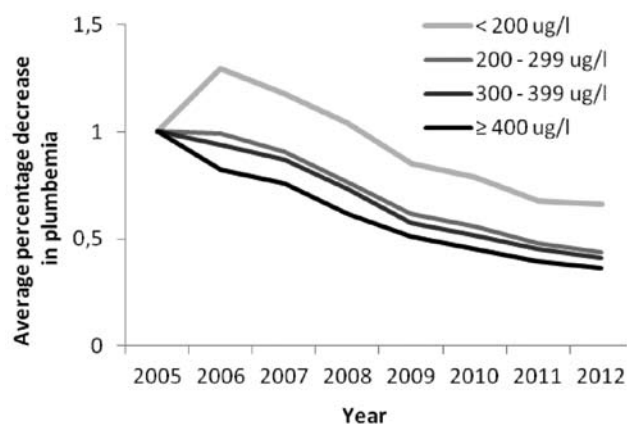
The results of our measurements are shown in the presenting figures. In all groups we found decrease in average plumbemia by the year 2012 (Fig. 1). In the group of workers with initial plumbemia < 200 µg/l we saw initial increase in average plumbemia by the year 2006. This is mainly caused by three individuals of the group whose plumbemia substantially increased in the year 2006 (from < 200 µg/l to 416 µg/l, 394 µg/l and 318 µg/l, respectively). Subsequently average plumbemia of this group decreased in following years. Average plumbemia of other groups decreased during the whole period 2005 – 2012.



**Fig. 1.** Average decrease in plumbemia in period 2005 – 2012. In the group < 200 µg/l initial increase in average plumbemia was measured by the year 2006 but subsequently plumbemia decreased in following years. In other groups we found decrease in plumbemia during the whole period.

In all groups we found significant average percentage decrease in plumbemia between years 2005 – 2012 (Fig. 2). As expected the most significant decrease was in the group of workers with initial plumbemia ≥ 400 µg/l. In this group we measured the average decrease to 37 % by the year 2012 ( $t(63) = 29.105$ ,  $p < 0.001$ ). Significant decreases were measured also in other groups. In the group of workers with initial plumbemia 300 – 399 µg/l we found average decrease to 41 % by

the year 2012,  $t(70) = 32.704$ ,  $p < 0.001$ ). Similar results of decreased plumbemia to 42 % ( $t(67) = 34.208$ ,  $p < 0.001$ ) we found in the group of workers with initial plumbemia 200 – 299 µg/l. In the group of workers with the lowest initial plumbemia under 200 µg/l we measured the smallest but still significant decrease in plumbemia to 51% by the year 2012 ( $t(32) = 11.663$ ,  $p < 0.001$ ).



**Fig. 2.** Average percentage decrease in plumbemia in period 2005 – 2012 (annual average percentage decrease was counted comparing the initial plumbemia in 2005). In all groups we found significant decrease in plumbemia by the year 2012.

## Discussion

The differences in initial plumbemia of 4 groups are probably due to the different length of occupational period of exposure and/or the placement in the factory.

In all groups we found significant decrease in plumbemia by the year 2012. As we expected the most significant decrease was in the group with highest initial plumbemia (≥ 400 µg/l). Such plumbemia exceeds the maximal permitted value in lead-exposed workers. These workers must strictly follow the preventive measures and they are more frequently monitored. This probably leads to the greater decrease of plumbemia in this group in comparison with other groups.

Results of this study highlight the effectiveness of preventive measures in reduction of lead exposition which is associated with decrease in plumbemia.

## Conclusion

We found significant decrease in plumbemia in all groups of lead-exposed workers during years 2005 - 2012. Our data show that applied preventive measures in the factory (high sanitation standards, protective equipment, industrial security) are highly effective in lowering lead exposition and decreasing plumbemia.

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*Adresa pro korespondenci*  
*MUDr. Mgr. Lenka Kotačková*  
*ÚLBDL VFN a 1. LF UK v Praze*  
*U Nemocnice 2*  
*128 08 Praha 2*  
*email: lenka.kotackova@vfn.cz*