

## Lead (Pb) poisoning in children from townships around an extensive lead-zinc mine in Kabwe, the Republic of Zambia

NAKAYAMA, Shouta<sup>1\*</sup>; YABE, John<sup>2</sup>; IKENAKA, Yoshinori<sup>1</sup>; BEYENE, Yared<sup>1</sup>; BORTEY-SAM, Nesta<sup>1</sup>; OROSZLANY, Balazs<sup>1</sup>; MUZANDU, Kaampwe<sup>2</sup>; CHOONGO, Kennedy<sup>2</sup>; MWEENE, Aaron<sup>2</sup>; KABALO, Abel<sup>3</sup>; MIZUKAWA, Hazuki<sup>1</sup>; ISHIZUKA, Mayumi<sup>1</sup>

<sup>1</sup>Graduate School of Veterinary Medicine, Hokkaido University, <sup>2</sup>School of Veterinary Medicine, University of Zambia, <sup>3</sup>Kabwe District Health Office, Ministry of Health

Childhood lead (Pb) poisoning is a serious public health concern worldwide. Young children under the age of 7 years are particularly vulnerable to Pb poisoning because of behavioral factors, such as frequent hand-to-mouth activities and biological factors including greater gastrointestinal absorption compared to adults and developing neurological systems. Lead exposure among children is associated with developmental abnormalities including impaired cognitive function, reduced intelligence, impaired hearing and reduced stature.

In Kabwe, Zambia, the capital of Central Province, extensive contamination of Pb in soils, wild rats as well as offal of cattle and chicken in townships in the vicinity of a lead-zinc mine has been reported and poses a serious health risk to children in these townships. We have previously reported that the concentrations of Pb (9-51188 mg/kg) in Kabwe soil (n=101) were much higher than benchmark values. Pb levels in tissues of Kabwe cattle were higher than those in other Zambian towns. Moreover, mean concentrations of Pb exceeded maximum levels for human consumption in some organs including muscle in free-range chickens, in contrast to low levels in broiler chickens, suggesting Pb exposure. Therefore, this study investigated blood lead levels (BLLs) in children in townships around the Pb-Zn mine in Kabwe and to identify children with BLLs that require medical intervention so as to mitigate the toxic effects of Pb.

The study was approved by the University of Zambia Research Ethics Committee and the Ministry of Health, Zambia. After informed and written consent was obtained from the parents or guardians, blood samples up to 3 mL (17 samples at Chowa, 100 samples at Kasanda and 129 samples at Makululu) were collected by qualified laboratory technicians from the children at clinics in the study areas. For each child, data on the age, sex and residential area were recorded. The blood samples were promptly transferred and stored at the laboratory of the Kabwe District Health Offices. The samples were transported to Japan and analyzed for Pb concentrations by ICP-MS.

Almost all of the sampled children in the current study had indications of Pb poisoning, with BLLs exceeding 5 microgram/dL. Children in these areas could be at serious risk of Pb toxicity as 18% of the sampled children in Chowa, 57% (Kasanda) and 25% (Makululu) had BLLs exceeding 65 microgram/dL. Eight children had BLLs exceeding 150 microgram/dL with the maximum being 427.8 microgram/dL. When children were grouped according to age, younger children between the ages of 0-3 years accumulated higher BLLs than their older counterparts (4-7 years). Significant negative correlation between age and BLLs supported this finding. This study demonstrated that childhood Pb poisoning in Kabwe is among the highest in the world. Although clinical cases and deaths due to Pb poisoning among children in Kabwe are rare, these findings indicate that more studies are needed to establish the health effects of Pb poisoning in children exposed to Pb pollution in townships around the Pb-Zn mine in Kabwe.

Given that Pb poisoning among children in Kabwe was extensive, it is recommended that chelation therapy be commenced in the children with BLL exceeding 45 microgram/dL prior to the onset of symptoms to reduce morbidity and prevent mortality in the affected children. This can be achieved for each child by devising and implementing an individualized plan of follow-up, especially for those children with extremely high BLLs.

Keywords: Zambia, Kabwe, Lead, Children, Mining