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# Medical implications of reduction of blood lead levels in children after polluted site remediation in Meza valley, Slovenia


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## INTRODUCTION:

The Meza valley, Slovenia, with a population of 6000 and three main residential communities (Mežica, Črna and Zerjav) was the site of lead mining and smelting. More than 300 years of industry and an unique, isolated topography have left the valley heavily contaminated, with soil levels of lead up to 8000mg/kg (critical regulatory threshold limit 530mg/kg) (2).

Due to behavioral and physiologic characteristics, young children up to 5 years of age are most at risk of exposure and long-term negative effects of lead poisoning (4). The potential of mitigating the risk of lead poisoning by remediation of soil with EDTA has been investigated by applying the Integrated Exposure Uptake Bio-Kinetic (IUBK) model (1).

## PATHOPHYSIOLOGY:

Lead has pathophysiologic effects on multiple organ systems, principally the neurologic (peripheral in adults, central in children) and hematologic systems and gastrointestinal tract, but also affecting the kidneys, endocrine and reproductive function and the bone matrix (6). It exerts its toxic influence via its affinity for sulphydryl groups, interference with calcium and zinc mediated metabolic pathways and mitochondrial injury (4).

Children represent the most vulnerable group, due to increased exposure because of age-related hands-mouth activity, higher absorption rate from the lungs and gastrointestinal tract (50% vs. 15% in adults), lower rate of excretion and higher percent of distribution to soft tissues (70% vs 90% in adults) including the vulnerable developing brain, which is made more accesible by an immature blood brain barrier (4).

Slow redistribution from the skeleton, which is the site of greatest accumulation, may elevate blood lead levels (BLL) for years after even sporadic exposure and accelerated mobilisation during times of increased turnover (pregnancy, immobilisation), may lead to unexpected peaks (6).

## METHODS:

In a study by Erika Jez and Domen Lestan from the Biotechnical Faculty of University of Ljubljana, laboratory-scale remediation of 268 soil samples from the Meza valley with EDTA was proven to have the potential of reducing the area of critically high soil lead content by 91%. By next applying the Integrated Exposure Uptake Bio-Kinetic (IUBK) model to the obtained data of total and bio-accessible soil lead concentrations, the method's potential of mitigating the risk of lead poisoning was investigated.

The IUBK model, that currently includes more than 120 equations that describe the uptake and bio-kinetic processes of children's lead exposure, predicted that soil remediation would successfully decrease the number of locations at which the predicted BLL exceeds the stipulated of 10 µg/dl (Slovenian legislation) by 90% (88% and 91% respectively) in the towns of Mežica, Zerjav and Črna. The mean BLL in 3-year old children was predicted to decrease by approximately a half. The lower bio-accessibility of lead in remediated soil, suggests that the actual decrease in BLLs would be even greater than the values predicted by the IUBK. (1,2,3)

## MEDICAL IMPLICATIONS:

As of 2012, the CDC has lowered the reference BLL to 5 µg/dl and eliminated the term threshold (7), as even lower values are proven to be in correlation with a reduction of IQ (up to 4.6 IQ point decrement for each 10 µg/dl and a 7.4 point loss in the 1-10 µg/dl range) (4,5), behavioral (hyperactivity, aggression), and academic problems (decreased attention span, cognitive flexibility, problems with abstract reasoning, as well as impaired fine motor function (5, 10), short stature, delayed puberty and hormonal disbalance (11).

The slightly higher levels that are found in 16/16 sites in Zerjav, 8/30 in Mežica and 19/33 sites in Črna (1) can lead to hematological toxicity, retinal damage, arterial hypertension in adult life as well as nephrotoxicity in vulnurable individuals (4,8,9).

Soil remediation with EDTA reduces exposure to environmental lead. The number of sites where the BLL would exceed 10 µg/dl are predicted to decrease from 16/16 to 10/16 in Zerjav, 9/30 to 3/30 in Mežica and 19/33 to 3/33 in Črna. This is particularly important in the case of Zerjav, where in 4 out of 16 sampling areas the measured BLLs in children are over 30 µg/dl that can be associated with clinically overt lead poisoning (anemia, flu-like symptoms, irritability, loss of aquired skills, abdominal cramps, loss of apetite) which is usually only recognised in retrospect (1,6).

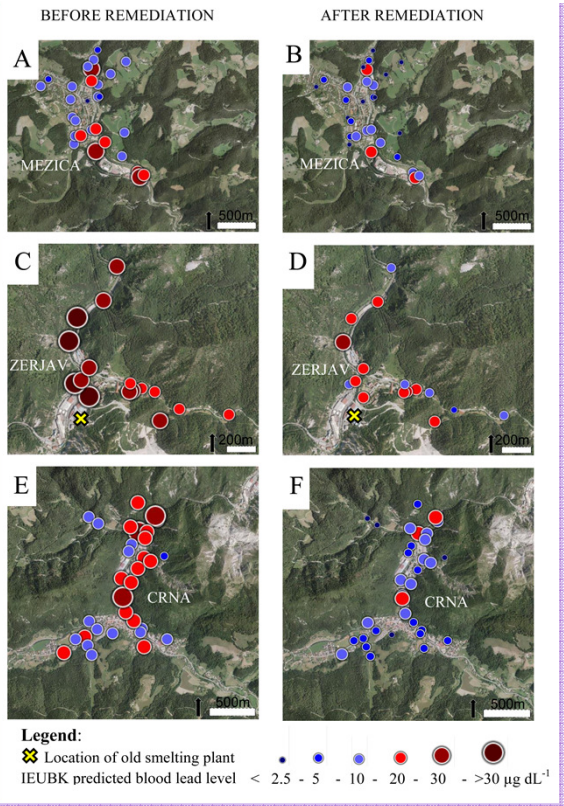
After remediation, the IUBK model predicts none of the BLLs would exceed 30 µg/dl and in only one area would it be more than 20 µg/dl. The mean BLL in Zerjav is predicted to decrease from 24.88 µg/dl to 11.72 µg/dl, in Mežica from 9.38 µg/dl to 0.48 µg/dl and in Črna from 11.54 µg/dl to 0.54 µg/dl (1), which correlates with an approximately 7.4 and 5 point increase of expected IQ in children, respectively (4).

## CONCLUSION:

No threshold for the health effects of lead is demonstrable. Intoxication with lead has permanent and generally irreversible consequences and long-term detrimental effects are present even after sporadic exposure due to the accumulation of lead in the body (6).

Even though acute intoxication with encephalopathy has become a rare occurance in the developed world, lead's neurocognitive and behavioral effects can prevent generations of children from reaching their innate potential and create strain on health and social services.

The only feasible way of diminishing lead-associated morbidity is to prevent lead from ever entering the body. Soil remediation is the most costly component of the rehabilitation of lead-contaminated sites but it's capacity to ameliorate the hazardous conditions in Meza valley and to prevent detrimental effects on the health of children is considerable, making it a viable management option.





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