Ministry of Environment, Forestry and Tourism

**BirdLife South Africa**

**Lead Advocacy Workshop for the Conservation of Southern African Vultures**

**27th and 28th February 2024 (Windhoek, Namibia)**

# The Impact of lead contamination in the vicinity of a lead-zinc mine in Kabwe, Zambia: a One Health approach


Yabe John

Team Leader –University of Namibia, University of Zambia (KAMPAI - G2 Team Leader)

jyabe@unam.na; john.yabe@unza.zm

Nakayama S, Yohannes YB, Nakata H, Toyomaki H, Muzandu K, Kataba A, Zyambo G, Moonga G, Munyinda NS, Mufune T, Liazambi A, Chawinga K, Sakala D, Ikenaka Y, Choongo K, Ishizuka M

# Profile – John YABE



## PERSONAL INFORMATION

Name: **John Yabe (PhD)**
Present Position: Senior Lecturer, University of Namibia
Research Publications: 59 (Peer Reviewed)
World Expert on Lead - Top 0.05%
Google Scholar H-index: 20

## ACADEMIC QUALIFICATIONS

1. **2012: PhD;** (Veterinary Pathology - Toxicological Pathology): Hokkaido University, Laboratory of Comparative Pathology, Graduate School of Veterinary Medicine, Japan
2. **2007: MSc;** (Veterinary Pathology): University of Zambia, Lusaka, Zambia
3. **2003: BVM;** University of Zambia, Lusaka, Zambia


lead the way against LEAD

# Lead Toxicity – Brief General Overview



## Lead Toxicity

- Lead (Pb) is a soft, silvery white or gray-black metal.
- It is malleable, ductile, and dense and is a poor conductor of electricity.
- It is ubiquitous in the environment
- It has no known biological role in humans or animals
- Serious problem in developing countries (extractive industries)
- Anthropogenic activities are the main sources of exposure

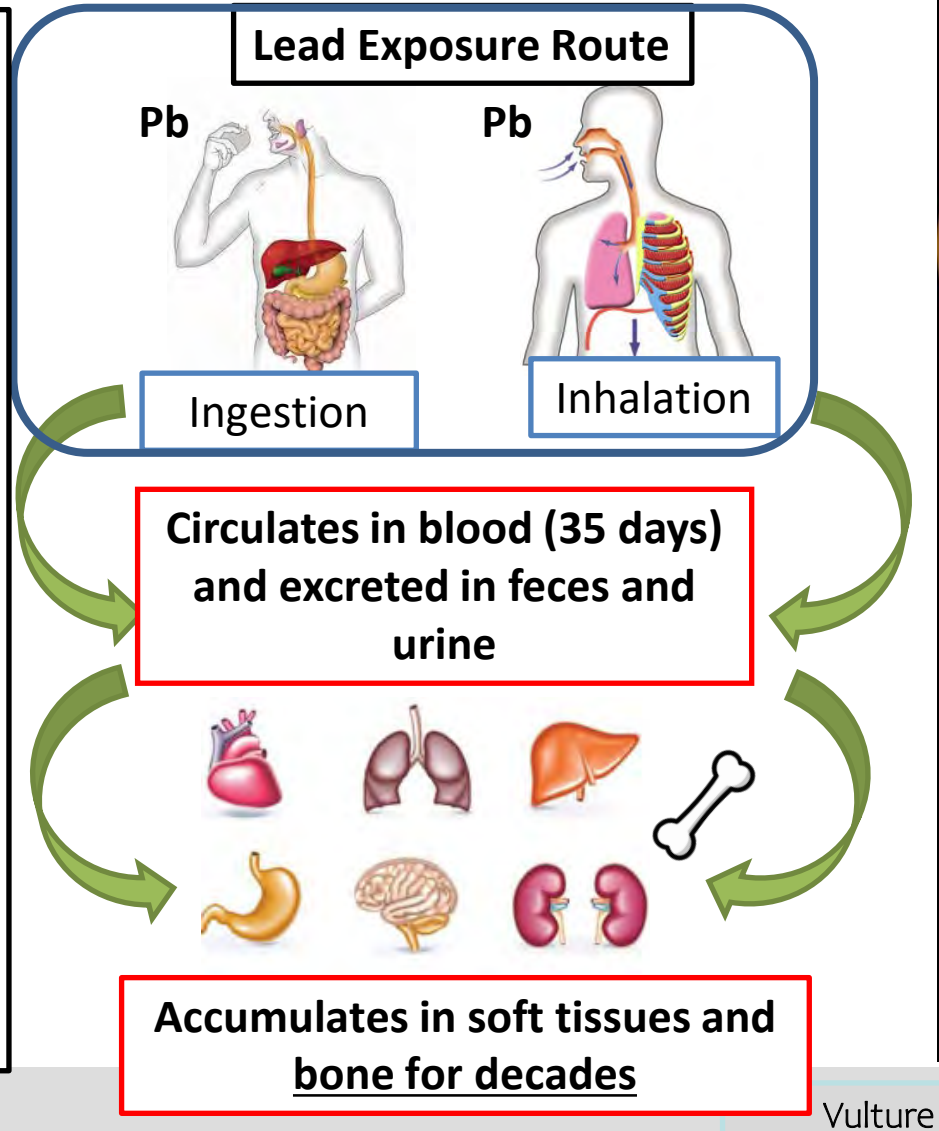



# Toxicokinetics of lead: Absorption, Distribution, Metabolism, and Excretion



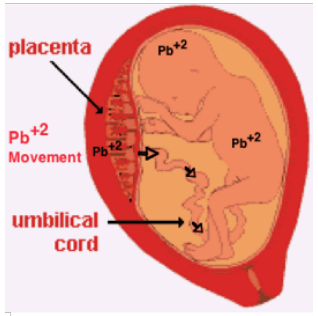
## Lead Toxicity

- Pb has a half-life of 35 days in the blood
  - Disseminated to various organs.
  - It accumulates in bones for decades.
- Negatively impacts pregnancy outcomes of mothers.
- Trans-placental exposure effects include:
  - preterm labour, abortions, stillbirth, low birth weight.
- Fatal cases of Pb toxicity have been reported in humans.



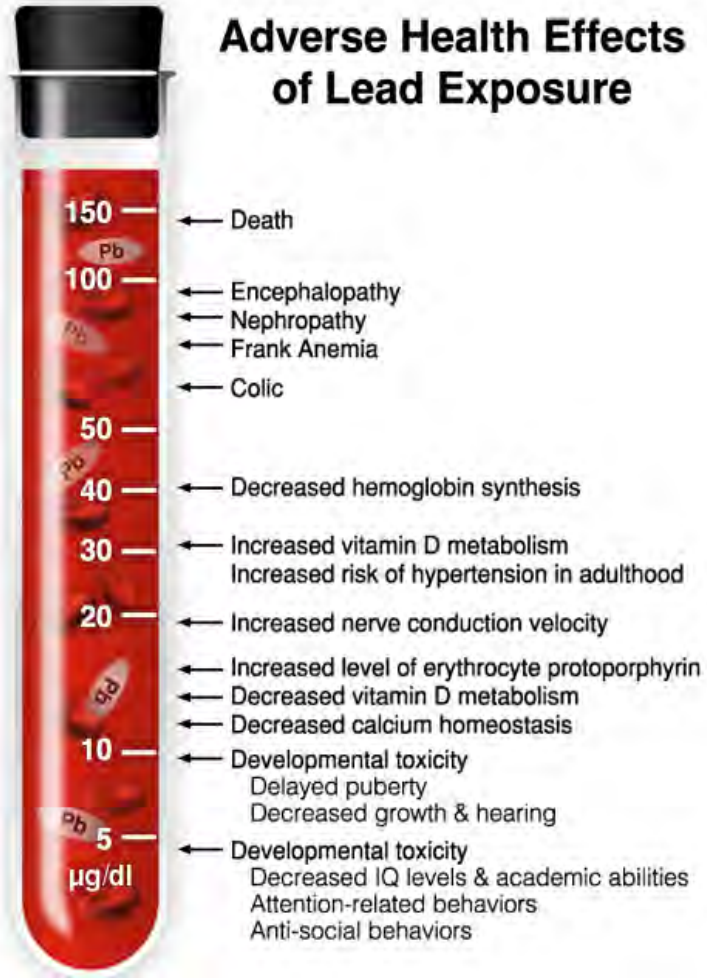

# Most at risk

Pregnant women




Developing fetus

Children



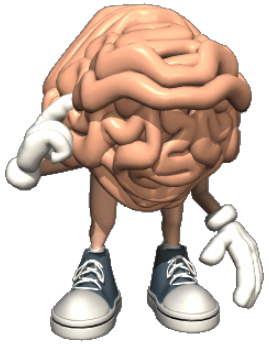

**Current CDC reference level = 3.5µg/dL**

# Toxic Effects of Lead



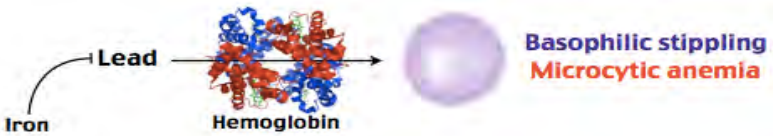
## Neurological and Developmental Effects

- **Affect the brain by multiple mechanisms**
  - Act as a surrogate for calcium and/or disrupt calcium homeostasis
  - A 2- to 4-point IQ deficit for each µg/dL increase in BLL



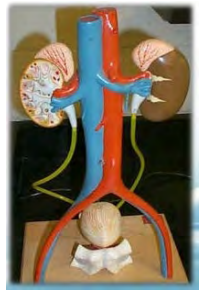
## Hematologic Effects

- **Affect HEME synthesis by inhibition of ALAD activity**




## Renal and hepato-Toxicity

- **Cause lead nephrotoxicity which lead to renal failure**
- **Often damage is not detected until it's too late**



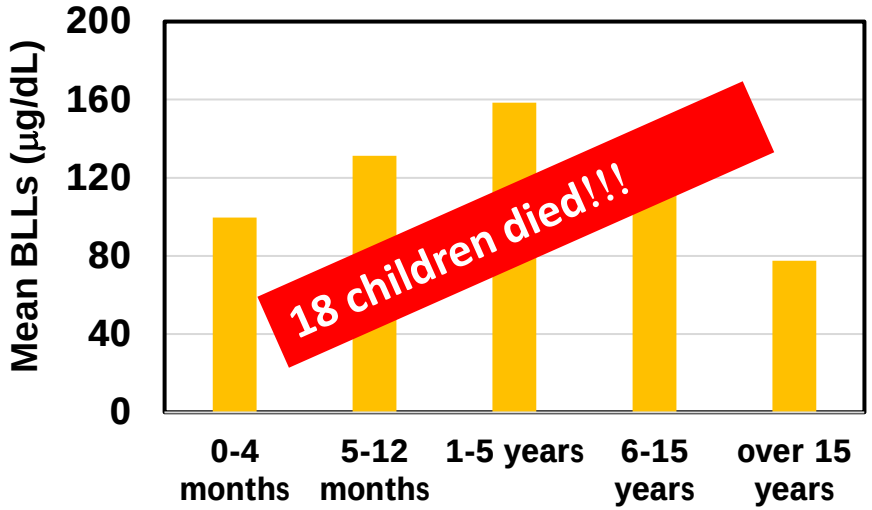
# Pb poisoning incidences in Africa...



## Dakar, Senegal

**Mass Lead Intoxication from Used Lead-Acid Battery Recycling in Dakar, Senegal**

EHP volume 117 (10), 2009




## Zamfara, Nigeria

**Massive Childhood Lead Poisoning**

The Price of Nigerian Gold

Childhood lead poisoning on a scale unheard of for decades has been detected in rural northwestern Nigeria [*EHP* 120(4):601–607;



**Going for GOLD, but poisoned by LEAD**

2010: approximately 400 children died
2015: 27 children died

# KAMPAI Project Summary and ZA.ZINAMBO Project Plans




KAMPAI Summary: Lead Poisoning-Kabwe, Zambia

ZA.ZINAMBO Project: Arsenic & Lead Pollution – Tsumeb and Rosh Pinah, Namibia

# Kabwe

- Capital of Zambia's Central Province
- 230,000 population size

- Long history of Pb-Zn mining; **from 1902 to 1994**


## Kabwe town is known as:


**KABWE IN TOP 10 MOST POLLUTED TOWNS**

**POST ON: February 12, 2015**

TIMES OF ZAMBIA
Forward with the Nation

Top 10 Most Polluted Places | 2007

www.worstpolluted.org/projects

PURE EARTH
BLACKSMITH INSTITUTE

# Exposure factors in the vicinity of the mine in Kabwe



Scavenging for lead on tailings dump

Children playing on lead contaminated soils

Houses less than 500m away from tailings dump

Women and children crushing stones to sell as gravel

Lead contaminated central canal – annual flooding

# Pre-KAMPAI: lead poisoning in children (first human report)





Chemosphere 119 (2015) 941–947

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

## Lead poisoning in children from townships in the vicinity of a lead–zinc mine in Kabwe, Zambia ☆

John Yabe [a,1], Shouta M.M. Nakayama [b,1], Yoshinori Ikenaka [b], Yared B. Yohannes [b], Nesta Bortey-Sam [b], Balazs Oroszlany [b], Kaampwe Muzandu [a], Kennedy Choongo [a], Abel Nketani Kabalo [c], John Ntapisha [c], Aaron Mweene [a], Takashi Umemura [b], Mayumi Ishizuka [b,*]

[a] The University of Zambia, School of Veterinary Medicine, P.O. Box 32379, Lusaka, Zambia
[b] Laboratory of Toxicology, Department of Environmental Veterinary Sciences, Graduate School of Veterinary Medicine, Hokkaido University, Kita 18, Nishi 9, Kita-ku, Sapporo 060-0818, Japan
[c] Ministry of Health, District Health Office, P.O. Box 80735, Kabwe, Zambia

### HIGHLIGHTS

- We measured blood lead levels in children near a Pb–Zn mine in Zambia.
- 100% of the sampled children under 7 years had BLLs > 5 μg $dL^{-1}$.
- Highest BLLs were seen in children around the age of 2 years.
- BLLs > 150 μg $dL^{-1}$ were recorded 8 children with a maximum of 427.8 μg $dL^{-1}$.
- The children living around the Pb–Zn mine are at serious risks of Pb poisoning.

### ARTICLE INFO

### ABSTRACT



Yabe et al. 2015. Chemosphere: 19, 941–947

# KAMPAI Project 2016 - 2022: Output Two Objectives



- Human health risk assessment and socio-economic impact of lead pollution in Kabwe
  - Household blood Pb concentration variations
  - Childhood Pb exposure through breast milk
  - Pb metabolism (urine and feces) in infants/children
  - Assessing biomarkers of exposure and effect
  - Cognitive assessment – IQ analysis
  - Assessing effects of Pb on Quality of Life
  - Neurodevelopmental impact assessment of Pb exposure in children
  - Socio-economical impact assessment of Pb pollution

ZMERIP (Treatment)

Remediation

PURE EARTH
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# Current trends of blood lead levels in Kabwe, Zambia



- Measured lead contamination among household members in Kabwe communities to characterize the town's burden of disease.
- This in turn would help define interventions to mitigate Pb exposure and alleviate adverse health outcomes.

- Blood
- Urine
- Fecal
- Breast milk

**KAMPAI broad surveillance - 2017**

**1000 households**

| | Father | Mother | < 4 years old | ≥ 4 years old |
|---|---|---|---|---|
| **Human Risk assessment** | ○ | ○ | ○ | ○ |
| **Urine and fecal Pb analysis** | ○ | ○ | ○ | ○ |
| **Quality of Life** | ○ | ○ | ○ | ○ |
| **Neurodevelopmental impairment** | | ○ | ○ | |
| **Milk lead levels and correlations** | | ○ | ○ | |

# Study sites

**Blood samples were collected from:**

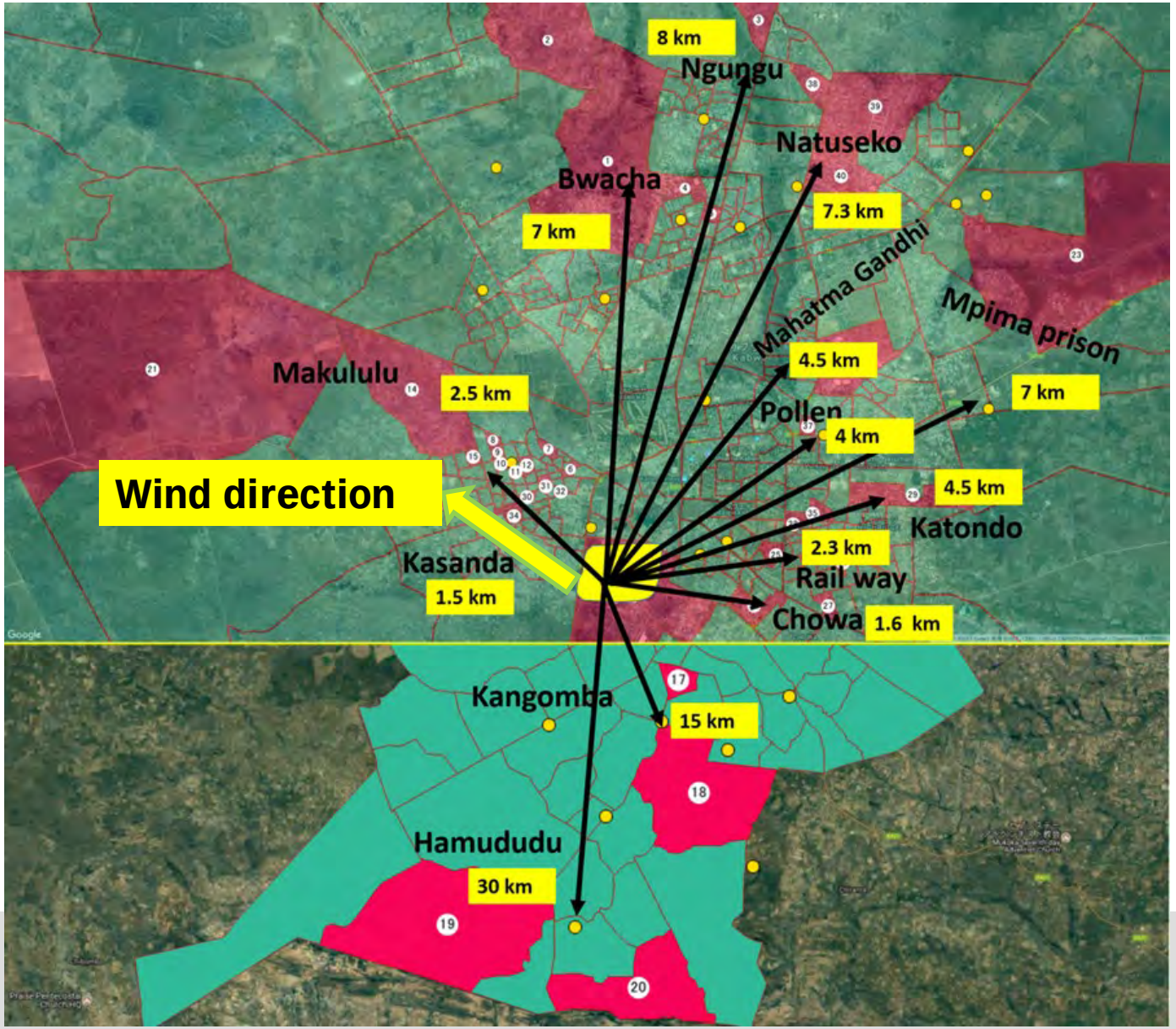
- 40 Standard Enumeration Areas (SEAs)
- 13 clinics
- About 1250 participants

**Venous blood**

Collected at each health center by laboratory technicians and nurses

**Pb analysis**


July-August, 2017




- Ethical clearance by UNZABREC & MOH
- Written informed consent obtained from parents

# Current trends of blood lead levels in Kabwe, Zambia



Bookmarks

- Current trends of blood lead levels, distribution patterns and exposure variations
  - 1. Introduction
  - 2. Materials and methods
    - 2.1. Sampling sites
    - 2.2. Sample collection
    - 2.3. Blood Pb analysis
    - 2.4. Statistical analysis
  - 3. Results
    - 3.1. Subjects and BLL
    - 3.2. Critical BLL values among household members
    - 3.3. Pb exposure patterns among

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Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere


## Current trends of blood lead levels, distribution patterns and exposure variations among household members in Kabwe, Zambia


John Yabe [a], Shouta MM. Nakayama [b], Hokuto Nakata [b], Haruya Toyomaki [b], Yared B. Yohannes [b], Kaampwe Muzandu [a], Andrew Kataba [a, b], Golden Zyambo [a], Masato Hiwatari [c], Daiju Narita [d], Daichi Yamada [d], Peter Hangoma [e], Nosiku Sipilanyambe Munyinda [e], Tiza Mufune [f], Yoshinori Ikenaka [b], Kennedy Choongo [a], Mayumi Ishizuka [b, *]

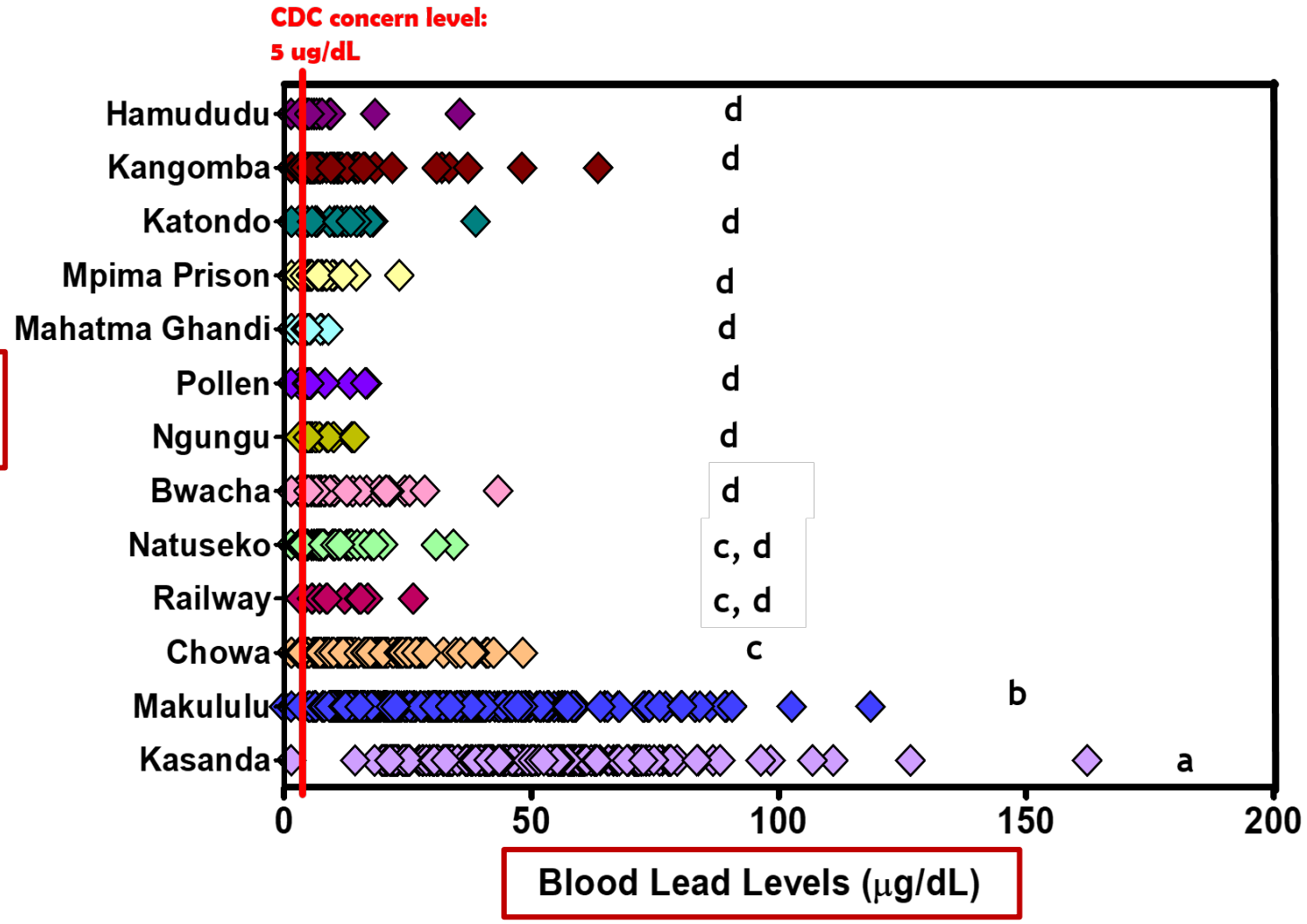
[a] The University of Zambia, School of Veterinary Medicine, P.O. Box 32379, Lusaka, Zambia
[b] Faculty of Veterinary Medicine, Hokkaido University, Kita 18, Nishi 9, Kita-ku, Sapporo, 060-0818, Japan
[c] Faculty of Economics & Business, Hokkaido University, Kita 9, Nishi 7, Kita-ku, Sapporo, 060-0809, Japan
[d] Graduate School of Arts and Sciences, University of Tokyo, 3-8-1 Komaba, Meguro-ku, Tokyo, 153-8902, Japan
[e] The University of Zambia, School of Public Health, P.O. Box 32379, Lusaka, Zambia
[f] Ministry of Health, District Health Office, P.O. Box 80735, Kabwe, Zambia

### HIGHLIGHTS

- We measured blood lead in household members in Kabwe, which has a history of Pb–Zn mining.
- Blood Lead Levels (BLL) ranged from 1.65 to 162 μg/dL and were highest in children compared to parents.
- LeadCare II analyser provided prompt diagnosis to identify children needing chelation therapy.
- Age, distance from the mine and direction were the main factors influencing Pb exposure.
- Children living near the Pb–Zn mine are at serious risks of Pb and Cd poisoning.

# Current trends of blood lead levels in Kabwe, Zambia






**Summary - Blood Lead Levels (BLLs):**

- Ranged from LOD to 162 µg/dL
- There was significant difference among BLLs based on area
- Distance from the mine and wind direction were key factors in exposure levels
- Only about 30 % had BLL below the CDC reference level (current level is 3.5 µg/dL)
- A high peak in children around the age of 2 years and lower BLL in older children

# Assessing BLLs in Mothers, Infants, breast milk and isotope ratios



Bookmarks

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Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol


Check for updates

# Lead concentrations and isotope ratios in blood, breastmilk and feces: contribution of both lactation and soil/dust exposure to infants in a lead mining area, Kabwe, Zambia☆


Haruya Toyomaki [a], John Yabe [b,h], Shouta M.M. Nakayama [a,*], Yared B. Yohannes [a,c], Kaampwe Muzandu [a,b], Tiza Mufune [d], Hokuto Nakata [a], Yoshinori Ikenaka [a,e,i,j], Takeshi Kuritani [f], Mitsuhiro Nakagawa [f], Kennedy Choongo [b,g], Mayumi Ishizuka [a]

[a] Laboratory of Toxicology, Department of Environmental Veterinary Sciences, Faculty of Veterinary Medicine, Hokkaido University, Japan
[b] The University of Zambia, School of Veterinary Medicine, Zambia
[c] Department of Chemistry, College of Natural and Computational Science, University of Gondar, Ethiopia
[d] Ministry of Health, District Health Office, Kabwe, Zambia
[e] Water Research Group, School of Environmental Sciences and Development, North-West University, South Africa
[f] Department of Earth and Planetary Sciences, Graduate School of Science, Hokkaido University, Sapporo, Japan
[g] Fiji National University, College of Agriculture, Fisheries & Forestry, School of Animal and Veterinary Sciences, Koronivia Campus, Suva, Fiji
[h] Department of Pathobiology, School of Veterinary Medicine, University of Namibia, Windhoek, Namibia
[i] Translational Research Unit, Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Hokkaido University, Sapporo, 060-0818, Japan
[j] One Health Research Center, Hokkaido University, Japan



ARTICLE INFO

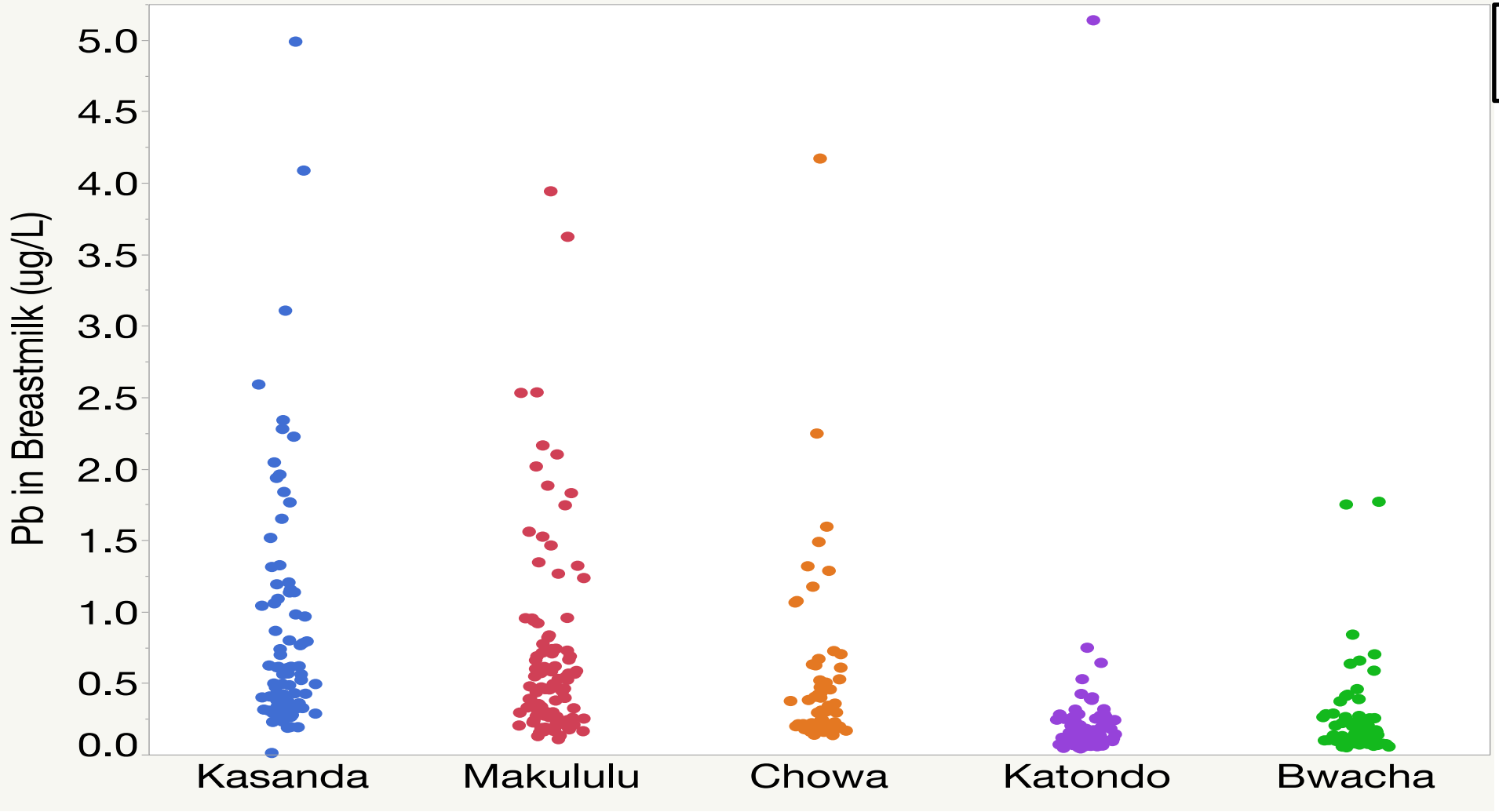
*Keywords:*
Lead poisoning
Infant
Mother
Breastmilk
Lead stable isotope



ABSTRACT

Lead (Pb) poses a serious public health concern. Breastmilk may be a possible source of Pb exposure in infants, as Pb can be transferred from the maternal blood to breastmilk. The present study was undertaken to determine the Pb exposure and the contribution of lactation as one of the exposure pathways to infants in a Pb mining area, Kabwe, Zambia. Blood, breastmilk and infants' feces were collected from 418 pairs of infants and mothers. The Pb concentrations, isotope ratios in the samples, and biochemistry in mothers' plasma were analyzed. The overall mean of blood lead levels (BLLs) in infants and mothers were 18.0 and 11.3 μg/dL, respectively. High Pb concentration in breastmilk (range: 0.4–51.9, mean: 5.3 μg/L) above the WHO acceptable level between 2 and 5 μg/L were found and could be one of the sources of Pb exposure in infants. The Pb isotope ratios in infants' feces were the most similar to Pb ratios in the soil samples. The results suggest that infants are also exposed to Pb from the environment. Pb exposure in infants through breastfeeding and soil ingestion could potentially exceed daily intake of Pb which causes neurodevelopmental toxicity. In contrast to the high BLLs in mothers, the plasma biochemical profiles of most analyzed parameters were interestingly within, or close to, the standard reference values. Our data suggest that environmental remediation is urgently needed to reduce the Pb exposure in infants and mothers from the environment in Kabwe in parallel with chelation therapy.

# Pb Levels in Breast milk Samples – below acceptable limits



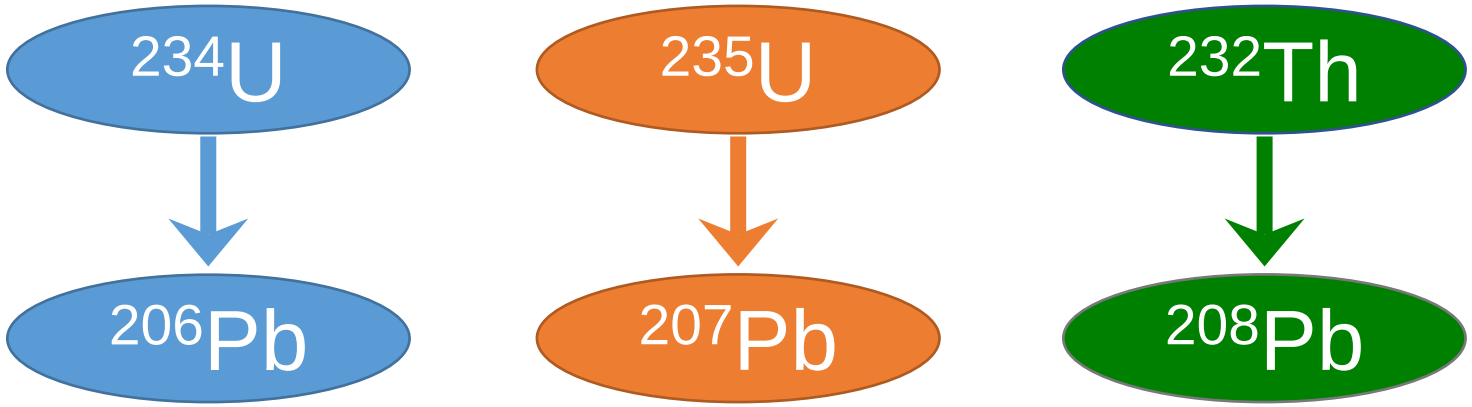

WHO's Acceptable Pb levels in breastmilk: 2 to 5 µg/L

| Breastmilk | All | Kasanda | Makululu | Chowa | Katondo | Bwacha |
|---|---|---|---|---|---|---|
| Mean (N) | 0.51 (417) | 0.89 (81) | 0.70 (102) | 0.55 (57) | 0.22 (93) | 0.22 (84) |
| Range | 0.01 – 5.1 | 0.01 – 5.0 | 0.11 – 3.9 | 0.14 – 4.2 | 0.04 – 5.1 | 0.05 – 1.8 |

# Background: Source identification by Pb isotope ratio analysis



- Lead has four stable, naturally occurring isotopes (Pb-Irs): $^{204}Pb$ (1.4%), $^{206}Pb$ (24.1%), $^{207}Pb$ (22.1%) and $^{208}Pb$ (52.4%).
- Pb isotope ratios; $^{207}Pb/^{206}Pb$, $^{208}Pb/^{206}Pb$) are not affected to a measurable extent by physico-chemical fractionation processes.
- Pb-IRs are different depending on Pb source
  → Natural tracer of Pb



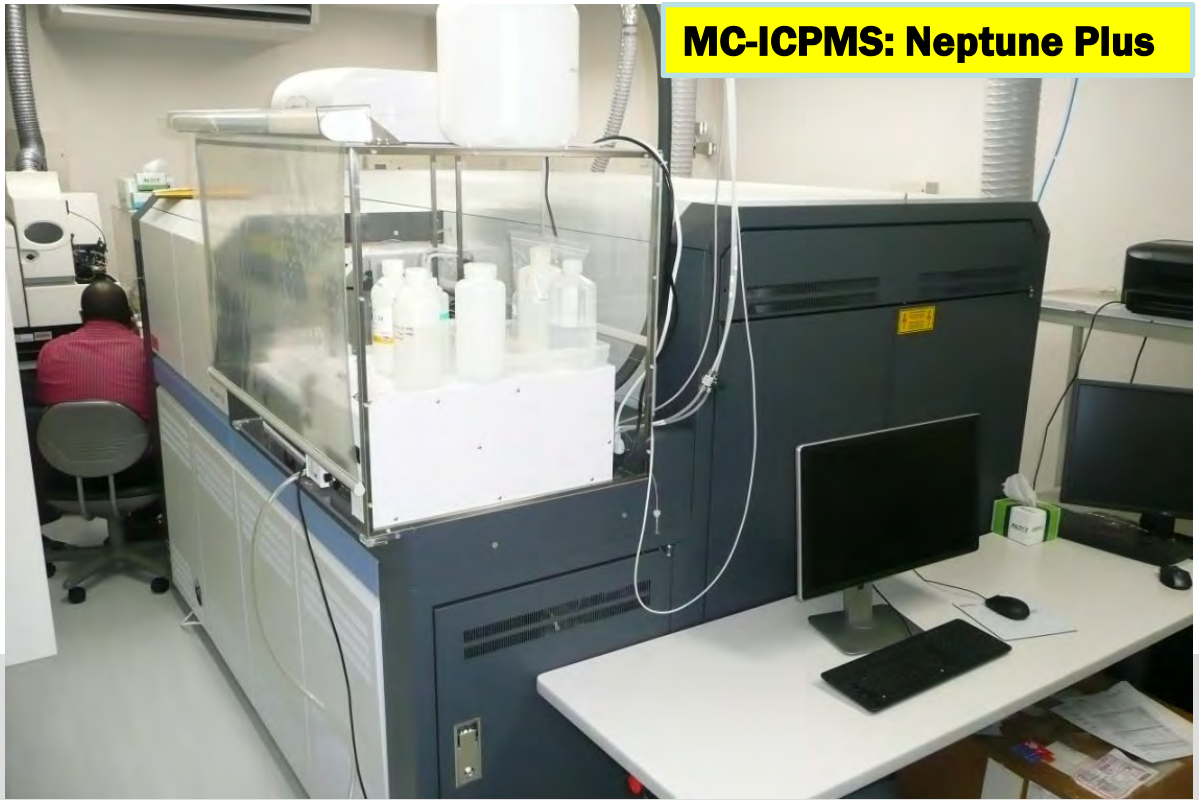

Similar isotope ratio value → Same Pb source

# Stable Pb isotope ratios and biomarkers



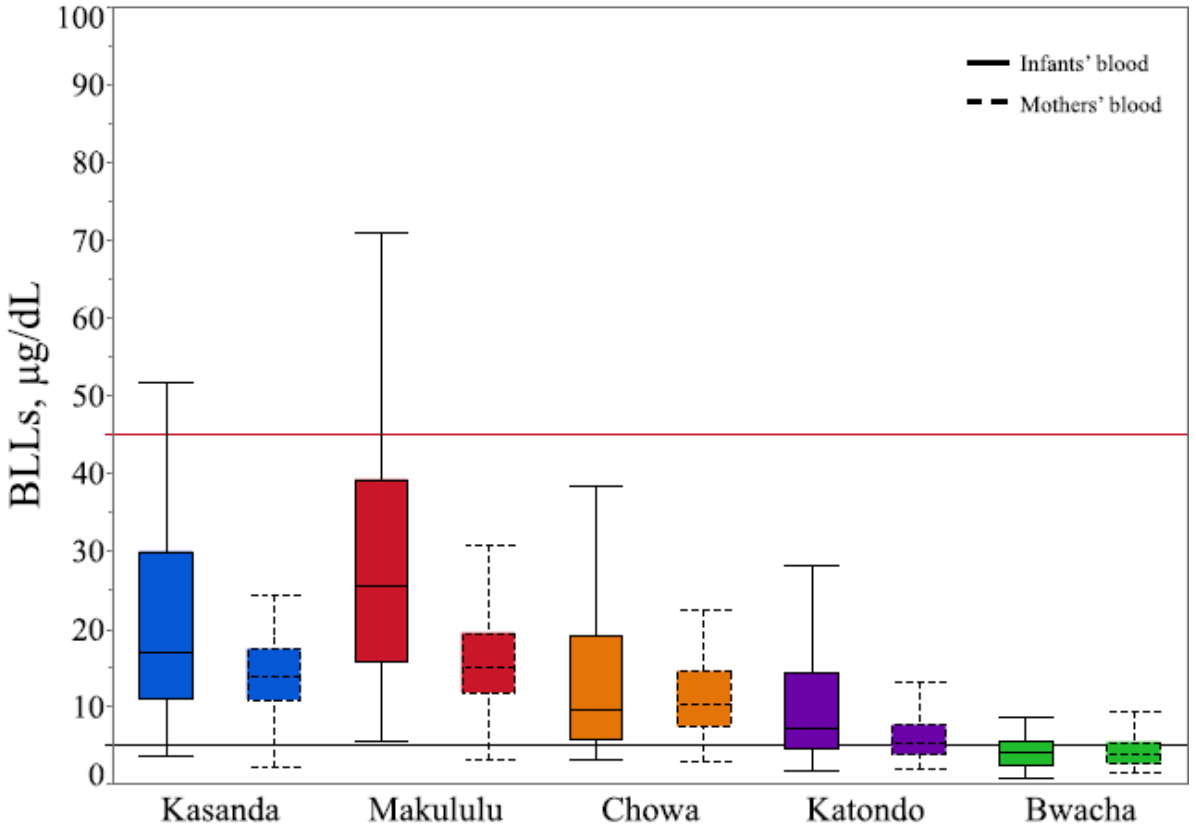
Stable Pb isotope ratios

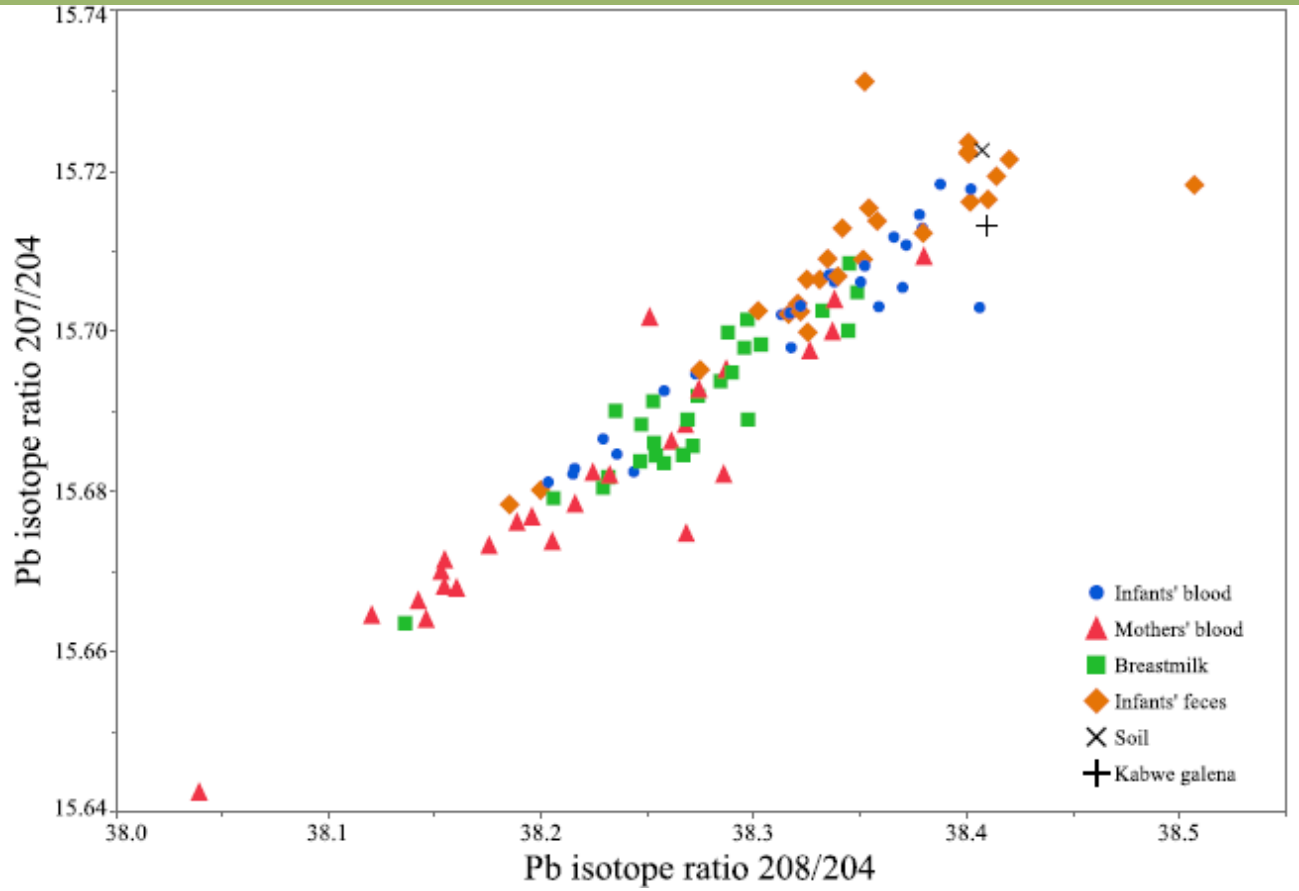
- Multi Collector MC-ICPMS
- To clarify source of exposure




# BLLs in Mothers and Infants and Isotope Ratio Analysis





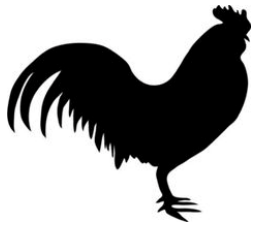

- BLLs in infants were higher than mothers
- A positive correlation between BLLs of paired Mothers and Infants ($p < 0.01$, $\rho = 0.6$)
- Pb isotope ratio analysis showed similar trends for **infants blood, feces, soil and Kabwe galena**
- Pb isotope ratios for **mothers' blood and milk** were **different from the galena and soil** but **similar to infants blood**

# Sentinel animal for tracing Pb sources using Pb-IRs analysis



Goat

- G150 (N=5, 150km from mine)
- G30 (N=5, 30km from mine)
- G0 (N=5, around mining area)



Chicken

- BC (N=5, broiler chicken)
- FRC (N=10, free range chicken)

(*both group were from around mining area)

Dissection

Blood, liver, kidney, lung, spleen, brain, bone, feces, stomach/gizzard contents, etc.

can be regarded as the dominant source of Pb

## Environmental samples (eg. soil)

Soil

- S150 (N=6, 150km from mine)
- S30 (N=2, 30km from mine)
- S0 (N=19, around mining area)

Drying and Microwave digestion

Analysis of Pb level and Pb-IRs using ICP-MS

# Sentinel animal for tracing Pb sources using Pb-IRs analysis





## Highlights

- Presence of Pb isotope fractionation in goat and chicken was studied.
- The variation of Pb-IRs in goat decreased with an increase in Pb-B.
- Chickens did not show a clear relationship for Pb-IRs against Pb-B.
- The biological fractionation of Pb isotopes should not occur in chickens but in goats.
- Threshold for triggering biological fractionation is at 5μg/dL of Pb-B in goats.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Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol



# Reliability of stable Pb isotopes to identify Pb sources and verifying biological fractionation of Pb isotopes in goats and chickens


Hokuto Nakata [a, 1], Shouta M.M. Nakayama [a, 1], John Yabe [b], Allan Liazambi [c], Hazuki Mizukawa [d], Wageh Sobhy Darwish [a, e], Yoshinori Ikenaka [a, f], Mayumi Ishizuka [a, *]

[a] *Laboratory of Toxicology, Department of Environmental Veterinary Sciences, Graduate School of Veterinary Medicine, Hokkaido University, Kita 18 Nishi 9, Kita-ku, Sapporo 060-0818, Japan*
[b] *The University of Zambia, School of Veterinary Medicine, P.O. Box 32379, Lusaka, Zambia*
[c] *Central Province Veterinary Office, Kabwe, Zambia*
[d] *Department of Environmental Veterinary Sciences, Graduate School of Veterinary Medicine, Hokkaido University, Kita 18 Nishi 9, Kita-ku, Sapporo 060-0818, Japan*
[e] *Food Control Department, Faculty of Veterinary Medicine, Zagazig University, Zagazig, Egypt*
[f] *Water Research Group, School of Environmental Sciences and Development, North-West University, South Africa*



ARTICLE INFO

*Article history:*
Received 30 July 2015
Received in revised form
4 October 2015
Accepted 5 October 2015
Available online 6 November 2015

*Keywords:*
Biological fractionation
Chicken
Goat

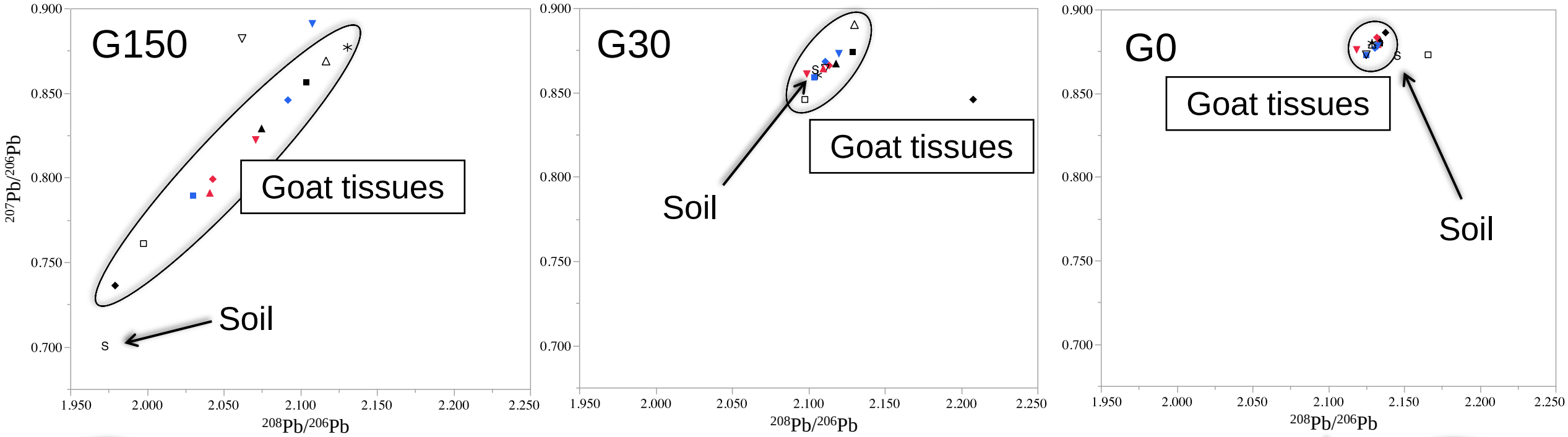


ABSTRACT

Stable Pb isotope ratios (Pb-IRs) have been recognized as an efficient tool for identifying sources. This study carried out at Kabwe mining area, Zambia, to elucidate the presence or absence of Pb isotope fractionation in goat and chicken, to evaluate the reliability of identifying Pb pollution sources via analysis of Pb-IRs, and to assess whether a threshold for blood Pb levels (Pb-B) for biological fractionation was present. The variation of Pb-IRs in goat decreased with an increase in Pb-B and were fixed at certain values close to those of the dominant source of Pb exposure at Pb-B > 5 μg/dL. However, chickens did not show a clear relationship for Pb-IRs against Pb-B, or a fractionation threshold. Given these, the biological fractionation of Pb isotopes should not occur in chickens but in goats, and the threshold for triggering biological fractionation is at around 5 μg/dL of Pb-B in goats.

# Pb-IRs in goat samples to determine source of exposure






Far → Distance from the mine → Near

Low → Pb levels in soil and goat → High

1. The values of Pb-IRs in goat with high Pb level reflected those in soil (similar isotopic fingerprints revealed pollution source)

## Objectives of the study

- The study analyzed various **hepatic and renal function parameters**.
- This was the first study to analyze the widespread association of exposure to Pb and other metals with clinical parameters in humans in Africa.
- The aim was to establish the health impact of Pb poisoning in Kabwe and to facilitate the implementation of possible countermeasures.

➢ Human plasma samples were used for blood biochemical analysis at UNZA

- Lactate dehydrogenase (LDH) : High
- γ-Glutamine transferase (GGT): High
- Alkaline phosphatase (ALP): High

Preliminary findings:

**Azotemia – Hepatic disorder?**

- Total protein (TP): Low

**Hepatic disorder?**
**Renal disorder?**

| % of tested clients | <standard value | Within standard | >standard value |
|---|---|---|---|
| T-bil (mg/dL) | 6.3 | 92.3 | 1.4 |
| AST (IU/L) | 0.0 | 97.0 | 3.0 |
| ALT (IU/L) | 0.0 | 99.8 | 0.2 |
| LDH (IU/L) | 1.0 | 62.9 | 36.1 |
| GGT (IU/L) | 0.0 | 58.3 | 41.7 |
| ALP (IU/L) | 0.0 | 46.6 | 53.4 |
| T-pro (g/dL) | 36.9 | 49.6 | 13.5 |
| Alb (g/dL) | 42.7 | 54.0 | 3.4 |
| BUN (mg/dL) | 21.2 | 77.8 | 1.0 |
| UA (mg/dL) | 14.9 | 69.6 | 15.5 |
| Cre (mg/dL) | 14.1 | 51.8 | 34.1 |

＊504 clients randomly selected with the age range from 0 to 86 years (out of 1250 participants tested in 2017: %)



HIGHLIGHTS

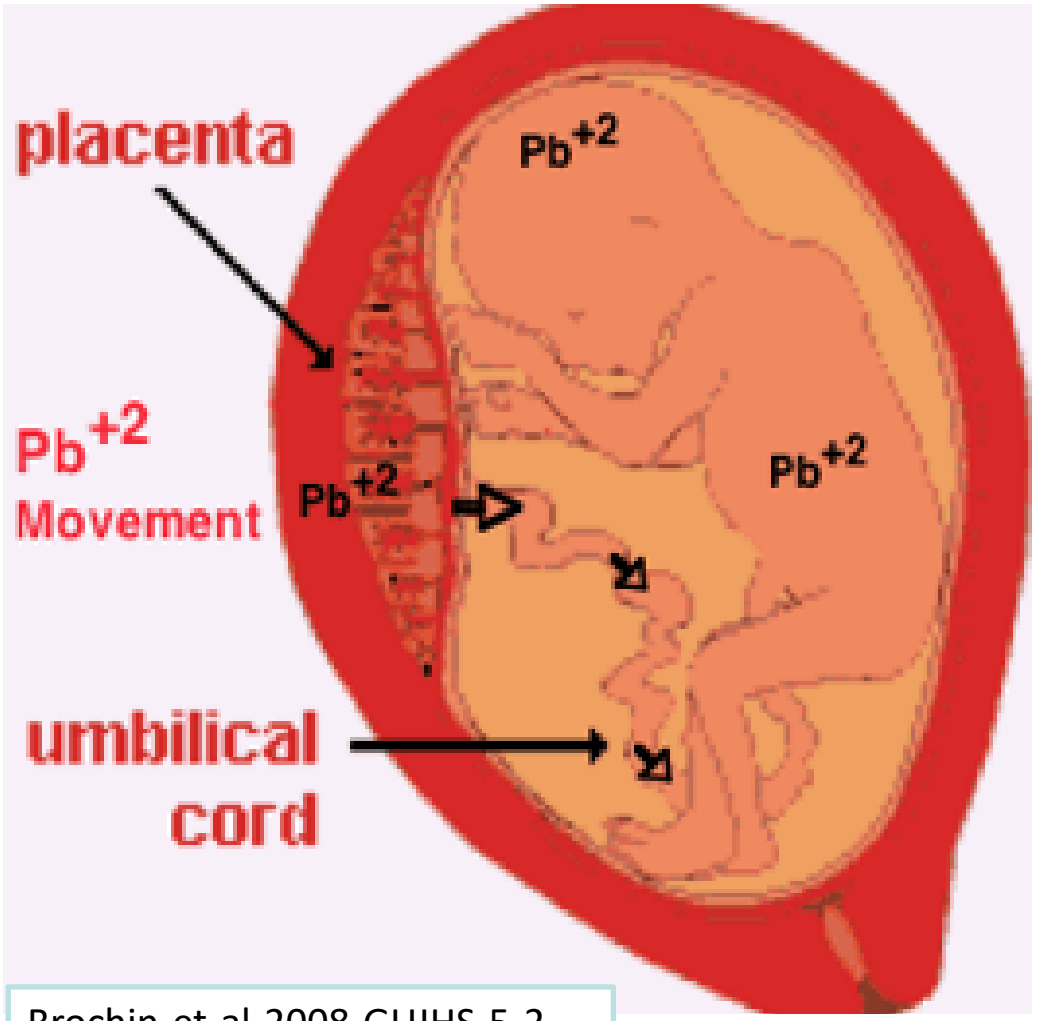
- Cross-sectional study with representative 504 residents in closed mine site.
- Significant elevation of blood lead and cadmium levels at areas near mine.
- Increase of hepatic and renal parameters in 20–50% of target adult population.
- Inhibition of δ-aminolevulinic acid dehydratase activity due to Pb exposure.
- Negative association between Cd level and estimated glomerular filtration rate.

# Assessing the Impact of Pb Exposure and Maternal Characteristics on Neurodevelopmental (ND) Outcomes in Children



## Background

- Trans-placental transfer of Pb is well known
  - ➢through syncytiotrophoblast.
- Increased mobilization of Pb from bones (endogenous source)
  - ➢Pregnancy, lactation and calcium deficiency
- Pb transfer peaks at 12-14 weeks gestation
  - ➢fetal production of 1,25-dihydroxyvitamin D
- Pre- and perinatal exposure results in higher brain Pb levels than postnatal exposure.
  - ➢Under-developed blood-brain barrier in early life.




Brochin-et-al-2008-GUJHS-5-2

# Assessing the Impact of Pb Exposure and Maternal Characteristics on Neurodevelopmental (ND) Outcomes in Children

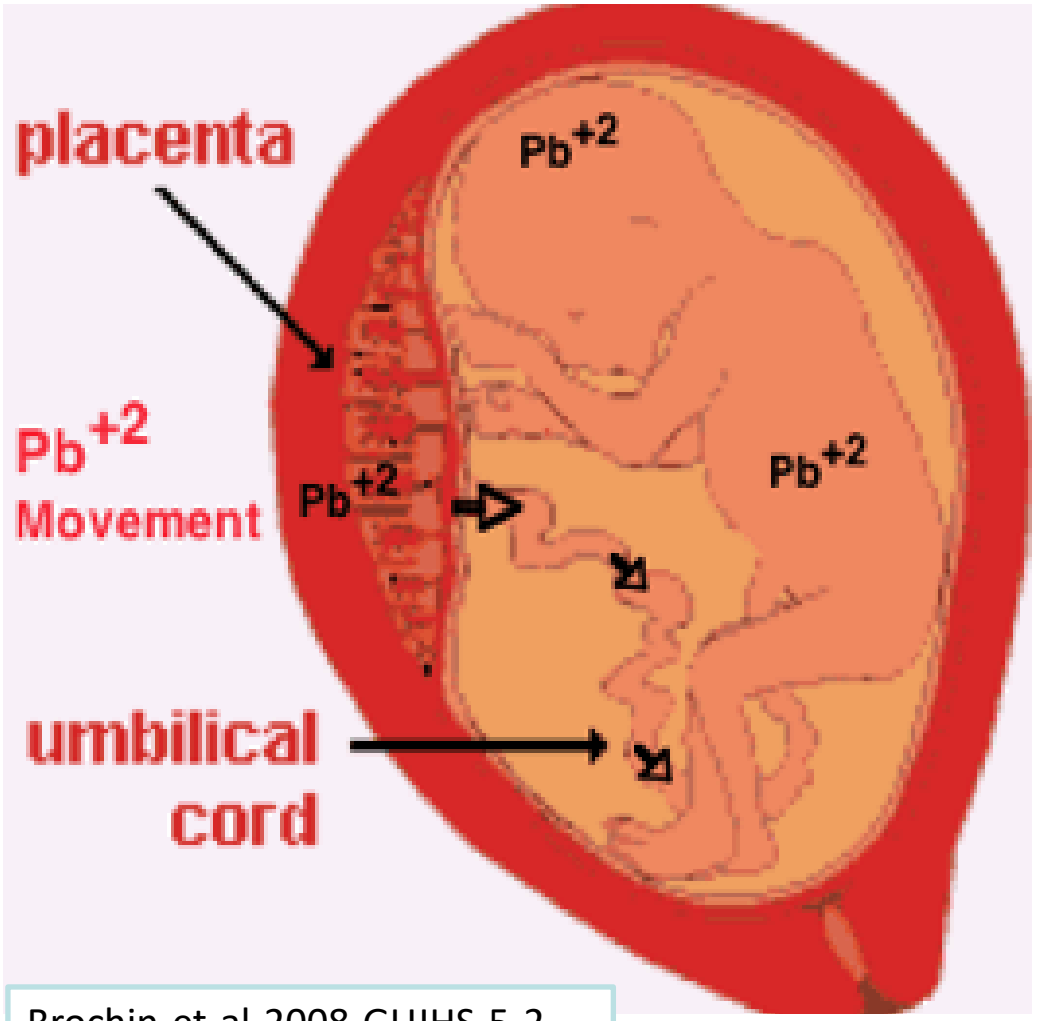


## Background

- Exposure to Pb during prenatal and postnatal development can cause serious neurocognitive damage.
- Social environmental factors alter susceptibility to the cognitive effects of Pb.

## Objectives

- Assess the impact of childhood Pb exposure on neurodevelopmental outcomes.
- Assess the influence of maternal characteristics on neurodevelopmental outcomes in selected exposed communities of Kabwe, Zambia




Brochin-et-al-2008-GUJHS-5-2

# Assessing the Impact of Pb Exposure and Maternal Characteristics on Neurodevelopmental (ND) Outcomes in Children



## Areas on ASQ-3

The ASQ®-3 screens five key areas of development in young children to create a well-rounded snapshot of the child's skills and abilities. This handout lists the areas of development and briefly explains each.

### Communication

Assesses language, both what a child understands and how they follow directions **(receptive)** and how they vocalize, use words, and start to make sentences **(expressive)**.

### Gross Motor

Assesses large muscle (body, arms, and legs) movement and coordination.

### Fine Motor

Assesses eye/hand and hand/finger movements and coordination, pre-writing skills.

### Problem Solving

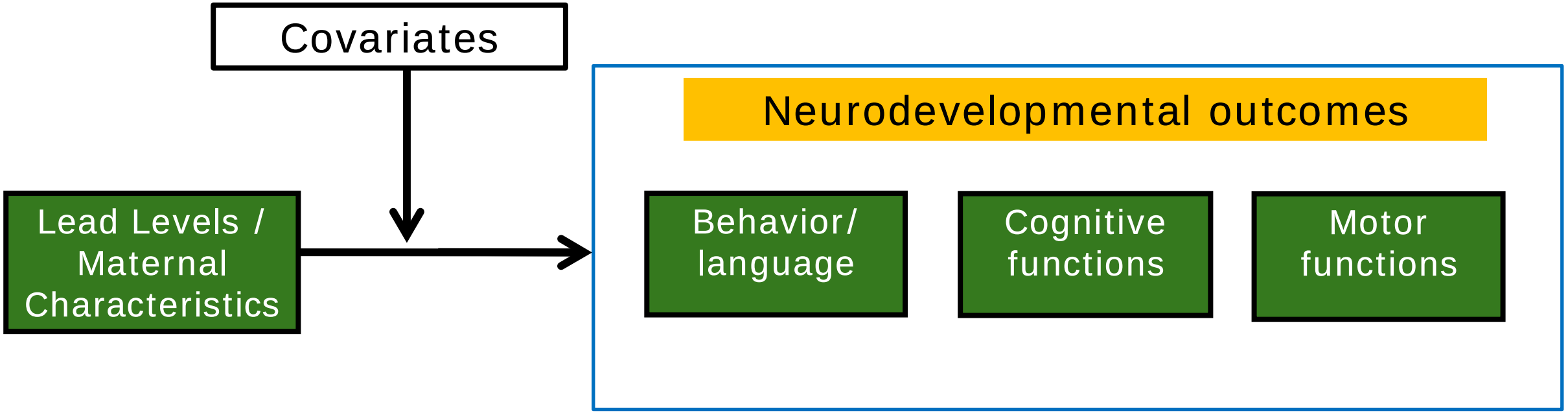
Assesses skills of thinking and learning, how child solves problems, pre-academic skills.

### Personal-Social

Assesses **self-help** skills (e.g., feeding, dressing, toileting) and **social interactions** with others.

# Assessing the Impact of Pb Exposure and Maternal Characteristics on Neurodevelopmental (ND) Outcomes in Children



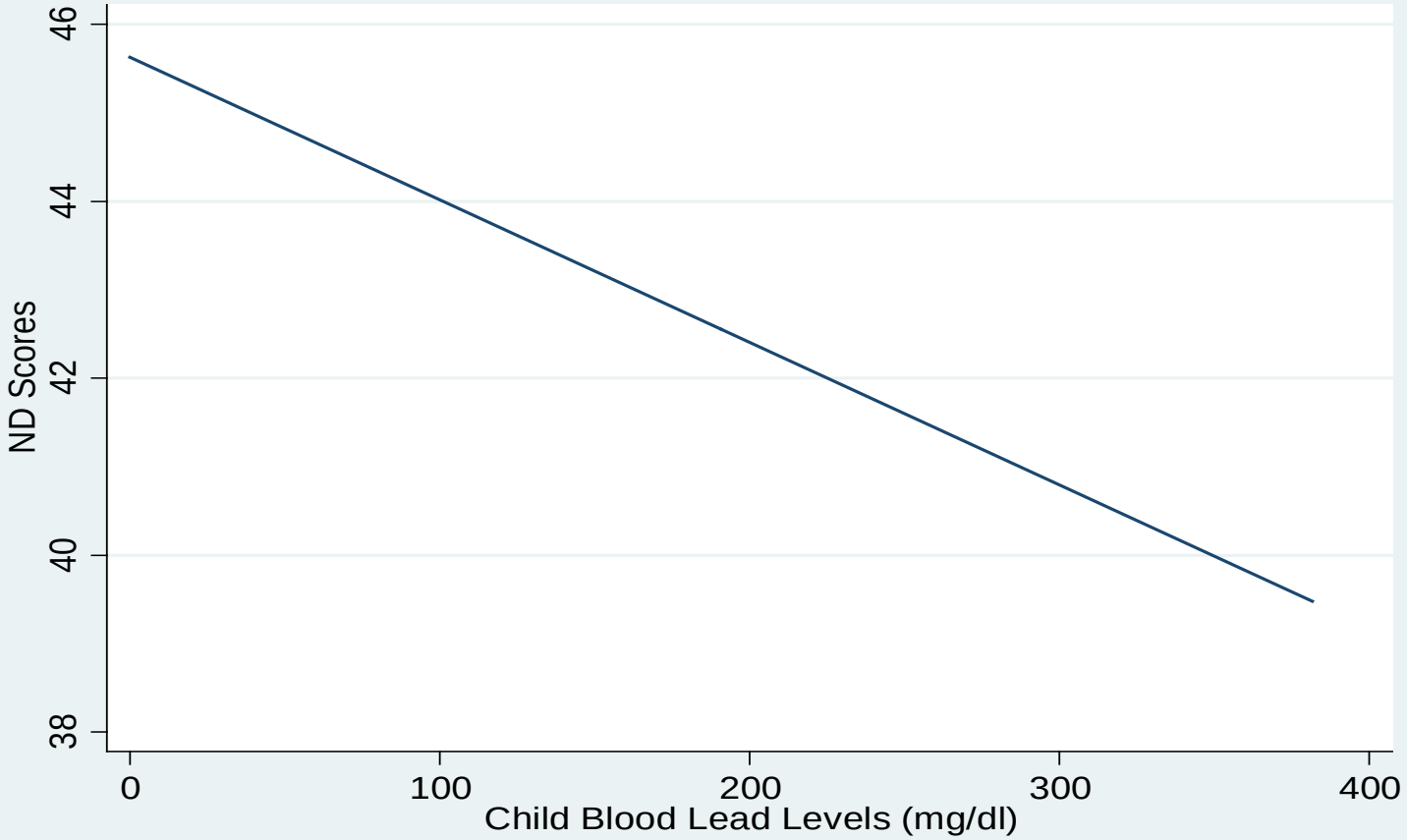



**Maternal Characteristics**

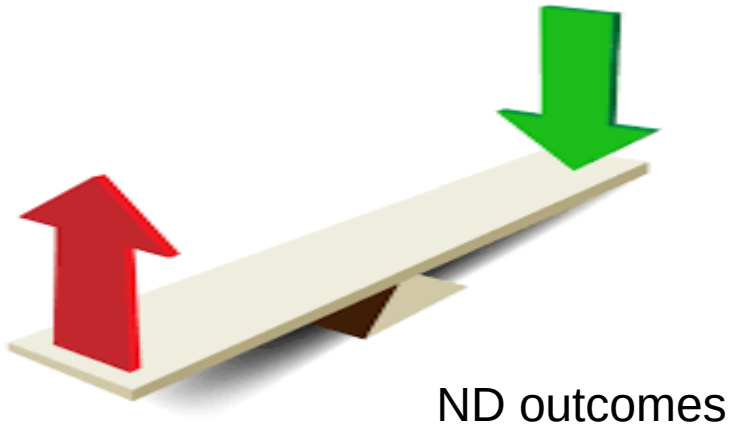
- Age
- Marital status
- Education level
- Income level
- Breast feeding duration

# Impact of Pb Exposure on ND Outcomes in Children






## Blood lead levels and ND scores

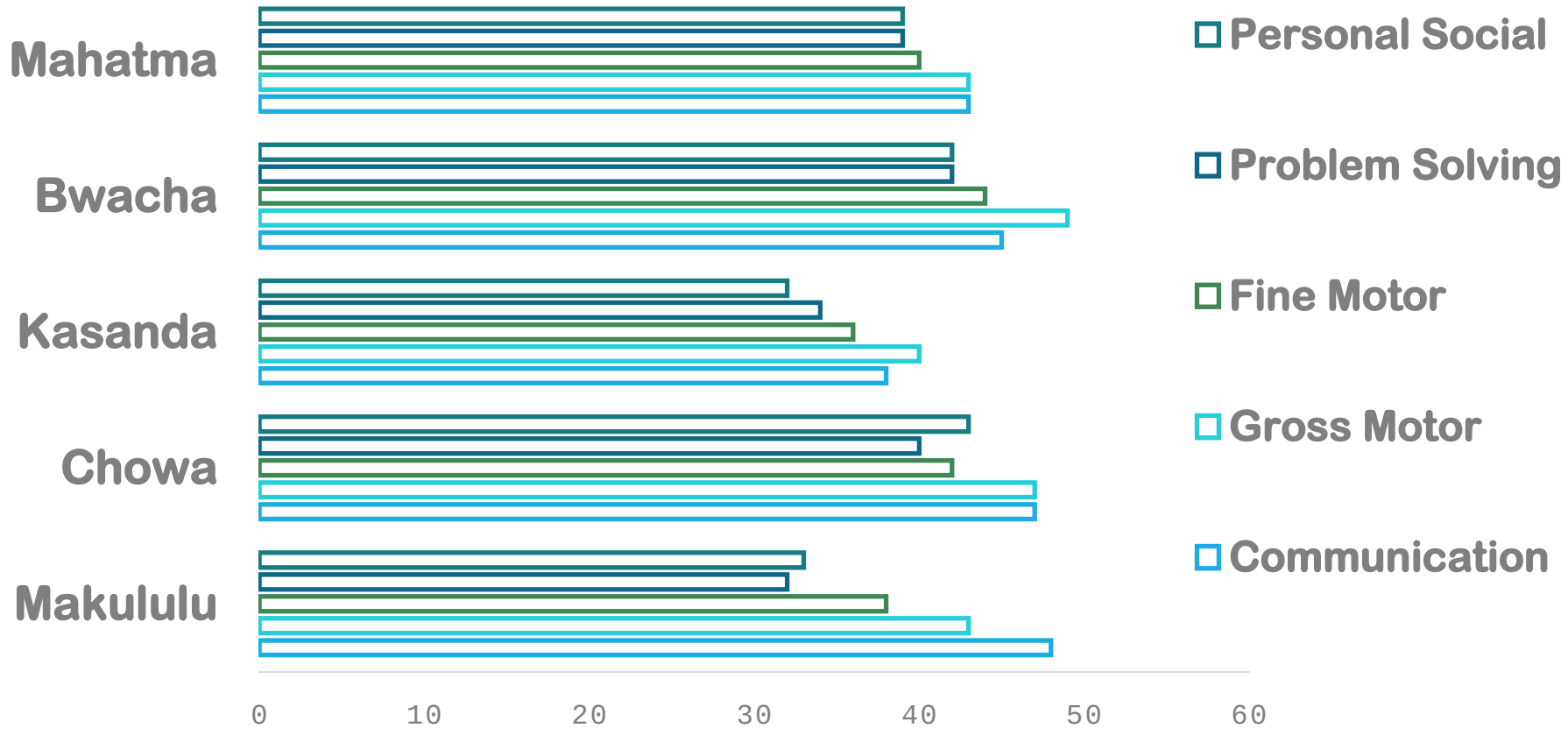



There was a negative correlation between BLLs and ND scores

# Impact of Pb Exposure (Locations) on ND Outcomes in Children



## Neurodevelopmental Scores in selected townships of Kabwe




There were significant differences in ND scores by the location.*except FM domain*

# Conclusions, Recommendations and Work in Progress



## Take-home message

- Blood lead levels in communities near the Pb mine in Kabwe are alarming
- Lead in levels in human breast milk are generally low
- Free range chickens could be an important source of Pb in Kabwe
- Children in Kabwe are mainly exposed to Pb through their mother's blood and from the soil
- Pb toxicity in Kabwe affects liver, kidney, hematopoietic system
- Dogs in Kabwe can be used as sentinel animals for Pb biomonitoring
- Hot spots that require urgent remediation are Kasanda, Mutwewansofu and Makululu

## World Bank funded project (ZMERIP) collaboration

- Treatment of the target children with BLL above 45 µg/dl is currently underway
- Environmental remediation programs under ZMERIP are already underway

## Further assessments

- Children below the age of 3 years – Neurodevelopmental Impairment Assessment
- School going children above the age of >3 - IQ, ADHD, etc.
- Lead (Pb) exposure and birth outcomes in pregnant mothers (PhD student – in progress)

# KAMPAI Project - Remediation Options



- Developed engineering and agricultural environmental remediation approaches applicable to mining and residential areas
  - Measures to prevent the spread of lead from mine tailings to residential areas
  - Environmental remediation of residential areas already contaminated with lead
  - Prevention of exposure to lead from diet and other sources
  - Screening of the population for lead poisoning and provision of health intervention.

EMCR Environmental Monitoring & Contaminants Research
https://emcr-journal.org/
DOI: https://doi.org/10.5985/emcr.20220004
Environmental Monitoring and Contaminants Research Vol.2, pp.94–111, 2022
Status Report

## Interdisciplinary approach to addressing lead pollution caused by mining activity in Kabwe, The Republic of Zambia

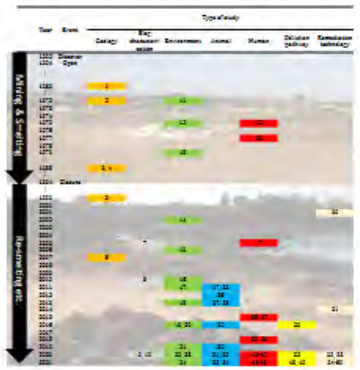
Hokuto NAKATA[1)], Shouta M. M. NAKAYAMA[1,2)], John YABE[2,3)], Kaampwe MUZANDU[2)], Andrew KATABA[1,2)], Yoshinori IKENAKA[1,4,5,6)] and Mayumi ISHIZUKA[1)]*

1) Laboratory of Toxicology, Department of Environmental Veterinary Sciences, Faculty of Veterinary Medicine, Hokkaido University, Kita 18 Nishi 9, Kita-ku, Sapporo 060-0818, Japan
2) School of Veterinary Medicine, The University of Zambia, P.O. Box 32379, Lusaka, 10101, Zambia
3) School of Veterinary Medicine, University of Namibia, P/B. 13301, Windhoek, 10005, Namibia
4) Water Research Group, Unit for Environmental Sciences and Development, North-West University, Private Bag X6001, Potchefstroom 2531, South Africa
5) Translational Research Unit, Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Hokkaido University, Sapporo 060-0818, Japan
6) One Health Research Center, Hokkaido University, Sapporo 060-0818, Japan

[Received February 4, 2022; Accepted June 17, 2022]

**ABSTRACT**

Industrial development and economic growth have made human life more convenient. However, the accompanying environmental pollution is a serious problem. The same situation that developed countries have experienced in the past is now being repeated in developing countries, especially in Asia and Africa. Although lead has long been a useful metal in supporting human life, it is highly toxic to living organisms and affects various biological functions, including the kidneys and nervous system. Lead is one of the substances symbolizing the trade-off between industrial and economic development and environmental pollution. Kabwe in the Republic of Zambia, a town that grew out of the discovery and development of lead-zinc deposits, is now known as one of the most lead-polluted areas in the world. While Kabwe is a classic example of the trade-off described above, it is distinct from other polluted areas in that it has been the site of diverse academic research. These include geological survey of the mine, the characterization of

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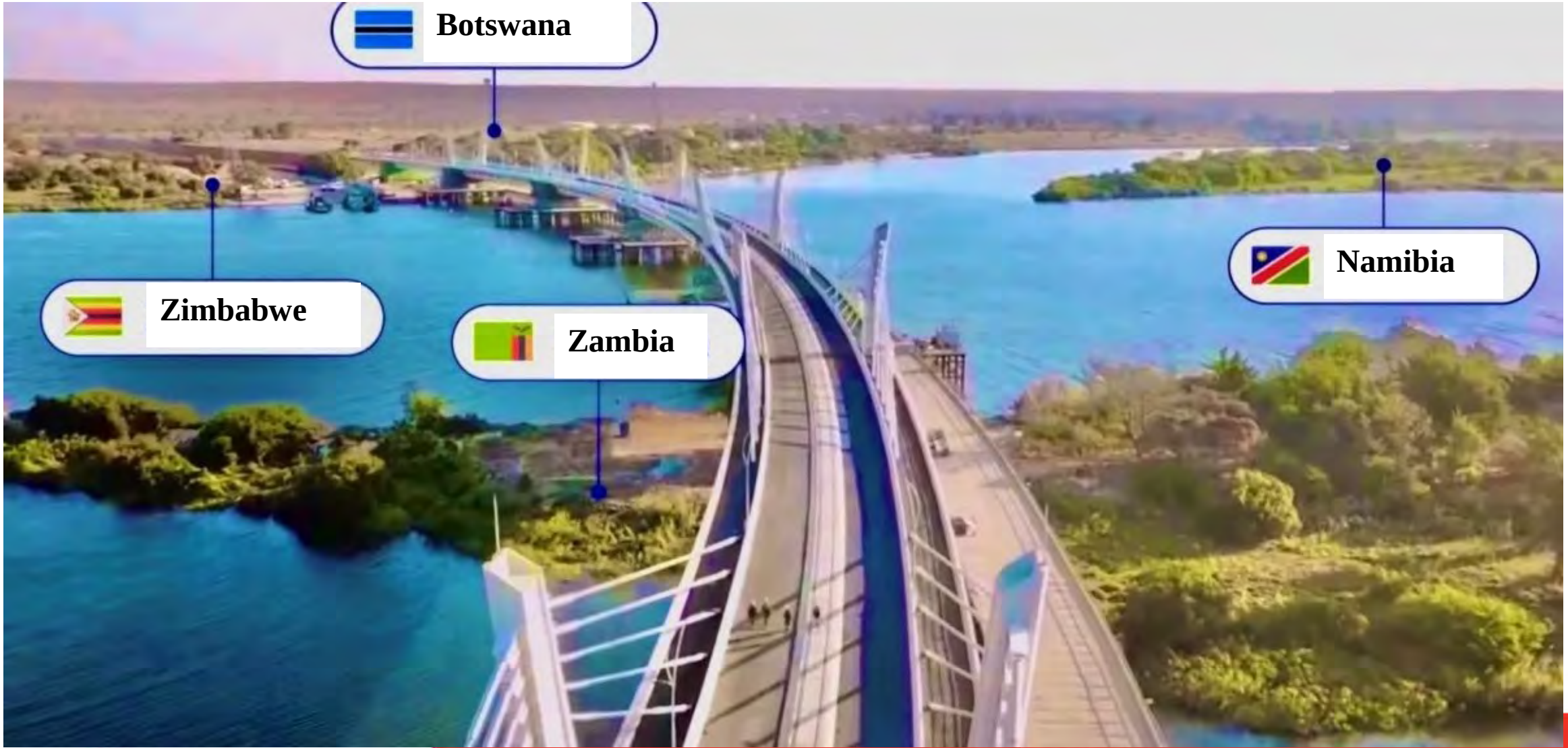
# **Research Plan**: Assessments of Arsenic and Lead Contamination in Tsumeb and Rosh Pinah, Namibia: a Multidisciplinary and One Health Approach

**John Yabe** – **University of Namibia; Regional Coordinator (ZA.ZINAMBO Project)**

Shouta Nakayama, Yvonne Hemberger, Mark Jago, Gerhard Iiputa, Johnson Oluwagbenga, Tuyenikelao Nekwaya, Moshood Onifade, Silas Hango, Victoria Ndeshimona, Mayumi Ito, Anna Marais, Mayumi Ishizuka

# ZA.ZINAMBO PROJECT
# (Zambia – Zimbabwe – Namibia – Botswana) + Japan



# Research Site Identification – Why Tsumeb?

Location

- North-central, about 440 km, north of Windhoek

❖Population

- About 19,000 residents (unverified)

❖Mining / smelting history

- Mining - Anglo-German company (1903)
- Tsumeb smelter – processes copper from Tsumeb and other mines (DPM)
- Lead and Copper (Arsenic as byproduct)

❖Important Agricultural Region

- High annual rainfalls (> 550 ml annually)
- Intensive agriculture (maize, fruits, vegetables)
- Part of the "Golden Triangle", or “Maize Triangle"

# Why are we interested in Arsenic (and Lead)?

## Arsenic Toxicity

- **Arsenic is toxic** - Acute poisoning causes nausea, vomiting, abdominal pain, and diarrhea
- Chronic exposure affects the skin
  - Hyperpigmentation, hyperkeratosis e.g., in the hands and feet
- **Arsenic is a carcinogen -** affects numerous organs
  - Workers and residents in the vicinity of smelters are most vulnerable
  - Lung, urinary tract and skin cancer are reported at levels in drinking water around and above 50 µg/L
- Encephalopathy and peripheral neuropathy may occur.

Int J Environ Health Res. 2007 Apr;17(2):141-9. doi: 10.1080/09603120701219154. PMID: 17616870.

# Does Arsenic Pollution occur in Tsumeb?

- The Namibia Custom Smelter (NCS or the Tsumeb smelter) processes complex Cu concentrates from Bulgaria and Peru
  - These are contaminated with As
- Drop in As demand - produced As is stored on-site
- Environmental contamination (Pb, Cd & As) reported
- Soil contamination - over 13,000 mg/kg were recorded in the vicinity of the smelter
- Plant contamination - As, Pb and Cd exceeded WHO limits in marula fruits, pumpkins, chilies and tomatoes
- NO scientific data for Animal and Human exposure.
- Conflicting reports of As exposure in Tsumeb

2013 – dumping (Tsumeb, Namibia

https://bankwatch.org/blog/health-reports-confirmed widespread-over-exposure-to-toxic-arsenic-at-tsumeb-smelter-in-namibia

# Arsenic Pollution in Tsumeb - Media Reports

- https://bankwatch.org/blog/health-reports-confirmed-widespread-over-exposure-to-toxic-arsenic-at-tsumeb-smelter-in-namibia (22 December 2015)
- http://www.thevillager.com.na/articles/93/-Tsumeb-copper-miners--suffer-from-arsenic--effects/ (2017?)
- https://ww2.namibian.com.na/tsumeb-residents-demand-compensation-from-dundee-for-alleged-water-contamination/ (24 August 2023)
- https://www.namibian.com.na/rosh-pinah-children-suffer-chronic-lead-exposure/ (13 July 2023)
- https://www.namibian.com.na/ministry-investigates-lead-exposure-among-rosh-pinah-children/ (25 July 2023)

# Assembled Research Team (UNAM) - One Health Concept

- Regional Coordinator (ZAZINAMBO)
  - John Yabe (Veterinary Medicine)
- National Coordinator (Namibia)
  - Yvonne Hemberger (Public Health, Vet. Med)
- School of Agriculture & Fisheries Science
  - Soil Science, Crop Science
- School of Science
  - Environmental Science
- School of Engineering and the Built Environment
  - Mining Engineering, Metallurgical Engineering,
- **School of Medicine**
- **School of Allied Health Sciences**
- **Government ministries**
- **Other stakeholders**

# Research Facilitation – MOU (UNAM and Hokkaido University)


THANK YOU FOR YOUR ATTENTION