

CHILDREN'S BLOOD LEAD LEVELS IN SOME MINING COMMUNITIES OF ARMENIA

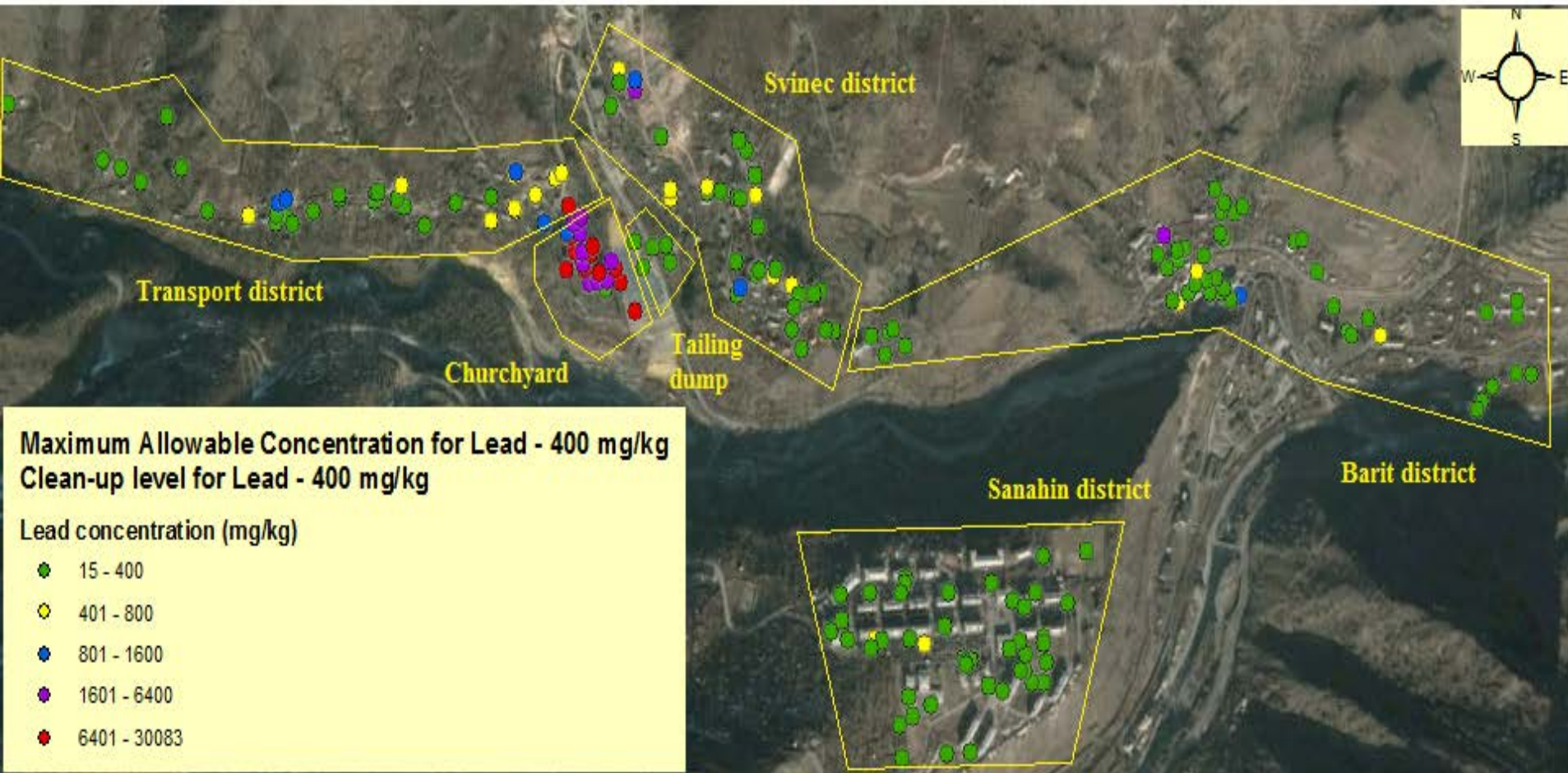
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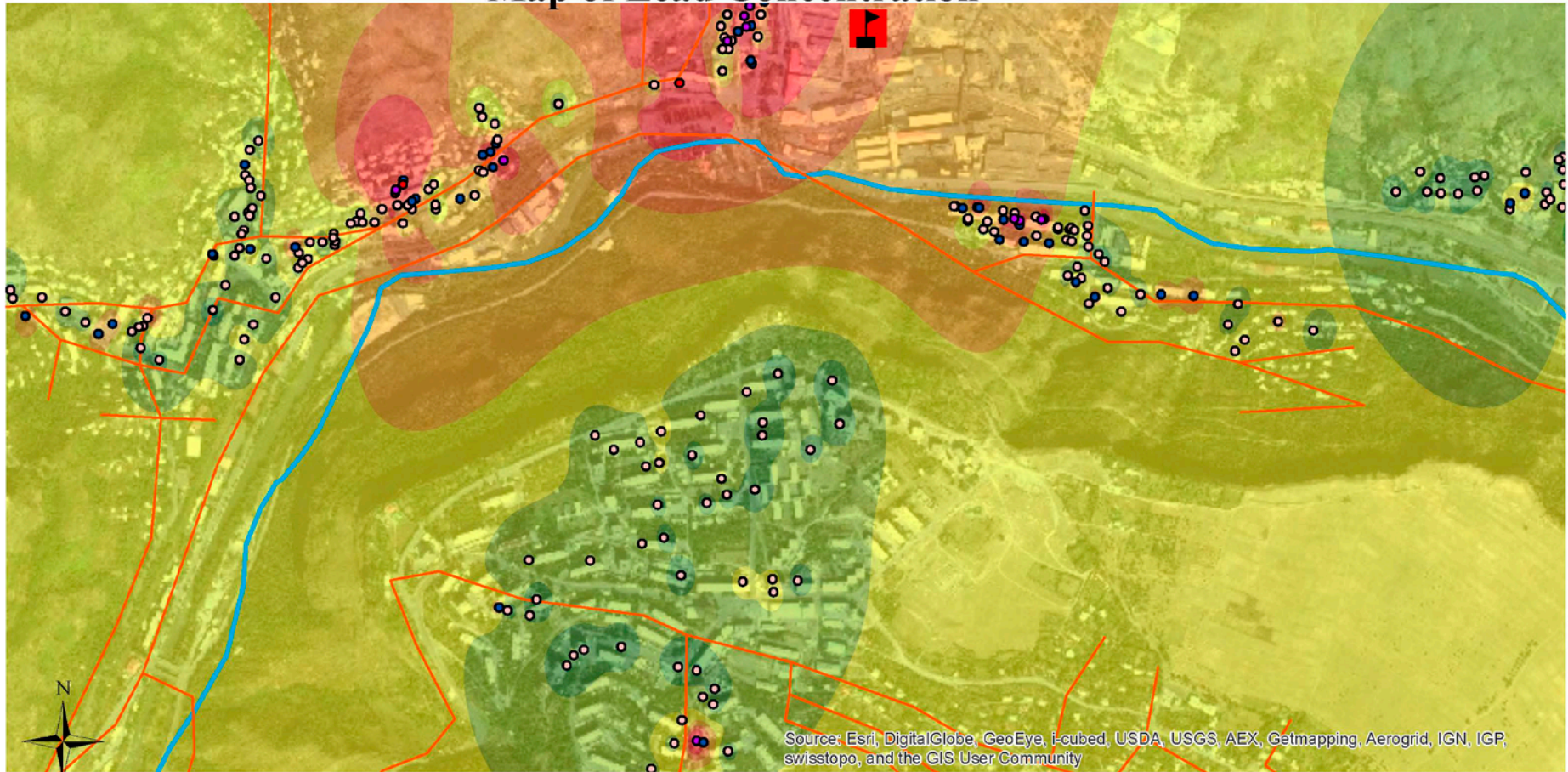
CHSR Projects

- Rapid risk assessment of affected communities
 - 6 marzes, 19 communities, 92 soil samples
- Detailed environmental assessment of the most contaminated communities
 - 2 marzes, 11 communities, 1930 soil samples
- Measurement of BLL in Alaverdi, Akhtala and Yerevan (Erebuni district)
- Akhtala Pilot project
 - Community trainings +
 - Development of local action plan+

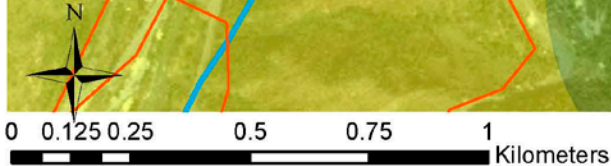
Map of Lead Concentrations in Soil Akhtala



Alaverdi Community Map of Lead Concentration



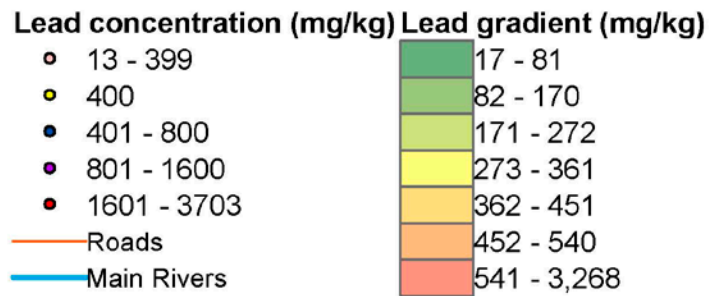
Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community




Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
 Projection: Mercator Auxiliary Sphere
 Datum: WGS 1984
 False Easting: 0.0000
 False Northing: 0.0000
 Central Meridian: 0.0000
 Standard Parallel 1: 0.0000
 Auxiliary Sphere Type: 0.0000
 Units: Meter

**School of Public Health
 American University of Armenia**

**Maximum Allowable Concentration for Lead - 400 mg/kg
 Clean-up level for Lead - 400 mg/kg**



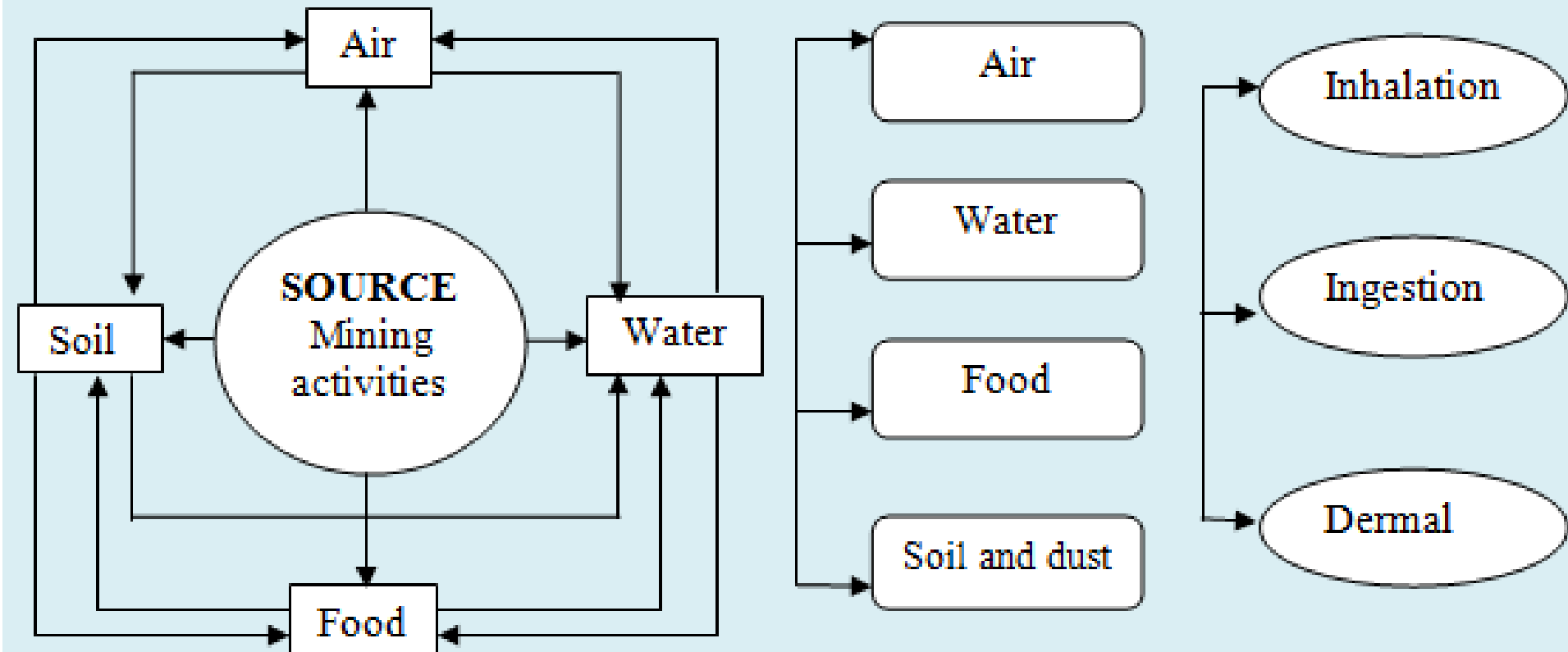
 Smokestack

Environment, exposure and routes

Environmental Media

Exposure Media

Exposure Routes



Lead (Pb)



- Naturally occurring, widely distributed element

Human Exposure

- ✓ General population - inhalation/ingestions through air, food, drinking water, dust and soil
- ✓ Occupational exposure – inhalation/ingestion of lead

Exposure to **any concentration** of lead is
hazardous for human health

Lowest Observed Effect Level (LOEL) for Lead-related Health Effects

Blood lead concentration $\mu\text{g}/\text{dL}$

Effect	Children	Adults
Encephalopathy	70 – 80	100-120
IQ deficit	< 10	-
In-utero effects	-	14
Peripheral nephropathy	40	40
Anemia	20-40	≤ 50
Nephropathy	40	-
Reproduction	-	40

Children (6-84 months)

- ❖ Tissues more sensitive to hazardous effects of lead due to anatomo-physiological structure
- ❖ Blood brain barrier not completely developed to protect brain from lead exposure
- ❖ Children absorb 41-50% of ingested lead (retain 31.8%) (about 5 times higher than absorption in adults)
- ❖ Children ingest more lead because of active hand-to-mouth activity and poor hygiene

Blood Lead Reference Level

NO SAFE LEVEL of lead for children

- US Center for Disease Control and Prevention (CDC) recommends 5 $\mu\text{g}/\text{dl}$ reference level of lead in the blood of children from 1-5 years old (97.5 percentile of blood lead data distribution in 1-5 years old children in the US)

97.5% of children of this age in the US have BLL **below 5 $\mu\text{g}/\text{dl}$** .

Methods – Study and aims

Cross-sectional study – Assessing BLL of children born from 2007-2009 and living in Alaverdi and Akhtala communities and Erebuni district in Yerevan.

Study aims:

1. Measure the BLL in children from Alaverdi, Akhtala and Erebuni district of Yerevan
2. Assess the potential risk factors for elevated BLL in those communities and check for interactions between the risk factors.

Methods – Study population

- Eligibility:
 - ▣ Children born in 2007, 2008 and 2009 residing in Alaverdi, Akhtala and Yerevan's Erebuni district
 - ▣ Main caregiver available for face-to-face interview
- Exclusion criteria:
 - ▣ Absent from their residential area longer than 10 days during the last month
 - ▣ Absent from their residential area longer than 3 months during the last year

Selection and recruitment of children conducted through local medical registries of the local healthcare facilities.

Methods – Study population (2)

- Sampling
 - ▣ All eligible children in Akhtala
 - ▣ Simple random sampling from the registration lists of the primary healthcare facilities in Alaverdi
 - ▣ Multistage, probability-proportional-to-size cluster sampling technique proportionate to the size of the population by each polyclinic in Erebuni district in Yerevan

Methods



- Trained pediatric nurse and CHSR researcher
- Capillary blood lead – US CDC recommended finger stick method
 - Height and weight measurements
- Mobile LeadCare II analyzer (ESA Biosciences, Inc., USA)
 - Developed in collaboration with the CDC
 - Classified by FDA as CLIA-waived (Clinical Laboratory Improvement Amendments) and approved for use at non-traditional laboratory settings
 - Detection range of 3.3 – 65.0 µg/dl

Methods

- Questionnaire developed based on international best practices and thorough literature review of BLL risk factors
- Double entry, data cleaning, analysis with SPSS 16.0
- Main outcome variable - continuous variable of child BLL

The **Institutional Review Board** of the American University of Armenia reviewed and approved the study protocol before the fieldwork.

The Prime Minister's Office of the Republic of Armenia approved the study.

Methods

- The trained interviewers asked the child's main caregiver to respond to a questionnaire (**159 interviews**)
 - Family's socio-demographics characteristics
 - Housing conditions
 - Caregivers' knowledge about lead exposure and preventive measures
 - Child's health, hygiene and nutrition

Methods

- ▣ Following the BLL testing and interview
 - Informed the caregivers about their child's BLL results
 - Counseled on evidence-based preventive measures to minimize lead exposure
 - Provided with an information brochure



BLL study Results

Results - BLL

Lead Levels In Children's Blood - 2013

Community	Number of children	Geometric mean Range ($\mu\text{g}/\text{dL}$)	Percentage of samples above the reference level
Akhtala	39	6.8 3.6-15.5	84.6
Alaverdi	69	6.4 3.5-24.0	75.4
Yerevan	54	5.2 0.1-11.7(52.8)	57.4



Results

- 159 eligible children recruited:
- Response rate - 70.4%
 - (80.4% - Akhtala, 73.4% - Alaverdi, 61.6% - Yerevan)
- Main caregivers - 90.6% mothers
 - (8.2% grandmothers, 0.6% fathers and 0.6% grandmother's sister)
- 99.4% - women

Final multivariable linear regression models for the total sample, for the sample from Yerevan and combined Akhtala+Alaverdi sample

Variables	Adjusted ratio of expected GM of BLL (95 % CI)	p value
Total sample		
Combined Akhtala and Alaverdi compared to Yerevan	1.24 (1.09, 1.42)	0.001*
Caregiver's lower education compared to higher	1.23 (1.07, 1.41)	0.004*
Dusting furniture less often than daily compared to daily	1.29 (0.98, 1.55)	0.075**
Closer housing distance from toxic source(s) compared to farther	1.22 (1.08,1.38)	0.002*

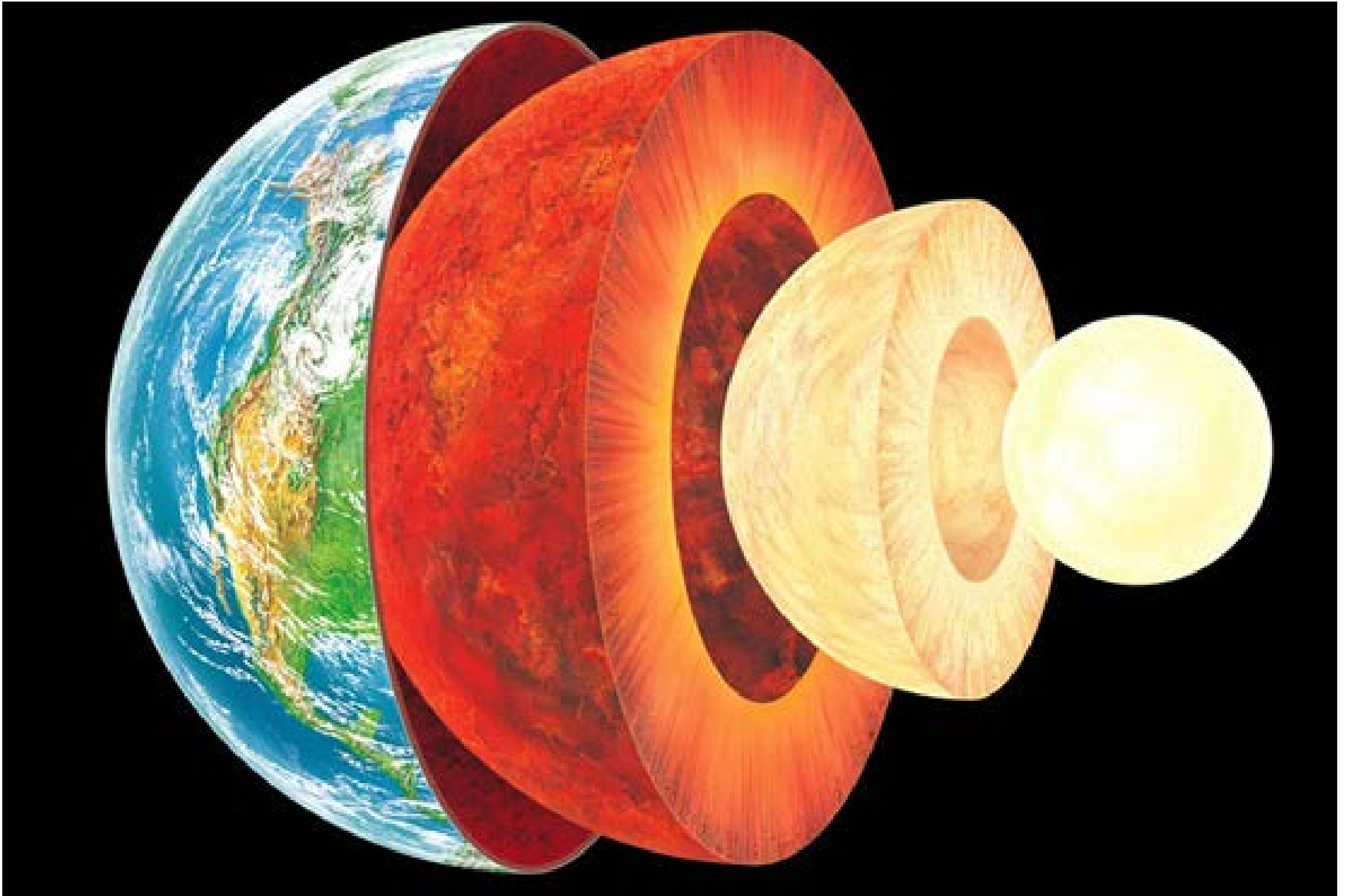
Final multivariable linear regression models - continued

Variables	Adjusted ratio of expected GM of BLL (95 % CI)	p value
Akhtala and Alaverdi combined		
Caregiver's lower education compared to higher	1.20 (1.01, 1.43)	0.035*
Dusting furniture less often than daily compared to daily	1.30 (1.04, 1.64)	0.024*
Yerevan		
Caregiver's lower education compared to higher	1.28 (1.02, 1.59)	0.030*
For housing located farther from toxic source(s)***		
Old windows compared to new ones	2.01 (1.42, 2.86)	0.000*
For housing located closer to the toxic source(s)		
Old windows compared to new ones	1.06 (0.82, 1.37)	0.628

Acknowledgements

- Pure Earth (formerly the Blacksmith Institute) provided financial support and equipment (portable LeadCare II Blood Lead Analyzer) for this study.
- We thank the Government of Armenia, particularly regional and local authorities, healthcare providers and the heads of kindergartens for supporting the study. We acknowledge all the members of the research team including Kristina Akopyan, Lusine Musheghyan, Armine Ghaltakhchyan and Naira Boshyan for their contribution to the project. We express our deepest gratitude to Francis Mayela Abreu Cedeno for her support during data analysis, Aram Bedrosian for his assistance, and to all study participants.
- Find the full article at <http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3613-9>

Thank you!



Questions???



2. Օգտագործե՛ք մաքուր ջուր խմելու և լվացվելու համար:

- Օճառով լվացե՛ք ձեռքերը ուսելուց առաջ և այգում գործ անելուց հետո:
- Հետևե՛ք, որ Ձեր երեխաները օճառով լվացվեն դրսում խաղալուց հետո և ուսելուց առաջ:
- Մինչև օգտագործելը թողե՛ք, որ ջուրը մի րոպե հոսի ծորակից:



3. Լավ լվացե՛ք բոլոր մրգերն ու բանջարեղենները մինչև ուտելը:

- Եթե ձեր այգին գտնվում է փողոցի մոտ, ապա ուտելուց առաջ հեռացրե՛ք բանջարեղենների և մրգերի արտաքին տերևներն ու թերթիկները և լավ լվացե՛ք 1%-ոց քաղցրահամ լուծույթով:
- Պահե՛ք սնունդը փակ դարակներում:

Մրգերն ու ձեր երեխաներին խաղալ արդյունաբերական թափոնների կոպտերի հետ. դրանք կարող են պարունակել մեծ քանակությամբ մկնդեղ և այլ ծանր մետաղներ:

Առողջ սնունդ

Նշված սննդամթերքի կիրառումը կօգնի նվազեցնել մկնդեղի վնասակար ազդեցությունները Ձեր և Ձեր երեխայի օրգանիզմում և լինել առողջ:



- ✓ Մխտոր, սոխ
- ✓ Ձու
- ✓ Բանջարեղեն՝ կաղամբ, ծաղկակաղամբ, գազար, լոլիկ, քաղցր բիբար
- ✓ Լոթի, ոլոռ, եգիպտացորեն, ոսպ
- ✓ Ընկուզեղեն, արևածաղկի սերմեր
- ✓ Մրգեր՝ նարինջ, էլակ, ազնվամորի
- ✓ Խոտաբույսերով թել

Այս քայլերը կօգնեն Ձեզ պաշտպանվել թե՛ մկնդեղի, թե՛ այլ ծանր մետաղների (օրինակ կապար, կարմիր) վնասակար ազդեցությունից:

ՄԱՔՈՒՐ ՄԻՋԱՎԱՅՐ ԱՌՈՂՋ ԸՆՏԱՆԻՔ ԱՌՈՂՋ ԵՐԵՒԱ



Քայլեր, որոնք կօգնեն Ձեզ և Ձեր երեխային պաշտպանվել միջավայրում գտնվող մկնդեղի և այլ ծանր մետաղների վնասակար ազդեցությունից



- ✓ Child's nutrition % score - calculated based on the frequency of having lead-preventive food items, such as milk, yogurt, cheese, beans, meat, dry fruits, dark chocolate, seeds, and dark green-leave vegetables. The higher the child's nutrition % score the more often the child had those foods in his/her diet.
- ✓ Caregiver's knowledge % score - calculated based on the correct answers to the 28 questions measuring caregivers' knowledge on how to prevent lead exposure in children. The higher % score is an indicator of caregiver's higher knowledge.
- ✓ Household living standard % score - calculated based on three questions: employment rate (% of employed adult family members), caregiver's perceived standard of living, and family's average monthly spending. The higher % score shows that the family had a higher prosperity level.
- ✓ Household hygiene % score - calculated based on the cleaning and hygiene practices in the house, such as dry vacuum or wet cleaning of floor surfaces, dusting furniture surfaces, cleaning the soles of shoes and taking them off when entering the house. The higher the household hygiene % score, the more preventive measures were taken in the house to reduce the level of lead exposure due to outdoor lead pollution.
- ✓ Child's hygiene % score – based on the frequency with which the child washed his/her hands after returning home from the yard, before having a meal, as well as based on whether or not they had a habit of biting their nails.

Descriptive statistics by communities and for the total sample - 1

Variables	%, mean, range, SD	Alaverdi (SS ^a =69)	Akhtala (SS=37)	Yerevan (SS=53)	Total (SS=159)
Children involved in the study	%	43.4	23.3	33.3	100.0
BLL above 5 µg/dl	%	72.5	83.8	52.8	68.6
GM of BLL	Mean ± SD	6.4 ± 3.1	6.8 ± 3.2	5.1 ± 2.4	6.0 ± 3.0
	Range	3.5 – 24.0	3.6 – 15.5	1.6 – 11.7	1.6 – 24.0
Caregivers' age	Mean ± SD	31.8 ± 8.43	32.14 ± 7.23	33.06 ± 8.17	32.3 ± 8.1
Caregiver's education: higher versus lower	Higher %	18.8	24.3	35.85	25.8
Caregivers' marital status: married versus widowed	Married %	97.1	94.6	96.2	96.2
Caregivers' employment status	Employed %	21.7	10.8	35.6	23.9

Descriptive statistics by communities and for the total sample - 2

Variables	%, mean, range, SD	Alaverdi (SS ^a =69)	Akhtala (SS=37)	Yerevan (SS=53)	Total SS=159
Children's sex	Female %	46.4	48.6	48.1	47.5
Child's age in years	Mean ± SD	5.2 ± 0.76	5.51 ± 0.83	5.35 ± 0.99	5.3 ± 0.9
Child nutrition % score	Mean ± SD	50.96 ± 15.64	49.22 ± 13.75	49.53 ± 15.56	50.0 ± 15.1
Stunting in children	Yes %	9.4	19.4	10.6	12.2
Child plays with soil in yards, play grounds or gardens in warm seasons	Yes %	79.1	75.7	69.2	75.0
Hours spent in yards, playgrounds or gardens daily in warm season	Mean ± SD	3.3 ± 2.8	4.1 ± 2.9	2.6 ± 2.8	3.3 ± 2.8
Frequency of child washing hands after coming home: always versus not always	Always %	89.9	66.7	90.4	84.7

Variables	%, mean, range, SD	Alaverdi (SS ^a =69)	Akhtala (SS=37)	Yerevan (SS=53)	Total (SS=159)
Hours spent in yards, playgrounds or gardens daily in warm season	Mean ± SD	3.3 ± 2.8	4.1 ± 2.9	2.6 ± 2.8	3.3 ± 2.8
Frequency of child washing hands after coming home: always versus not always	Always %	89.9	66.7	90.4	84.7
Frequency of child washing hands before eating: always versus not always	Always %	67.6	56.8	63.5	63.7
Child's behavior of biting nails	Yes %	17.4	21.6	13.5	17.1
Child's hygiene score	Mean ± SD	1.74 ± 0.68	1.44 ± 0.84	1.67 ± 0.59	1.7 ± 0.7
Household living standard % score	Mean ± SD	35.9 ± 13.3	30.4	40.7 ± 14.3	36.3 ± 14.3
Household size	Mean ± SD	4.97 ± 1.14	5.03 ± 1.46	5.51 ± 1.40	5.2 ± 1.3
Housing type ^b : flat or house	Flat %	89.9	70.3	45.3	70.4
Housing floor ^b : first versus higher floor	First floor %	34.8	56.8	58.5	47.8
Type of windows: new versus old	New %	13.0	18.9	41.5	23.9
Daily mean duration of opening the windows in summer -in hours	Mean ± SD	14.80 ± 6.11	17.76 ± 7.35	19.12 ± 7.50	16.9 ± 7.1
Having carpet on the floor	Always %	56.5	54.1	50.9	54.1
	Seasonal %	34.8	29.7	34	33.3
	Never %	8.7	16.2	15.1	12.6

Variables	%, mean, range, SD	Alaverdi (SS ^a =69)	Akhtala (SS=37)	Yerevan (SS=53)	Total (SS=159)
	Never %	8.7	16.2	15.1	12.6
Duration of occupying the current flat/house in years	Mean ± SD	8.7 ± 8.6	7.9 ± 7.4	9.5 ± 8.5	8.8 ± 8.3
Number of current smokers in the family	Mean ± SD	1.1 ± 0.6	0.9 ± 0.6	1.3 ± 0.8	1.1 ± 0.7
Smoking in presence of the child	Yes %	55.9	85.7	76.1	69.2
Family member working in a processing facility, mine or smelter compared to not having any	Yes %	29.0	58.3	0	25.9
Number of family members working in a processing facility, mine or smelter	Mean ± SD	0.4 ± 0.6	0.6 ± 0.6	0 ± 0	0.3 ± 0.5
Caregiver's knowledge % score	Mean ± SD	53.6 ± 17.7	58.8 ± 19.1	42.2 ± 18.1	52.3 ± 18.6
Frequency of parents changing clothes/shoes before coming from processing facility, mine or smelter	Always %	85.0	71.4	100	78.0
	Not always %	15.0	28.6	0	22.0
Household hygiene % score	Mean ± SD	67.4 ± 13.1	68.4 ± 13.7	74.6 ± 12.9	70.4 ± 13.5
Frequency of furniture dusting ^c : daily versus less than daily	Daily %	92.6	83.8	98.1	92.4
Housing distance from the toxic source(s)	Closer %	59.4	56.8	64.2	60.4
	Farther %	40.6	43.2	35.8	39.6
Midpoint distance from the toxic (meters)	Closer	640	846	3 516	
	Farther	1 218 ^d	840 ^d	5 402	