

Interdisciplinarna ocena izpostavljenosti otrok svincu na območjih, degradiranih zaradi rudarjenja (Zgornja Mežiška dolina, Slovenija)

Projekt 6.2.1.a

Predstavlja: Špela Bavec

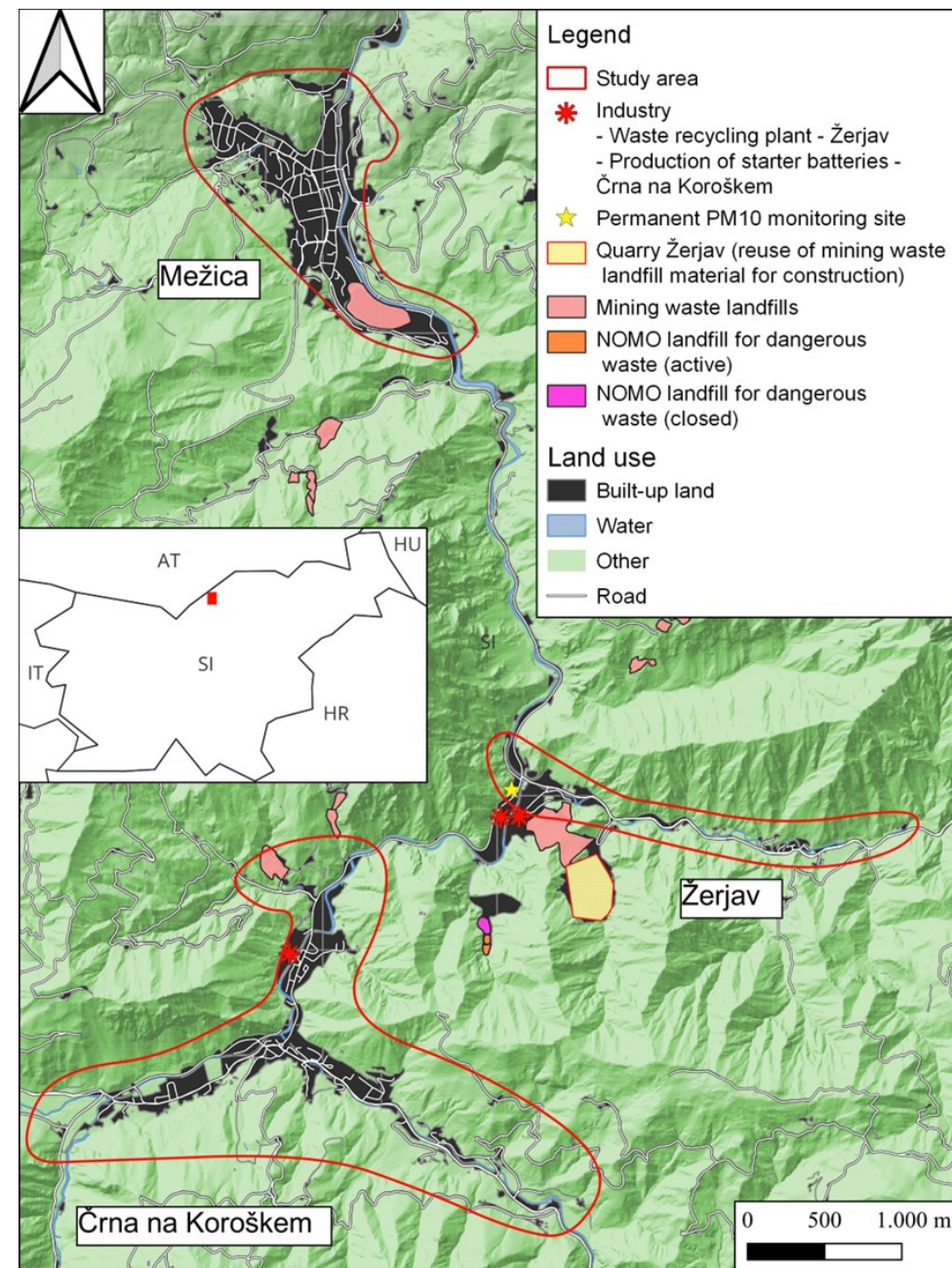
Delovna skupina: GeoZS: Š. Bavec; T. Čeru; K. Teran; M. Miler; NIJZ: S. Kirinčič; V. Golja; A. Remškar; ARSO: J. Turšič

Nacionalni vozliščni sestanek: Ljubljana, 05. 12. 2024

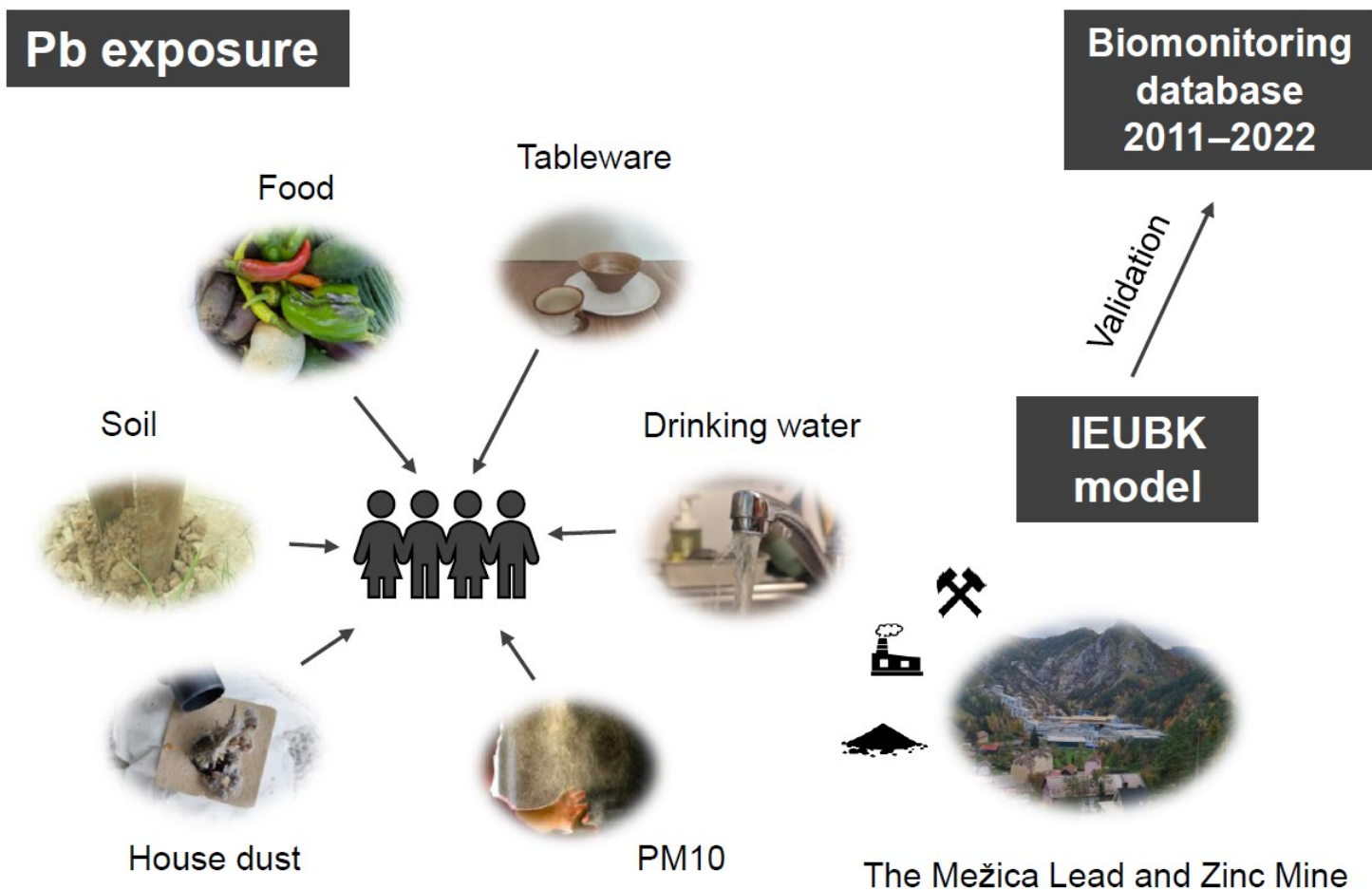
Območje raziskave: Zg. Mežiška dolina



Žerjav (vir: Polšak, 2011)



Modeliranje v IEUBK modelu z vsemi razpoložljivimi podatki



Vhodni okoljski podatki: tla

- Podatki za območje Zg. Mežiške doline v okviru monitoringa sanacijskih ukrepov (ARSO) med 2008-2022
- Za splošno populacijo: tla iz 2016 (Teran, 2020)

Parameter	Unit	This study									Pokorny et al. (2002)			Jež and Leštan (2015)			Gosar et al. (2019)	Teran (2020)	
		Garden & lawn soil			Garden soil (0–20 cm)			Lawn soil (0–5 cm)			Garden soil (0–20)			Garden, grassland and orchard soil (0–8, 8–14, 14–21cm)			Slovenia (0-10)	Slovenia rural (0–5 cm)	Slovenia urban (0–5 cm)
		Č	M	Ž	Č	M	Ž	Č	M	Ž	Č	M	Ž	Č	M	Ž			
Count		46	30	20	28	21	12	18	9	8	9	9	2	33	30	16	819	105	143
Minimum	mg/kg	23	54	75	140	54	75	23	170	310	511	573	3350	181	116	1331	6.2	14	18
Maximum	mg/kg	1600	2100	5100	1600	2100	4483	1200	1510	5100	1950	2830	4470	4517	3270	7384	850	1700	1300
Arithmetic mean	mg/kg	584	673	1397	659	667	1260	468	686	1604	1180	1090	3910	1267	1037	3892	40	/	/
Median	mg/kg	555	543	645	590	495	730	480	620	635	925	936	3910	1050	671	3789	34	36	51
Geometric mean	mg/kg	473	491	782	545	482	681	380	512	963	/	/	/	/	/	/	34	/	/

Č = Črna, M = Mežica, Ž = Žerjav; **In bold** values used for modelling are presented

Vhodni okoljski podatki: hišni prah, pitna voda

- Podatki za območje Zg. Mežiške doline v okviru vzorčenja iz več raziskav: 2011 (Miler in Gosar 2019), 2016 (Teran, 2020), 2023 (neobjavljeno)
- Za splošno populacijo hišni prah iz leta 2016 (Teran, 2020)

Parameter	Drinking water ($\mu\text{g/L}$)			House dust (mg/kg)							
	This study			This study			Flis et al. (2002)			Teran (2020)	
Study area	Črna	Mežica	Žerjav	Črna	Mežica	Žerjav	Črna	Mežica	Žerjav	Slovenia rural	Slovenia urban
count	4	4	4	6	8	4	5	8	2	101	137
minimum	1.2	<1	<1	176	31	75	724	524	2126	15	7.9
maximum	2.7	<1	<1	344	829	2636	1426	1287	2277	2500	890
arithmetic mean	1.775			266	319	1855	1089	896	2202	/	/
median	1.6			275	211	2354	1092	813	2202	54	61

in bold values used in modelling are presented

Vhodni okoljski podatki: zrak

- Podatki za območje Zg. Mežiške doline v okviru monitoringa sanacijskih ukrepov (ARSO)
- Za splošno populacijo vzete najbolj primerne postaje za urbano in ruralno območje (ARSO)

Study area	Location name	GKY ¹	GKX ¹	factor	Arithmetic mean Pb (ng/m ³) ²	Study area arithmetic mean Pb (ng/m ³)
	<i>permanent monitoring site</i>	490348	149042	1	357.6	
Žerjav	Žerjav 77	490506	149048	0.25	89.4	91.8
	Žerjav 20	490465	149131	0.32	114.4	
	Žerjav market	490584	149025	0.2	71.5	
Črna	Črna	488923	147890	0.2	71.5	80.5
	Črna	489239	148041	0.25	89.4	
Mežica	Mežica	489067	152850	0.2	71.5	71.5
Slovenia urban	Celje hospital	520614	121189	-	7	8.4
	Ljubljana Bežigrad	462673	102490	-	8.1	
	Ljubljana Biotehniška	459457	100591	-	8	
	Maribor Titova	550305	157414	-	10.4	
Slovenia rural	Iskrba	489292	46323	-	2.7	2.7

¹ spatial coordinate according to D48 – Slovenia (ESRI:104131); ²Data source for Upper Meža valley (Slovenian Environmental Agency Air Quality archive) and for Slovenia (Koleša 2023); **in bold** values used for modelling are presented

Vhodni podatki za koncentracije Cd v živilih (NIJZ)

(Kirinčič, et al., 2019,
Ribarič-Lasnik et al., 2002 in
Kirinčič et al., 2017)

Food categories	N	<LOQ (%)	> EU (%)	LB	MB	UB	SD (UB)	Median (UB)	Max	Note
Grains and products										
Grains for humans	271	89	0.4	0.006	0.023	0.039	0.025	0.020	0.210	SI
Grain milling products	47	79	0.0	0.009	0.020	0.031	0.020	0.020	0.130	SI
Bread and rolls				0.025	0.029	0.033				EU
Pasta (raw)				0.021	0.024	0.027				EU
Breakfast cereals	18	94	0.0	0.002	0.023	0.044	0.013	0.040	0.070	SI
Fine bakery wares				0.021	0.025	0.028				EU
Vegetables and products										
Root vegetables	171	94	0.6	0.003	0.019	0.035	0.015	0.040	0.180	SI
Root vegetables	39	0	48.7	0.397	0.397	0.397	0.627	0.105	2.333	UMV: Carrots, red beets, parsley roots, celeriacs
Bulb vegetables	35	94	0.0	0.002	0.014	0.026	0.009	0.020	0.040	SI
Fruiting vegetables	38	97	2.6	0.002	0.015	0.029	0.011	0.020	0.060	SI
Fruiting vegetables	5	0	20.0	0.032	0.032	0.032	0.018	0.031	0.059	UMV: Tomatoes and peppers
Brassica vegetables	94	100	0.0	0.000	0.013	0.025	0.009	0.020	0.040	SI
Leaf vegetables	525	93	0.0	0.003	0.015	0.027	0.011	0.020	0.100	SI
Leaf vegetables	58	0	13.8	0.170	0.170	0.170	0.238	0.101	1.511	UMV: Chicory
Parsley - Aromatic Herbs	10	0	30.0	0.770	0.770	0.770	0.588	0.595	2.167	UMV: Parsley
Legume vegetables	31	100	0.0	0.000	0.010	0.020	0.000	0.020	0.020	SI
Stem vegetables	10	100	0.0	0.000	0.020	0.040	0.000	0.040	0.040	SI
Tea and infusions (solid)	31	19	0.0	0.416	0.421	0.426	0.512	0.150	2.240	SI
Cocoa powder				0.138	0.139	0.139				EU
Coffee beans				0.050	0.052	0.053				EU: coffee beans, roasted and ground
Vegetable products	7	100	0.0	0.000	0.020	0.040	0.000	0.040	0.040	SI
Fungi, cultivated	37	97	0.0	0.005	0.021	0.037	0.029	0.040	0.200	SI
Fungi, wild, edible				0.478	0.491	0.503				EU
Starchy roots and tubers	315	98	0.0	0.001	0.012	0.023	0.007	0.020	0.065	SI: Potatoes and 5 samples of sweet potatoes
Starchy roots and tubers	13	38	15.0	0.050	0.066	0.081	0.036	0.069	0.147	UMV: Potatoes
Legumes, nuts, oilseeds										
Legumes no pods	20	100	0.0	0.000	0.020	0.040	0.000	0.040	0.040	SI
Legumes dried	40	100	0.0	0.000	0.016	0.033	0.010	0.040	0.040	SI
Tree nuts				0.026	0.033	0.039				EU
Oilseeds	6	33	0.0	0.024	0.028	0.031	0.016	0.027	0.062	SI
Fruit and fruit products										
Citrus fruits				0.009	0.012	0.014				EU
Pome fruits	72	100	0.0	0.000	0.012	0.024	0.008	0.020	0.040	SI
Stone fruits				0.009	0.012	0.016				EU
Berries and small fruits	101	100	0.0	0.000	0.016	0.032	0.010	0.040	0.040	SI
Miscellaneous fruits	37	97	0.0	0.001	0.011	0.020	0.002	0.020	0.032	SI
Dried fruits	6	100	0.0	0.000	0.020	0.040	0.000	0.040	0.040	SI
Jam and spreads				0.016	0.017	0.019				EU
Other fruit products				0.020	0.023	0.025				EU
Meat and edible offal										

Vhodni podatki za koncentracije Cd v živilih (NIJZ)

(Kirinčič, et al., 2019,
Ribarič-Lasnik et al., 2002 in
Kirinčič et al., 2017)

	Other fruit products				0.020	0.023	0.025				EU		
Meat and edible offal	Livestock meat	77	97	0.0	0.001	0.013	0.025	0.023	0.010	0.060	SI: Meat (bovine and poultry)		
	Poultry	14	100	0.0	0.000	0.005	0.010	0.000	0.010	0.010	SI		
	Game mammals	200	87	10.0	0.042	0.068	0.094	0.111	0.060	0.500	SI		
	Edible offal	108	94	0.0	0.008	0.056	0.104	0.033	0.120	0.220	SI: Edible offal from farmed animals		
	Preserved meat				0.021	0.023	0.025				EU		
	Sausages				0.011	0.017	0.022				EU		
Fish and seafood	Fish meat	60	97	0.0	0.001	0.022	0.043	0.024	0.060	0.060	SI		
	Fish meat	10	0	70.0	0.089	0.089	0.089	0.386	0.470	1.250	UMV: Trouts - wild		
	Fish products				0.023	0.026	0.028				EU		
	Crustaceans	4	75	0.0	0.005	0.015	0.025	0.024	0.015	0.060	SI		
	Water molluscs	32	63	0.0	0.064	0.077	0.089	0.100	0.060	0.527	SI		
Milk and dairy products				0.0	0.008	0.010	0.012	0.003	0.002	0.018	EU: Liquid milk		
Milk and dairy products				12	8	92.0	0.098	0.100	0.102	0.053	0.090	0.230	UMV: Cattle milk
Eggs and products					0.008	0.012	0.015				EU		
Eggs and products				39	0		0.235	0.235	0.235	0.209	0.210	1.200	UMV: Hen eggs
Sugar and confectionary				16	88	0.0	0.012	0.038	0.064	0.012	0.060	0.100	SI: Honey
Fats and oils				35	100	0.0	0.017	0.020	0.022	0.000	0.020	0.020	EU: Vegetable oils
Fruit and vegetable juices				48	100	0.0	0.000	0.018	0.037	0.008	0.040	0.040	
Non-alcoholic beverages							0.012	0.013	0.014				EU
Alcoholic beverages				18	83	0.0	0.004	0.013	0.023	0.006	0.020	0.040	SI Wine and white sparkling wine
Herbs, spices and condiments				55	96	0.0	0.011	0.022	0.033	0.074	0.020	0.570	SI
Food for children													
	Infant formulae powder	21	100	0.0	0.000	0.004	0.008	0.003	0.010	0.010	SI		
	Follow-on formulae powder	19	100	0.0	0.000	0.005	0.010	0.000	0.010	0.010	SI		
	Cereal-based food for children	57	96	1.8	0.001	0.030	0.059	0.015	0.070	0.070	SI		
	Ready-to-eat meal for children	61	97	0.0	0.000	0.005	0.010	0.000	0.010	0.013	SI		
Special nutritional products		245	52	2.4	0.369	0.383	0.398	1.196	0.080	11.560	SI: Dietary supplements		
Composite food					0.034	0.036	0.039				EU		
Snacks, desserts, other foods					0.025	0.026	0.028				EU		

Figures in **bold** were used for exposure calculation in different scenarios.

SI: Data from Slovenian (SI) market 2011–2016 (Kirinčič et al., 2019).

UMV: data from Upper Meža Valley (Ribarič-Lasnik et al., 2002; Kirinčič et al., 2017).

EU: only data from EFSA, 2012

>EU: >EU maximum level from Commission Regulation (EU) 2023/915.

Različni scenariji prehranske izpostavljenosti

(Deterministična ocena, podatki o količinah zaužitih živil: SI-MENU 2017/18)

- Izračunane vrednosti za 7 različnih scenarijev
- Podrobneje obravnavani 3, ki vključujejo min., max. in srednjo vrednost prehranske izpostavljenosti
- V modeliranju uporabljena LB povprečna koncentracija Pb v posameznih skupinah živil



Toddlers (1–3 years) dietary exposure	LB	MB	UB	LB	MB	UB
	μg/kg bw/day			μg/day		
D1: children consume only food from Slovenian market (general – reference scenario for Slovenian toddlers)	0.7	1.4	2.0	9.5	17.4	25.3
D2: most of the foods are consumed from the market except for half of the consumption of the local foods listed in Table S1	2.0	2.6	3.2	25.4	33.0	40.7
D3: children consume local foods instead of market foods listed in Table S1, the rest are foods from the market	3.3	3.8	4.4	41.4	48.7	56.1
market food and only milk and milk products from local produce	2.3	2.9	3.5	28.6	36.5	44.4
market food and only eggs from local produce	1.0	1.6	2.3	12.9	20.8	28.6
market food and only vegetables from local produce	1.3	1.9	2.5	16.6	24.0	31.3
market food and only brook trout from local rivers	0.8	1.4	2.0	9.9	17.7	25.5

Overall chronic dietary exposure was estimated with 3 different arithmetic mean concentrations of Pb in different food groups: LB = lower bound., MB = middle bound and UB = upper bound; the exposure scenario (D1, D2, D3) values used for IEUBK modelling are shown in **bold font**

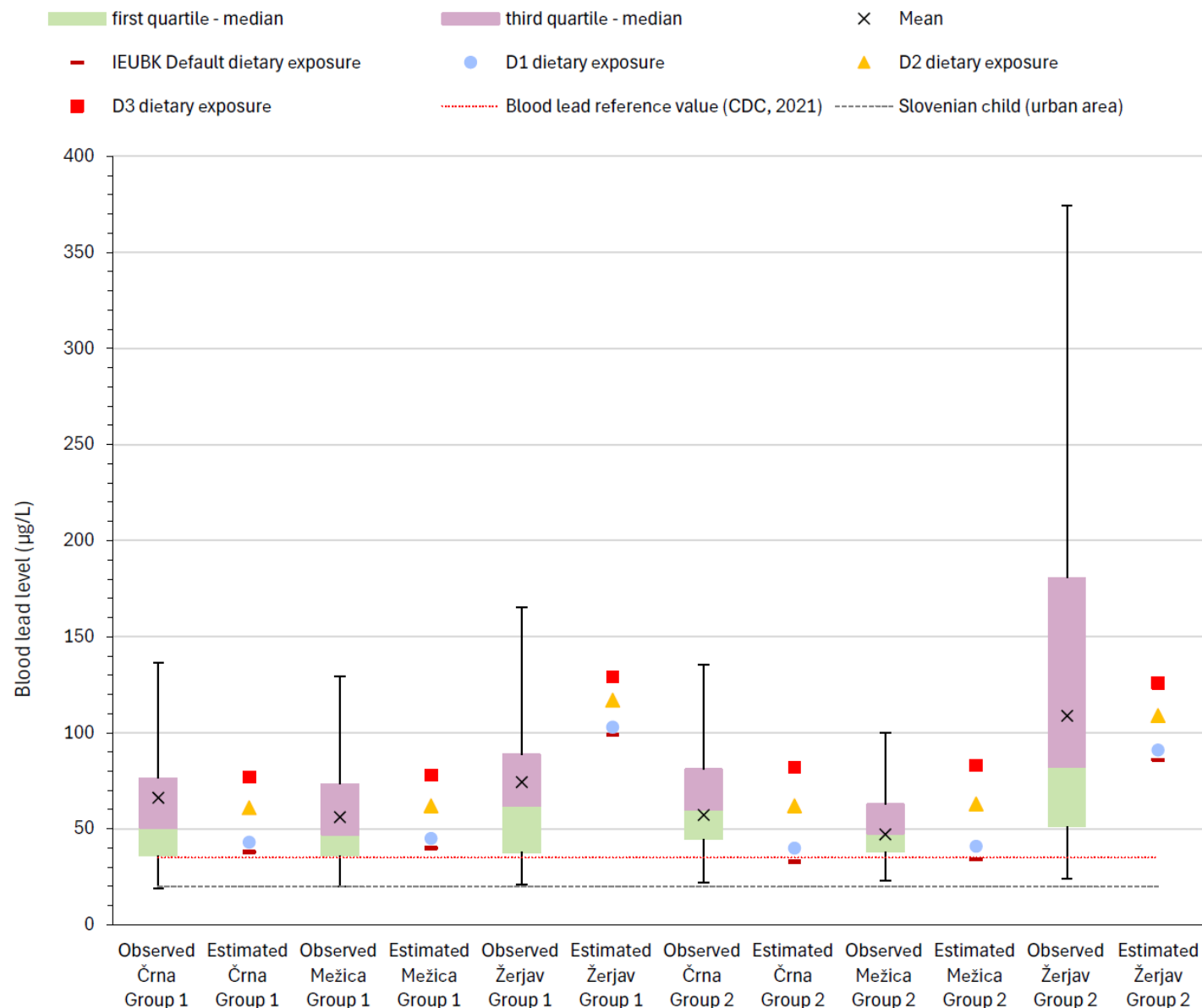
Materiali v stiku s živili - keramika (NIJZ)

- Vir podatkov – Zdravstveni inšpektorat RS (2013-2023)
- Vrednosti zelo nizke v primerjavi s prehransko izpostavljenostjo
- Pri modeliranju niso bile upoštevane

Scenario Number	Allocation for hollowware	Substitution	Decreasing factor	Exposure from food contact ceramics ($\mu\text{g}/\text{day}$)	A in %	B in %	C in %
FCM1	0.85	LB	0.2	0.048	0.50	0.19	0.12
FCM2	0.85	MB	0.2	0.13	0.77	0.41	0.28
FCM3	0.85	UB	0.2	0.23	0.89	0.56	0.40

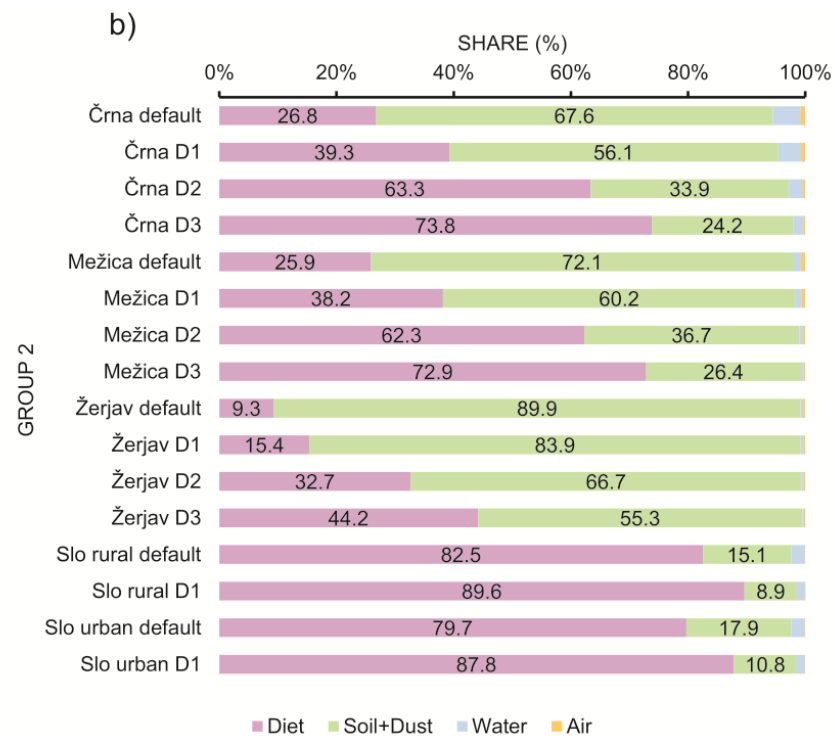
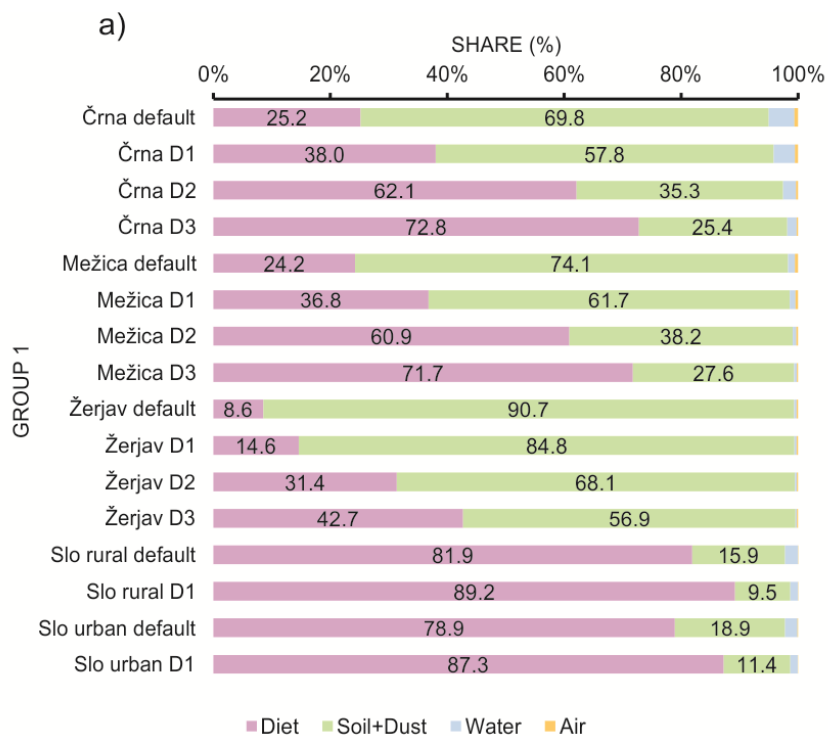
Modeliranje - rezultati

- Primerjava izračunanih (3 scenariji) in izmerjenih vrednosti svinca v krvi otrok
- Biomonitoring podatki (2011-2023)
- Skupina 1 (24-36 mesecev), 2 (36-48 mesecev)
- Izmerjene in izračunane vrednosti se dobro ujemajo v Črni in delno v Mežici
- V Žerjavu so izračunane vrednosti za skupino otrok 24-36 m pretirane v primerjavi z izmerjenimi, za otroke 36-48 m pa izračunane pokrivajo območje povprečnih vrednosti (posledica majhnega števila izmerjenih vrednosti)



Modeliranje - deleži k celokupni izpostavljenosti iz različnih virov

- 73-60 % celokupne izpostavljenosti Pb izvira iz prehrane pri scenariju D1 (uživanje samo lokalne hrane) in D2 (lokalna+market) v Črni in Mežici
- V Žerjavu v vseh treh scenarijih največji delež k celokupni izpostavljenosti Pb prispevajo tla/prah, nato sledi prehrana
- Pb v vodi in zraku prispeva zanemarljiv delež k celokupni izpostavljenosti



Interdisciplinarna ocena izpostavljenosti odraslih kadmiju na območju Slovenije

Projekt 6.2.1.b

Predstavlja: Špela Bavec

Delovna skupina: GeoZS: Š. Bavec; T. Čeru; K. Teran; M. Miler; NIJZ: S. Kirinčič; V. Golja; A. Remškar; ARSO: J. Turšič

Nacionalni vozliščni sestanek: Ljubljana, 05. 12. 2024

Referenčna populacija in viri izpostavljenosti

1. Ref. populacija

- Odrasli (18-64 let): SI-MENU 2017/18 (food consumption)
- HBM1 validacija (18-49 let)

2. Modeliranje v RSExp in MCRA

- Okoljska izpostavljenost: RSExp (GeoZS in ARSO)
- Prehranska izpostavljenost: MCRA (NIIJZ)
- Materiali v stiku z živili- MCRA? (NIJZ)

➤ *Modeliranje za celotno Slovenijo, glede na smiselnost in podatke tudi modeliranje ruralna/urbana območja in po regijah*

Okoljska izpostavljenost (ARSO)

- Individualni podatki za delce **PM10** (letne oz. več letne povprečne vrednosti)
- Za merilna mesta, kjer se ravni kovin v delcih spremljajo stalno, je izračunano povprečje v zadnjih petih letih. Za ostala merilna mesta je podano letno povprečje, za posamezno leto oz. več let, če so meritve potekale več let.
- Merilno mesto **Iskrba** odraža raven ruralnega ozadja.
- Izključena postaja Žerjav, Celje?

Merilna postaja	Koncentracija (ng/m ³)	Obdobje
Celje	0,46	*
Deskle	0,09	2021
Ilirska Bistrica	0,10	2023
Iskrba	0,06	*
Ljubljana	0,20	**
Maribor	0,15	*
Nova Gorica	0,15	***
Ptuj	0,16	2021

* povprečje zadnjih petih let

** Za Ljubljano je izbrana podstaja Ljubljana Bežigrad, ki je reprezentativna za širše območje.
Vzporedne meritve na drugih lokacijah podobnega tipa (urban background) kažejo, da so ravni primerljive.

*** Izračunano je povprečje v zadnjih treh letih

Prehranska izpostavljenost, ref. populacija (NIJZ)

- **Ref: populacija:** Nacionalna prehranska raziskava SI-Menu 2017/18
- Na podlagi vprašalnika podatki o ref. populaciji (392 odraslih): starost, spol, teža, regija, itd.
- **Verjetnostna (probabilistična) ocena prehranske izpostavljenosti (MCRA):**
 - okoli 5600 vzorcev različnih živil s slovenskega trga (2011-2022), manjkajoči podatki bodo vzeti iz literature
 - Vzorci vode (2013-2023)

GENDER	Gender	G1	Controlled vocabulary	G1 Male G2 Female
AGE	Age in years	27	Numerical value	
WEIGHT	Body weight in kg from the first measurement	68	Numerical value	
HEIGHT	Height in cm from the first measurement	176	Numerical value	
SWEIGHT	Body weight in kg from the second measurement, if any	70	Numerical value	
SHEIGHT	Height in cm from the second measurement, if any	176	Numerical value	
GEO	Region, area or city of residence	ES5	Controlled vocabulary	See GEO sheet. This is the 3rd level of the NUTS classification (Nomenclature of
ENRGYINTAKE	Average energy intake over the survey period in Kcal per day	2500	Numerical value	
WF	Weighting factor used to normalize for age groups, gender, regions ...	365	Numerical value	
NHOUSEHOLD	Size of household - Number of individuals in the household	4	Numerical value	
LABOURS	Labour status of the subject (Not applicable in case of children)		Controlled vocabulary	L0 Not applicable L1 Working for pay
LABOURM	Labour status of the mother of the subject (Only applicable in case of children)		Controlled vocabulary	L0 Not applicable L1 Working for pay
LABOURF	Labour status of the father of the subject (Only applicable in case of children)		Controlled vocabulary	L0 Not applicable L1 Working for pay
PROFESSS	Professional category of the subject (Not applicable in case of children)		Controlled vocabulary	P1 Manager P2 Professional
PROFESSM	Professional category of the mother of the subject (Only applicable in case of children)			P1 Manager P2 Professional
PROFESSF	Professional category of the father of the subject (Only applicable in case of children)			P1 Manager P2 Professional
EDUCATIONS	Description of the current education level or highest diploma obtained by the [ary school		Controlled vocabulary	E0 Not applicable E1 No applicable
EDUCATIONM	Description of the current education level or highest diploma obtained by the mother		Controlled vocabulary	E0 Not applicable E1 No applicable
EDUCATIONF	Description of the current education level or highest diploma obtained by the father		Controlled vocabulary	E0 Not applicable E1 No applicable

RSExpo in MCRA

- Modeliranje okoljskih podatkov v R programu: po nastavljenih tabelah za vhodne podatke (razvili ANSES)
- Delovna skupina v okviru PARC-a dela na združevanju različnih modelov (Jasper Engel in ekipa)

Prehranska izpostavljenost in materiali v stiku z živili v MCRA?

- Pripraviti moramo podatke specifične za Slovenijo
- Kar ne bomo imeli, bomo vzeli iz Exposure Factors Handbook US-EPA 2011 oz. usklajeno s podatki, ki jih je uporabila ekipa iz ANSES, da bodo rezultati primerljivi

Hvala za pozornost!

