POPULATION-BASED STUDIES IN TWO MONTANA SUPERFUND COUNTIES

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WHAT LED TO THIS STUDY?

- Longstanding research program related to Superfund exposures in South Carolina
- NIH/NIEHS funding from 2005-2014 "Methods to Detect Maternal Exposures and Child Outcomes" with 22 publications
- Reading reports and recognizing other ways the data can be analyzed

FINDINGS FROM TEN YEARS OF SUPERFUND STUDIES:

- We can identify clusters of low prevalence outcomes using Bayesian local likelihood cluster modeling- with "lassos"
- We can use simple techniques to sample soil
- Residential addresses can be used to estimate exposure using a semi-parametric additive model (GAM)
- We can distinguish natural and anthropogenic sources of metals
- Soil metals are associated with LBW (Pb*Cd), intellectual disability (Pb, As, **As*Pb**, Ni*Pb), cerebral palsy (Cd)
- There are more vulnerable times during pregnancy- As 1st trimester, Hg 1st and 3rd trimester
- We can model human absorption using physiologic extraction tests- gastric and intestinal – Cd, Ni, Pb, Cr
- Change points for Pb that convey high risk- e.g. bioavailable intestinal 9.15mg/kg (130.6mg/kg^{-1} of soil Pb)*

* EPA PRG-RSSL for Pb= 400mg/kg^{-1} dw

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ORIGINAL PAPER

Population-based mortality data suggests remediation is modestly effective in two Montana Superfund counties

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Known heavy metal exposures for Deer Lodge and Silver Bow counties			
Metal	Locations discovered		Relationship to mining
Aluminum[a,c]	Hair	Surface water	Combined with copper to form an alloy-aluminum bronze
Arsenic[b,c]	Blood Hair Air Buildings/Structures Ground water	Sediment Soil Solid waste Surface water	Released during the copper mining process
Cadmium[b,c]	Hair Air Buildings/Structures Ground water	Sediment Soil Solid waste Surface water	Released during the mining and smelting processes
Copper[b]	Hair Ground water Sediment	Soil Surface water	Mined from the Berkeley and Continental pits

[a]**Silver Bow county**
[b]**Silver Bow and Deer Lodge**
[c]**EPA or ATSDR Identified as threat to human health and/or carcinogen**

Table cont. Known heavy metal exposures for Deer Lodge and Silver Bow counties			
Metal	Locations discovered		Relationship to mining
Iron[a]	Ground water	Surface water	Present in the copper minerals and released in the smelting stage
Lead[b,c]	Air Buildings/Structures Ground water Sediment	Soil Solid waste Surface water	Mined from the Berkeley Pit
Manganese[a]	Hair Air	Ground water	Mined from the Berkeley Pit
Mercury[a,c]	Surface water Ground water	Sediment Soil	Used to purify gold mined from the Berkeley Pit
Molybdenum[a]	Hair		Mined from the Berkeley and Continental pits
Zinc[a]	Ground water Sediment	Soil Surface water	Mined from the Berkeley Pit
Uranium[a,c]	Hair		Unknown
Silver[a,c]	Surface water		Mined from the Berkeley Pit

[a]**Silver Bow**
[b]**Silver Bow and Deer Lodge**
[c]EPA or ATSDR Identified as threat to human health and/or carcinogen

Table 2. Targeted conditions associated with heavy metal exposure and ICD – 10 codes			
Type	Condition	ICD-10-CM Code	Reference
Cancers	Stomach	C16, D00.2	Yuan, Yang, & Li, 2016; Arita & Costa, 2010
	Liver and intrahepatic bile ducts	C22, D01.5	Naujokas et al., 2013; Arita & Costa, 2010
	Pancreas	C25, D01.7	Arita & Costa, 2010; Garcia-Esquinas, et al., 2013
	Bronchus and lung	C34, D02.20	Nawrot et al., 2015; Naujokas et al., 2013; Smith et al., 2018; Garcia-Esquinas, et al., 2013
	Skin	C43, C44, D03, D04	Naujokas et al., 2013
	Breast	C50, D05	Byrne et al., 2013
	Prostate	C61, D07.5	Arita & Costa, 2010; Garcia-Esquinas, et al., 2013
	Kidney, except renal pelvis	C64, D09.1	Naujokas et al., 2013; Smith et al., 2018; Arita & Costa, 2010; Song et al., 2015
	Bladder	C67, D09.0	Smith et al., 2018; Naujokas et al., 2013; Arita & Costa, 2010
	Brain	C71	Caffo et al., 2014

Targeted conditions associated with heavy metal exposure and ICD – 10 codes			
Type	Condition	ICD-10-CM Code	Reference
Neurological conditions	Alzheimer's disease	G30	Squitti et al., 2012; Bonda et al., 2010
	Motor neuron disease*	G12.2	di Capozzella et al., 2014; Vinceti et al., 2012; Sutedja et al., 2009
	Multiple sclerosis	G35	Etemadifar et al., 2015
	Parkinson's disease	G20	Liu et al., 2013; Campbell, 2006; Racette et al., 2016
Cardio- and cerebrovascular diseases	Ischemic heart diseases	I20-I25	Naujokas, et al., 2013; Tellez-Plaza et al., 2013; States et al., 2009; Lee, et al., 2011
	Heart failure	I50	Tellez-Plaza et al., 2013; Borné, et al., 2015
	Cerebrovascular disease	I60-I69	Tellez-Plaza et al., 2013; Agarwal, et al., 2011
	Atherosclerosis	I70	Fagerberg et al., 2015; Solenkova et al., 2014
Organ failure	Liver failure	K72	Hyder et al., 2013;
	Renal failure	N17-N19	Sabath et al., 2012; Soderland et al., 2010

Mortality Statistics - Standardized mortality ratios for Deer Lodge and Silver Bow compared to Montana, 2000-2015

		Cancer	CCVD	Neurological conditions	Organ failure
Observed deaths, n		1245	3463	486	678
Expected deaths, n		1041.96	2542.59	478.98	545.91
Overall mortality, SMR (95% CI)		1.19 (1.13, 1.26)*	1.36 (1.32, 1.40)	1.01 (0.92, 1.10)*	1.24 (1.15, 1.34)*
Age and sex specific mortality, SMR (95% CI)					
Male	<35	2.12 (0.42, 3.82)	1.12 (0.22, 2.02)	--	0.74 (0.00, 1.77)
	35-54	1.21 (0.85, 1.56)	**1.71 (1.42, 2.00)**	1.69 (0.34, 3.04)	**1.52 (1.05, 1.99)**
	55-74	**1.29 (1.15, 1.44)**	**1.46 (1.34, 1.59)**	1.20 (0.80, 1.60)	**1.61 (1.33, 1.89)**
	75+	1.09 (0.97, 1.21)	**1.28 (1.20, 1.36)**	0.96 (0.80, 1.11)	**1.19 (1.03, 1.35)**
Female	<35	0.40 (0.00, 1.19)	0.92 (0.00, 1.96)	--	0.78 (0.00, 1.85)
	35-54	0.82 (0.53, 1.10)	**1.62 (1.16, 2.07)**	0.88 (0.02, 1.74)	1.28 (0.75, 1.80)
	55-74	**1.32 (1.16, 1.48)**	**1.67 (1.49, 1.85)**	1.28 (0.85, 1.71)	**1.34 (1.05, 1.63)**
	75+	**1.19 (1.05, 1.33)**	**1.30 (1.23, 1.37)**	0.99 (0.87, 1.11)	**1.07 (0.92, 1.22)**
Trend analysis, hazard ratio for each additional year (p-value)		0.97 (0.0004)	0.95 (<.0001)†	0.97 (0.01)	0.98 (0.16)

***Homogenous by age and sex, overall SMR**
Bolded text indicates statistically significant
†Trend analysis was performed for 55-74 year olds as there was heterogeneity amongst age groups

Standardized to US Population

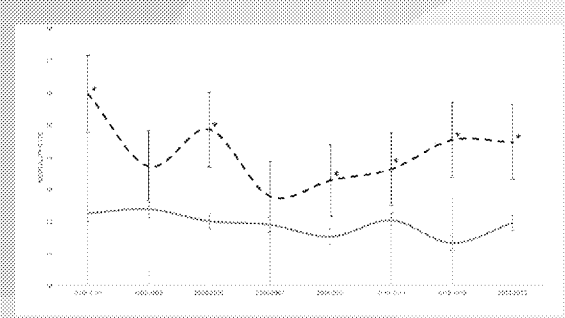


Figure 1. Cancer related mortality rates for Deer Lodge & Silver Bow compared to all remaining Montana counties, 2000-2015

*Indicates significant differences between case and comparison groups

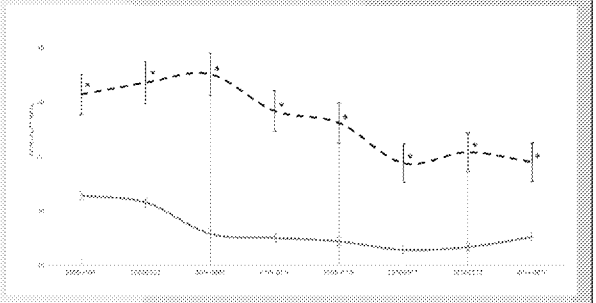


Figure 2. Cerebro- and cardiovascular disease related mortality rates for Deer Lodge & Silver Bow compared to all remaining Montana counties, 2000-2015

*Indicates significant differences between case and comparison groups

Adjusted - Deer Lodge & Silver Bow

Adjusted - Montana

Standardized to US Population

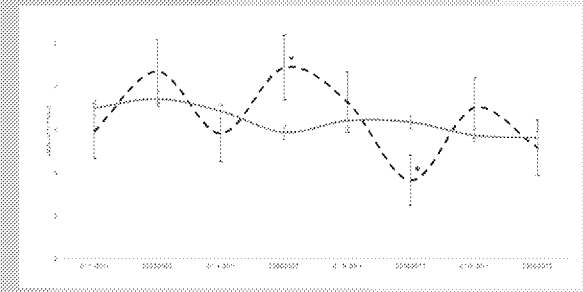


Figure 3. Neurological disease related mortality rates for Deer Lodge & Silver Bow compared to all remaining Montana counties, 2000-2015
*Indicates significant differences between case and comparison groups

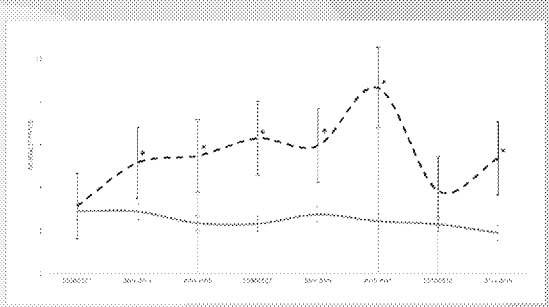


Figure 4. Organ failure related mortality rates for Deer Lodge & Silver Bow compared to all remaining Montana counties, 2000-2015
*Indicates significant differences between case and comparison groups

Adjusted - Deer Lodge & Silver Bow

Adjusted - Montana

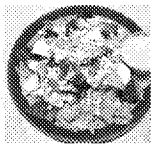
The MONTANA STANDARD

Walk to fight cancer

Butte Chamber of Commerce

Cafe Zydeco hits Butte

Serving Louisiana-style food BUSINESS, PAGE D1



Kavanaugh meeting correction

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Higher mortality rates

Study: Cancer and diseases claim more in Butte, Anaconda

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New research indicates that from 2006 to 2015, adults living in Butte-Silver Bow and Anaconda-Deer Lodge counties died from cancer and several other diseases at significantly higher rates than residents of all other counties in Montana.

A team of researchers based at the Arnold School of Public Health at the University of South Carolina-Columbia studied death certificates from an online database kept by the Atlanta-based Centers for Disease Control and Prevention. They found that among adults in Butte-Silver Bow and Anaconda-Deer Lodge counties, deaths from stroke, heart disease, cancer, and organ failure were elevated.

Overall, in the two counties over the 15-year period, adult deaths from stroke and heart disease were 39 percent higher than in the other counties, deaths due to kidney and liver failure were 24 percent higher, and cancer deaths were 18 percent higher.

Within these overall numbers, there were many variations of the death rates, depending on age and gender.

For instance, when comparing stroke or heart disease:

McDermott

Davis

- Deaths among men ages 35 to 54 were 71 percent higher
- Deaths among men ages 55 to 74 were 46 percent higher
- Deaths among women ages 35 to 54 were 62 percent higher
- Deaths among women age 55 to 74 were 67 percent higher

Organ failure:

- Deaths among men ages 55 to 74 were 59 percent higher

Cancer:

- Deaths among men ages 55 to 74 were 29 percent higher
- Deaths among women ages 55 to 74 were 31 percent higher

The team, led by Suzanne McDermott, a professor of epidemiology at USC, published its findings in Environmental Geochemistry and Health journal last month. The paper was peer reviewed.

The silver lining is that although

Please see CANCER, Page A5

Andrew Wheeler, the Environmental Protection Agency's acting administrator, right, and EPA Region 8 Administrator Doug Benevento listen to long-time Superfund watchdog Fritz Daily during a private meeting Friday afternoon at the Butte-Silver Bow Public Archives.

Image/Thomas The Montana Standard

Acting EPA Administrator Andrew Wheeler makes historic visit to Butte, Anaconda Friday

"Wheeler said the EPA is evaluating Professor Suzanne McDermott's epidemiological study that came out late last month and is considering asking ATSDR to expand their study to include Butte residents."

Cancer site specific IRRs between DL & SB and the remaining counties in Montana, 2001-2015						
	SB & DL		Remaining counties (ref)			
Cancer sites	**n**	**age-adjusted incidence**	**n**	**age-adjusted incidence**	**IRR (95% CI)**	**p-value**
All sites	4061	475.1	77470	470.2	1.01 (0.98, 1.04)	0.4624
Liver & bile duct	52	5.6	794	4.5	**1.62 (1.14-2.31)**	0.0076
Small intestine, colorectal, & anus	440	51.1	7752	47.0	**1.10 (1.00-1.22)**	0.0494
Lung & bronchus	551	62.4	10114	61.0	1.09 (0.99-1.19)	0.0659
Kidney & renal pelvis	120	14.5	2270	13.6	1.07 (0.87-1.32)	0.4997
Brain & other organs of the central nervous system	60	8.1	1137	7.3	**1.72 (1.05-2.82)**	0.0317
Lymphoma, myeloma, leukemia, mesothelioma, & Kaposi sarcoma	343	40.7	7145	44.1	0.94 (0.84-1.05)	0.2863
Female genital organs	206	50.8	4072	50.9	1.00 (0.87-1.16)	0.9553
Male genital organs	572	124.6	12882	143.6	0.94 (0.87-1.03)	0.1997
Others	1717	203.3	31304	191.7	**1.07 (1.02-1.13)**	0.0045
Bolded= significant results						

22 PUBLICATIONS FOR OUR SUPERFUND RESEARCH

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NOW WHAT?

- EPA and ATSDR scientists need to describe their approaches – independent experts needs to determine if state of the art methods are being used
- Need evidence based approaches to monitoring – air, water, soil
- Risk directed surveillance of health impacts – pregnant women, infants, children, adults