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Assessment of Current Lead Fact Sheets for Development of a Revised Lead Fact Sheet

Michael Sparks

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By

Michael Lloyd Sparks

10 December 2016

Abstract

Introduction: The United States Environmental Protection Agency began monitoring lead and other contaminants in residential properties the 35th Avenue district of Northern Birmingham in October of 2012. The EPA sampled eleven-hundred homes for lead and other contaminants, and in 2014 the EPA began cleanup on 400 sites. Residents have refused cleanup here and in other sites such as the Colorado smelter site and the Omaha City Superfund site due to lack of knowledge of the harms of lead poisoning, general mistrust of government agencies, or apathy. A complete and concise lead fact sheet for residents from the community outreach may encourage the remaining residents to allow the EPA to sample and cleanup. Lead contamination and poisoning are serious threats that can adversely affect people's health and lives.

Purpose: The purpose of this study was to determine whether or not the selected lead fact sheets were understandable to the general public, and future fact sheets need to be revised before being used. If a new fact sheet needed to be completed, what information would be needed? Is there a way to effectively convey information in a simple and direct way?

Methods: The methodology will focus on four areas to assess the 35th avenue fact sheet and eleven other fact sheets used in the various government and private establishments. Information obtained from these areas will then be used to create a new fact sheet. The following studied areas are: 1) How fact sheets were gathered; 2) Reading analysis; 3) Suitability Assessment of Materials; and 4) Development of new fact sheet.

Results: The Flesch-Kincaid reading levels ranged from 5.5 to 16. The average level for the twelve fact sheets was 9.9. Seven fact sheets could be read at a level below the 10th grade. Therefore, with the use of the currently evaluated lead fact sheets, more that 50% of Americans would not be able to understand them (Doak et al., 1996).

Discussion: A lead fact sheet should be no more than one page in length that focuses on background, procedures, and prevention during a response to lead contamination. The new lead fact sheet should be written at a 6th-grade reading level and receive a high score on SAM. The new revisions to the fact sheet will ensure that the new fact sheet will be comprehensible by the majority of adults in the United States.

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By

Michael Lloyd Sparks

B.S., GEORGIA STATE UNIVERSITY

A Capstone Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
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MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
30303

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Committee Chair

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Date

Author's Statement Page

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Michael Lloyd Sparks
Signature of Author

TABLE OF CONTENTS

List of Tables

List of Figures

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Discussion: A lead fact sheet should be no more than one page in length that focuses on background, procedures, and prevention during a response to lead contamination. The new lead

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Objectives

To gain experience in and assist in campaigns that promote wellness and provide opportunities for people as a whole. To work with organizations that maintain these values to have positive health outcomes and add relevance.

Education

Georgia State University, Atlanta, Georgia
MPH Environment Health
Master's Candidate 2016

Georgia State University, Atlanta, Georgia
BS Biological Sciences, 2010

Experience

Bartender ▪ 2011-Current
Cumming, Georgia

- Manage and develop all aspects and media promotions of the organization to include Twitter, Facebook, Instagram, and other social media outlets
- Interact with customers regularly and utilize experience in relating to and understanding others to provide a memorable dining experience
- Analyze any areas of concern and develop actions to promote the business and increase sales and revenues
- Assure that all bar functions are legally compliant

Worked to complete a Biological
Environmental Protection Agency ▪ May-December 2015
Internship, Region IV ▪ Atlanta, Georgia

- Worked to complete a Biological Assessment with the Region VI Coordinator by completing research, analyzing the situation, establishing a baseline, and controlling documentation
- Responsible for organizing and maintaining communications with several government agencies to include the NMFS and USFWS to assure compliance with ESA
- Developed the environmental baseline for the Atlantic Ocean and the Gulf of Mexico for professional agencies to be able to make assessment decisions for the protection of these areas
- Provided full analysis of the program and research to improve overall understanding and management of the actual, current situation

Georgia Aquarium ▪ January-May 2015
Internship, Atlanta, Georgia

- Completed and performed research and observations to determine patterns, behaviors, and swim patterns of whale sharks
- Provide report and findings of research to assist local biologists and aid in benefiting the species and the effects of captivity versus natural behaviors
- Maintained strict project timelines and communicated report findings to multiple entities
- Developed organized system and approach to documentation

Georgia State University ▪ 2012, 2014-2015
Teacher's Assistant Atlanta, Georgia

- Responsible for developing student knowledge through instruction of biology labs
- Analyze student needs through assessments of knowledge and testing
- Developed a plan to assist instructor in student development for areas of need
- Maintained grades and student progress in class

Chapter I

Introduction

Background

The United States Environmental Protection Agency began monitoring lead and other contaminants in residential properties the 35th Avenue district of Northern Birmingham in October of 2012. The EPA sampled eleven-hundred homes for lead and other contaminants, and in 2014 the EPA began cleanup on 400 sites ("North Birmingham Environmental Collaboration Project," 2016). Residents have refused cleanup here and in other sites such as the Colorado smelter site and the Omaha City Superfund site due to lack of knowledge of the harms of lead poisoning, general mistrust of government agencies, or apathy. A complete and concise lead fact sheet for residents from the community outreach may encourage the remaining residents to allow the EPA to sample and cleanup. Lead contamination and poisoning are serious threats that can adversely affect people's health and lives.

Last year I had the privilege to participate in an internship at the Environmental Protection Agency. While working on my project, I was invited to see a Superfund site courtesy of a previous professor. This Superfund site turned out to be the 35th Avenue Superfund site. While on tour of the EPA's facilities and the surrounding Superfund site, I had the chance to meet with both of the On-Scene Coordinators, Richard Jardine, and Subash Patel. While visiting, I had the chance to talk to them about what they were doing there and how the community outreach efforts in place resulted in trouble getting permission from residents to remediate contaminated property. Most residents had various reasons to why they wouldn't let the EPA clean up the contaminated soil, but the community outreach staff felt that a lot of the residents

just didn't know the risks of living in a lead contaminated area. After discussing this with my professor, he recommended that I evaluate current lead fact sheets and discuss a way to revise them if they needed to be. Thus began my journey of this paper and my capstone project.

Lead is a naturally occurring metal in the earth's crust at about 15-20 mg/kg. Lead is an uncommon metal, however, the largest use of lead is in the world is in the production of batteries, especially automobile batteries (*Toxicological Profile for Lead*, 2016). Lead exposure can lead to bioaccumulation; detrimental health effects can occur even after a small amount of lead accumulation. Lead storage in the bones alongside with calcium can occur. Every organ in the human body is at risk for lead exposure. The most vulnerable population to lead exposure is children and pregnant women. The US EPA has found that the side effects of lead exposure in children range from acute to chronic symptoms, and even death in some cases. Li et al., 2016 found that lead exposure in pregnant women can lead to a reduced growth rate and premature birth (Li, Xu, Liu, & Yan, 2016). Even adults are at risk from lead exposure which could potentially lead to cardiovascular effects and increased blood pressure and hypertension. The US EPA has found that lead exposure in men and women can lead to a decrease in kidney function and may lead to reproductive problems ("US Environmental Agency Profile of Lead," 2016).

In 2014 the EPA began cleanup of 400 contaminated sites in the northern Birmingham area, with over 1100 site left to remediate. The EPA typically uses soil removal for lead contamination in residences. Cleaning & reclamation is the most effective method to reduce lead concentrations in household dust. A case study from 2005 (Jusko, Canfield, Henderson, & Lanphear, 2005) found that cleaning up properties near each other had a "three-fold reduction of children's blood lead levels" when compared to only cleaning the homes where the children live.

This study underscores the need for the EPA to continue cleanup in existing properties and to reach out to the remaining properties for cleanup.

Purpose of Study

The intention of this study was to establish whether or not the selected lead fact sheets were understandable to the general public, if not then recommendations for future lead fact sheets. What information is needed? Is there a way to effectively convey information in a simple and direct way?

Research Questions

To determine what is necessary for a revised fact sheet, the data analysis directed its attention to two significant components:

- What crucial information should be in a lead fact sheet?
- What are the essential elements of a fact sheet that should be included to increase the likelihood that it can be read and understood by the mainstream populace?

Chapter II

Review of Literature

The intent of this study was to determine what factors are needed for a lead fact sheet to ensure that the populace could understand the information and further what information should be in the lead fact sheet. This information would be vital to emergency responses and lead contamination responses for government agencies. The following literature review focused on:

1) Physical properties,

2) Exposure,

3) Health effects,

4) Methods to reduce exposure and prevent spread of contamination,

5) Development & Effectiveness of Health Education Materials & Campaigns

6) The Role of Fact Sheets in Intervention

7) SAM and Reading Analysis

Physical Properties

Lead has a blue-grey color to it naturally and is quite malleable. Lead exists in many oxidation states, but the most common are Pb (II). The US EPA states that lead usage still occurs so often as it does because of its low melting point and its corrosion resistance. ("US Environmental Agency Profile of Lead," 2016).

Exposure

Exposure Routes

Environmental lead exposure happens to most every citizen of the United States. Most lead exposure is either inhalation or ingestion. There are some cases where lead can enter the body via dermal contact, but this is very unlikely in the United States since the EPA banned leaded gasoline. Lead can be in the air and inhaled very easily. However, inhalation isn't the only risk, ingestion of lead particles while inhalation can also occur. Ingestion of lead is problematic for children (Turner & Solman, 2016).

Ingestion

The most common source of lead poisoning in the US is from ingestion. (*Case Studies in Environmental Medicine (CSEM),* 2012). Ingestion can be from soil, water, food, or vapor. Lead paint is the major source of lead poisoning in children in the United States. Over time, lead paint can peel, chip, or deteriorate. Children can ingest these paint chips and cause serious medical problems if left unchecked. Older homes are more at risk for having lead-based paint. The EPA estimates that nearly 87% of homes built before 1940 have lead-based paint, 69% of homes built between 1940 and 1959, and 24% between 1960 and 1977. If lead contaminates the soil, children can ingest this readily through playing, or dust collection in the home (Lanphear, 2000). Lead ingestion from hand-to-mouth activity which is common among young children (*Toxicological Profile for Lead*, 2016). Lead can also contaminate vegetables in a community garden where anyone eating them can be affected (Mielke, 2016).

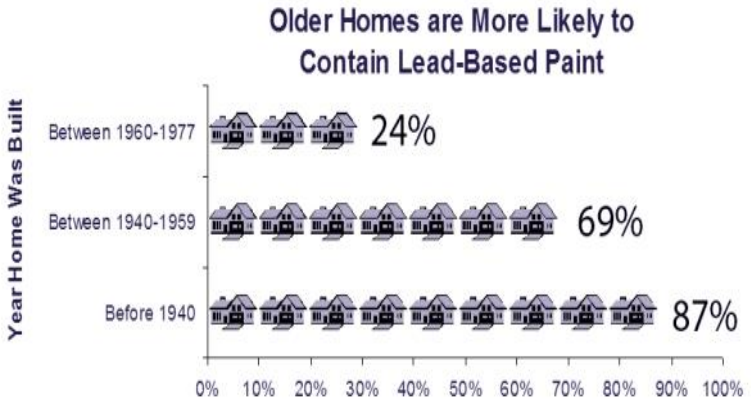


Figure 2.1 Percentage of Homes Likely to Contain Lead Paint. Reprinted from the EPA's Lead Fact page. March 7, 2016, retireved from https://www.epa.gov/lead/protect-your-family-exposures-lead#sources. Copyright 2016.

Inhalation

The second foremost pathway of lead exposure is from inhalation. Although inhalation is the second major pathway of lead exposure, it is the most dangerous. When lead is inhaled almost all of it is absorbed, where only a portion of ingested lead is absorbed. Inhalation of lead dust can even occur in well-maintained homes. Chipped or peeling paint from home repairs can lead to lead dust formation. Lead dust is on most all fomites in the household. Lead dust can also be kicked up during cleaning, vacuuming, or foot traffic.

Dose Response

Since lead has several exposure pathways, and each pathway affects the body in a different way, the EPA has set up four dose-response parameters for lead contamination in children since children are at the highest risk for lead contaminations deleterious effects. If the mode of exposure is not known, the IEUBK model becomes the default metric for a lead dose response. The US EPA uses the IEUBK (Integrated Exposure, Uptake, and Bio-kinetic) model in risk analysis to determine any relationships between environmental lead levels and blood-lead levels in children 0-<7 (Taylor, Tilling, Golding, & Emond, 2016).

The IEUBK model utilizes four factors the environmental risk assessment: 1) multimedia nature of exposures to lead, 2) the differential bioavailability of various sources of lead, 3) the pharmacokinetics of internal distribution of lead to bone, blood, and other tissues, and 4) individual variability in blood-lead levels ("US Environmental Agency Profile of Lead," 2016).

The first parameter is air concentrations. Under air concentrations, there are parameters set up for indoor and outdoor air exposure. For indoor exposure, no more than 30% of outdoor value and outdoor exposure cannot exceed value 0.10 µg/m3. Diet intake parameters range from

6.78 µg/day to 7.00 µg/day for ages 1 to 7. Water intake parameters range from 0.20 L/day to 0.59 L/day for children ages 1 to 7. Soil and dust parameters range from 0.085 g/day to 0.135 g/day for children ages 1-7. However, it is to be noted that these are default parameters. Exposure rates and concentrations in the environment can be updated based on site-specific information.

Table 2.1 Blood and Bone Lead Concentrations Corresponding to Adverse Health Effects. Reprinted from ATSDR Toxicological Profiles, retrieved March 8, 2016 from https://www.atsdr.cdc.gov/toxprofiles/tp13-c2.pdf. Copyright 2016.

Age	Effect	Blood lead[a] (µg/dL)	Bone lead[a] (⏭g/g)
Children	Depressed ALAD	<5	ND
Children	Neurodevelopmental effects	<10	ND
Children	Sexual maturation	<10	ND
Children	Depressed vitamin D	>15	ND
Children	Elevated EP	>15	ND
Children	Depressed NCV	>30	ND
Children	Depressed hemoglobin	>40	ND
Children	Colic	>60	ND
Adults (elderly)	Neurobehavioral effects	>4	>30
Adults	Depressed ALAD	<5	ND
Adults	Depressed GFR	<10	>10
Adults	Elevated blood pressure	<10	>10
Adults	Elevated EP (females)	>20	ND
Adults	Enzymuria/proteinuria	>30	ND
Adults	Peripheral neuropathy	>40	ND
Adults	Neurobehavioral effects	>40	ND
Adults	Altered thyroid hormone	>40	ND
Adults	Reduced fertility	>40	ND
Adults	Depressed hemoglobin	>50	ND

[a]Concentration range associated with effect.

ALAD = δ-aminolevulinic acid dehydratase; EP = erythrocyte protoporphyrin; GFR = glomerular filtration rate; NCV = nerve conduction velocity; ND = no data

Table 2.2 Lead intake Parameters for Air. Reprinted from ATSDR Lead Toxicity, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=8. Copyright 2012.

Air Parameters

Parameter	Vary air concentration by year?	Outdoor air lead concentration	Indoor air lead concentration
Setting*	No	0.10 µg/m³	30% of outdoor value

* All air parameters use default values

Diet Intake Parameters

Parameter	Lead intake in diet, by age of child						
	0-1 yrs	1-2 yrs	2-3 yrs	3-4 yrs	4-5 yrs	5-6 yrs	6-7 yrs
Setting*	5.53 µg/day	5.78 µg/day	6.49 µg/day	6.24 µg/day	6.01 µg/day	6.34 µg/day	7.00 µg/day

* All diet intake parameters use default values

Water Intake Parameters

Parameter	Lead Conc. in Water	Drinking water consumption, by age of child						
		0-1 yrs	1-2 yrs	2-3 yrs	3-4 yrs	4-5 yrs	5-6 yrs	6-7 yrs
Setting*	4 µg/L	0.20 L/day	0.50 L/day	0.52 L/day	0.53 L/day	0.55 L/day	0.58 L/day	0.59 L/day

* All water intake parameters use default values

Table 2.3: Lead Intake Parameters for Soil. Reprinted from ATSDR Lead Toxicity, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=8. Copyright 2012.

Soil and Dust Intake Parameters

Parameter	Soil/Dust Ingestion Weighting Factor	Total soil + dust intake, by age of child						
		0-1 yrs	1-2 yrs	2-3 yrs	3-4 yrs	4-5 yrs	5-6 yrs	6-7 yrs
Setting*	45% soil; 55% dust	0.085 g/day	0.135 g/day	0.135 g/day	0.135 g/day	0.1 g/day	0.09 g/day	0.085 g/day

* Soil and dust lead concentrations are input. All other parameters use default values.

Absorption Method Parameters

Parameter	Half Saturation Level	Total Absorption					Fraction of Total Assumed Passive Absorption				
		Soil	Dust	Water	Diet	Alt.	Soil	Dust	Water	Diet	Alt.
Setting	100 µg/day	30%	30%	50%	50%	0%	0.20	0.20	0.20	0.20	0.20

Blood Lead Parameter

Parameter	Geometric Standard Deviation (GSD)
Setting	1.6

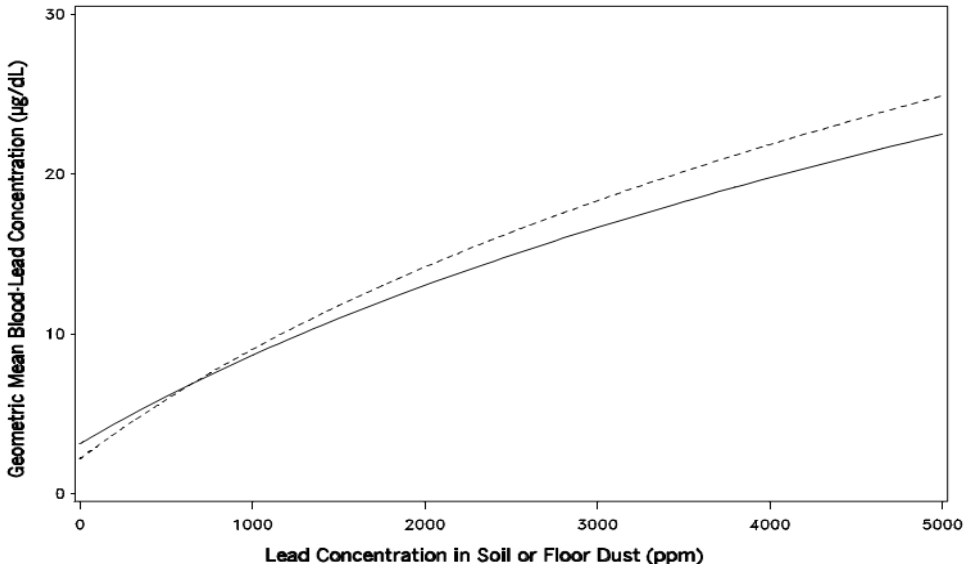


Figure 1.3: Dose Response for Blood Lead Levels. Reprinted from ATSDR Lead Toxicity, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=8. Copyright 2012.

IEUBK Model Predicted Geometric Mean Blood-Lead Concentration for Children Aged 24 Months Plotted Separately Against Soil-Lead Concentration and Dust-Lead Concentration for Fixed Default Values of the Remaining Model Parameters (Deshommes et al., 2016).

Background Concentrations

In 2007 the United States Geological Survey (USGS) initiated a soil study to determine what chemicals and minerals were in the available area. Samples were taken all over the continental United States at three different soil-depths. Three samples are procured (1) soil from 0-5 cm, (2) soil from the A Horizon (the uppermost soil), and (3) soil from the C Horizon (partially weathered parent soil). The soil sampling process occurred from 2007 until 2010 (Jez & Lestan, 2015). Not all sample types are retrieved at each location for fear of digging into utilities or buried pipes and electrical wires. The following three tables show the results of each metal found in the soil. For the sake of this project, the sample taken from 0-5 cm will be the background concentration of interest.

Lead concentrations in soil were summarized as mg/kg at the lower limit of detection, mean, median, and maximum. The LLD for Lead used in this study was 0.5 mg/kg. Anything found under this threshold would not be viable data for this particular study.

Table 2.4: Soil Taken from 0-5 cm. Reprinted from ATSDR Toxicological Profile for Lead, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/ToxProFiles/tp13-c6.pdf. Copyright 2005.

Element	Units	Number of samples	Number of samples below LLD	Min	Q1	Median	Mean	Q3	Max	MAD	Standard deviation
Ag	mg/kg	4,841	4,828	<1	<1	<1	<1	<1	7.7	ND	ND
Al	wt. %	4,841	0	0.02	3.20	4.67	4.59	6.00	15.3	2.06	2.12
As	mg/kg	4,841	56	<0.6	3.1	5.2	6.4	7.6	830	3.3	16.7
Ba	mg/kg	4,841	0	5	329	510	518	683	4,770	262	288
Be	mg/kg	4,841	97	<0.1	0.9	1.3	1.3	1.7	17.3	0.6	0.8
Bi	mg/kg	4,841	121	<0.04	0.11	0.16	0.34	0.23	694	0.09	10
Ca	wt. %	4,841	57	<0.01	0.31	0.76	1.59	1.71	32.8	0.82	2.66
Cd	mg/kg	4,841	1,054	<0.1	0.1	0.2	0.3	0.3	76.8	0.15	1.4
Ce	mg/kg	4,841	0	0.65	36.2	51.1	52.1	63.6	415	20.2	26.1
Co	mg/kg	4,841	24	<0.1	4.4	7.7	8.9	11.1	216	4.9	7.9
Cr	mg/kg	4,841	6	<1	18	30	36	41	4,120	18	89
Cs	mg/kg	4,841	3,954	<5	<5	<5	<5	<5	97	ND	ND
Cu	mg/kg	4,841	2	<0.5	8.8	14.4	17.9	20.9	996	8.7	22.1
Fe	wt. %	4,841	8	<0.01	1.28	1.95	2.14	2.66	13.3	1.02	1.39
Ga	mg/kg	4,841	0	0.10	7.45	11.0	11.1	14.7	45.1	5.4	5.4
Hg	mg/kg	4,841	367	<0.01	0.01	0.02	0.05	0.04	56.4	0.01	0.8
In	mg/kg	4,841	1,017	<0.02	0.02	0.03	0.04	0.05	4.54	0.01	0.08
K	wt. %	4,841	24	<0.01	0.99	1.49	1.46	1.88	5.44	0.65	0.74
La	mg/kg	4,841	5	<0.5	18.0	25.7	26.0	31.9	239	10.2	13.0
Li	mg/kg	4,841	18	<1	13	20	21	27	300	10.4	14
Mg	wt. %	4,841	50	<0.01	0.22	0.46	0.58	0.74	13.6	0.39	0.61
Mn	mg/kg	4,841	16	<5	290	492	512	791	7,780	353	529
Mo	mg/kg	4,841	11	<0.05	0.51	0.78	1.04	1.14	75.7	0.46	2.10
Na	wt. %	4,841	200	<0.01	0.29	0.69	0.81	1.10	6.41	0.61	0.68
Nb	mg/kg	4,841	2	<0.1	6.0	8.5	9.3	11.1	80.1	3.7	5.9
Ni	mg/kg	4,841	23	<0.5	7.8	13.5	17.7	19.8	1,890	8.9	45.2
P	mg/kg	4,841	34	<50	360	580	660	840	9,120	356	488
Pb	mg/kg	4,841	2	<0.5	13.5	18.1	25.8	23.9	12,400	7.4	185
Rb	mg/kg	4,841	14	<0.2	45.0	65.2	66.2	84.4	299	29.2	34.3
S	wt. %	4,841	436	<0.01	0.02	0.03	0.05	0.04	16.1	0.01	0.40
Sb	mg/kg	4,841	34	<0.05	0.37	0.57	0.83	0.80	482	0.31	7.33
Sc	mg/kg	4,841	20	<0.1	3.8	6.1	6.8	8.4	42.3	3.4	4.7
Se	mg/kg	4,841	2,154	<0.2	0.2	0.3	0.4	0.4	6.9	0.1	0.3
Sn	mg/kg	4,841	9	<0.1	0.9	1.3	1.6	1.8	88.9	0.6	2.6
Sr	mg/kg	4,841	0	0.5	63.4	121	159	203	2,620	96.5	162
Tc	mg/kg	4,841	4,684	<0.1	<0.1	<0.1	<0.1	<0.1	50.5	ND	ND
Th	mg/kg	4,841	5	<0.2	5.2	7.6	8.0	9.9	78.3	3.6	4.8
Ti	wt. %	4,841	2	<0.01	0.18	0.24	0.27	0.32	2.47	0.10	0.17
Tl	mg/kg	4,841	276	<0.1	0.3	0.4	0.4	0.5	8.8	0.1	0.3
U	mg/kg	4,841	5	<0.1	1.4	2.0	2.1	2.6	102	0.9	1.9
V	mg/kg	4,841	12	<1	33	53	60	74	530	31	43
W	mg/kg	4,841	72	<0.1	0.5	0.8	1.3	1.1	1,150	0.4	18
Y	mg/kg	4,841	0	0.2	9.8	14.4	14.8	18.4	191	6.4	8.6
Zn	mg/kg	4,841	3	<1	36	58	66	80	11,700	33	176

Table 2.5: Soil Taken from the A Horizon. Reprinted from ATSDR Toxicological Profile for Lead, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/ToxProFiles/tp13-c6.pdf. Copyright 2005.

Element	Units	Number of samples	Number of samples below LLD	Min	Q1	Median	Mean	Q3	Max	MAD	Standard deviation
Ag	mg/kg	4,813	4,799	<1	<1	<1	<1	<1	14	ND	ND
Al	wt. %	4,813	0	0.01	3.22	4.71	4.65	6.12	15.6	2.15	2.15
As	mg/kg	4,813	67	<0.6	3.1	5.2	6.6	7.8	1,110	3.4	19.6
Ba	mg/kg	4,813	0	6	331	513	522	686	4,850	261	289
Be	mg/kg	4,813	89	<0.1	0.9	1.3	1.4	1.7	22.1	0.6	0.8
Bi	mg/kg	4,813	118	<0.04	0.11	0.16	0.22	0.23	129	0.09	1.87
C_Total	wt. %	4,810	0	0.04	0.96	1.78	3.01	3.15	60.2	1.44	4.60
C_Inorg	wt. %	4,801	3,623	<0.2	<0.2	<0.2	0.3	<0.2	8.6	ND	ND
C_Org	wt. %	4,810	10	0	0.84	1.55	2.75	2.80	60.1	1.26	4.58
Ca	wt. %	4,813	57	<0.01	0.31	0.74	1.61	1.68	29.7	0.82	2.76
Cd	mg/kg	4,813	1,146	<0.1	0.1	0.2	0.3	0.3	46.6	0.1	0.8
Ce	mg/kg	4,813	2	<0.05	36.9	51.7	52.7	65.1	487	20.9	26.2
Co	mg/kg	4,813	34	<0.1	4.6	7.8	9.1	11.3	184	5.0	8.2
Cr	mg/kg	4,813	12	<1	18	31	37	42	3,850	18	89
Cs	mg/kg	4,813	3,942	<5	<5	<5	<5	<5	97	ND	ND
Cu	mg/kg	4,813	4	<0.5	9.1	14.8	19.9	21.8	5,090	9.2	75.5
Fe	wt. %	4,813	6	<0.01	1.30	1.99	2.19	2.75	13.9	1.08	1.46
Ga	mg/kg	4,813	0	0.08	7.54	11.2	11.2	15.0	40.8	5.5	5.3
Hg	mg/kg	4,813	386	<0.01	0.01	0.02	0.04	0.04	8.24	0.01	0.17
In	mg/kg	4,813	1,017	<0.02	0.02	0.03	0.04	0.05	4.61	0.01	0.07
K	wt. %	4,813	26	<0.01	0.98	1.50	1.46	1.90	5.10	0.65	0.74
La	mg/kg	4,813	4	<0.5	18.2	25.7	25.9	31.9	205	10.1	12.7
Li	mg/kg	4,813	13	<1	13	20	22	27	315	10	14
Mg	wt. %	4,813	41	<0.01	0.21	0.46	0.59	0.75	13.3	0.39	0.64
Mn	mg/kg	4,813	14	<5	289	498	622	797	6,850	365	542
Mo	mg/kg	4,813	7	<0.05	0.50	0.78	1.02	1.13	70.3	0.46	1.75
Na	wt. %	4,813	182	<0.01	0.28	0.69	0.81	1.10	6.60	0.61	0.68
Nb	mg/kg	4,813	1	<0.1	6.1	8.6	9.4	11.2	96.8	3.7	6.0
Ni	mg/kg	4,813	9	<0.5	7.9	13.8	18.5	20.0	2,310	8.9	54.4
P	mg/kg	4,813	42	<50	340	550	632	810	7,650	341	466
Pb	mg/kg	4,813	1	<0.5	13.2	17.8	22.2	23.2	2,200	7.3	46.6
Rb	mg/kg	4,813	14	<0.2	44.7	65.8	66.4	84.8	461	29.7	34.7
S	wt. %	4,813	583	<0.01	0.02	0.03	0.06	0.04	16.6	0.01	0.6
Sb	mg/kg	4,813	25	<0.05	0.37	0.57	0.84	0.80	630	0.33	9.1
Sc	mg/kg	4,813	10	<0.1	3.9	6.1	6.9	8.5	48.9	3.4	4.8
Se	mg/kg	4,813	2,116	<0.2	<0.2	0.2	0.3	0.4	8.3	0.1	0.3
Sn	mg/kg	4,813	6	<0.1	0.9	1.3	1.6	1.7	375	0.6	5.9
Sr	mg/kg	4,813	2	<0.5	64	122	163	204	7,080	98	196
Te	mg/kg	4,813	4,655	<0.1	<0.1	<0.1	<0.1	<0.1	9.6	ND	ND
Th	mg/kg	4,813	6	<0.2	5.3	7.7	8.1	10.0	84.1	3.6	4.7
Ti	wt. %	4,813	0	0.01	0.18	0.24	0.27	0.31	2.76	0.10	0.18
Tl	mg/kg	4,813	276	<0.1	0.3	0.4	0.4	0.5	11.5	0.1	0.3
U	mg/kg	4,813	6	<0.1	1.4	2.0	2.1	2.6	105	0.9	1.9
V	mg/kg	4,813	10	<1	33	54	61	76	524	31	44
W	mg/kg	4,813	61	<0.1	0.5	0.8	1.1	1.1	299	0.4	5.5
Y	mg/kg	4,813	0	0.2	10.0	14.6	15.0	18.7	254	6.4	8.8
Zn	mg/kg	4,813	6	<1	36	59	64	81	2,130	34	60

Table 2.6: Soil Taken from the C Horizon (ATSDR, 2016)

Ag	mg/kg	4,780	4,769	<1	<1	<1	<1	<1	3.0	ND	ND
Al	wt. %	4,780	0	0.02	3.93	5.40	5.44	6.88	18.6	2.18	2.31
As	mg/kg	4,780	73	<0.6	3.4	5.7	7.0	8.4	397	3.7	9.7
Ba	mg/kg	4,780	0	5	343	506	542	701	9,360	265	380
Be	mg/kg	4,780	86	<0.1	1.0	1.4	1.5	1.9	31.6	0.6	0.9
Bi	mg/kg	4,780	238	<0.04	0.11	0.16	0.19	0.23	8.41	0.09	0.22
C_Total	wt. %	4,777	4	<0.01	0.22	0.62	1.32	1.65	43	0.71	2.17
C_Inorg	wt. %	4,773	2,903	<0.2	<0.2	<0.2	0.7	0.6	10.6	ND	ND
C_Org	wt. %	4,777	114	0	0.18	0.38	0.72	0.71	43	0.4	1.8
Ca	wt. %	4,780	183	<0.01	0.26	1.05	2.63	3.36	32.3	1.45	3.99
Cd	mg/kg	4,780	2,149	<0.1	<0.1	0.1	0.18	0.2	36.4	0.07	0.58
Ce	mg/kg	4,780	0	0.5	37.4	52.2	55.5	68.1	914	22.7	33.9
Co	mg/kg	4,780	24	<0.1	5.0	8.4	10.1	12.3	316	5.3	9.9
Cr	mg/kg	4,780	19	<1	17	30	39	45	4,620	21	107
Cs	mg/kg	4,780	3,470	<5	<5	<5	<5	5.0	144	ND	ND
Cu	mg/kg	4,780	14	<0.5	9.2	15.1	19.8	23.0	2,540	9.9	41.7
Fe	wt. %	4,780	6	<0.01	1.57	2.34	2.62	3.28	15.3	1.25	1.67
Ga	mg/kg	4,780	0	0.13	9.28	13.1	13.3	16.9	50.4	5.63	5.86
Hg	mg/kg	4,780	752	<0.01	0.01	0.02	0.028	0.03	1.75	0.01	0.053
In	mg/kg	4,780	687	<0.02	0.03	0.04	0.04	0.05	4.39	0.01	0.07
K	wt. %	4,780	34	<0.01	1.04	1.53	1.51	1.96	5.67	0.68	0.76
La	mg/kg	4,780	4	<0.5	18.7	26.1	27.3	33.8	283	11.3	15.6
Li	mg/kg	4,780	7	<1	16	24	27	33	280	12	18
Mg	wt. %	4,780	41	<0.01	0.32	0.61	0.82	1.06	16.8	0.52	0.84
Mn	mg/kg	4,780	23	<5	202	392	504	646	12,000	323	564
Mo	mg/kg	4,780	11	<0.05	0.51	0.83	1.20	1.27	94.7	0.53	2.64
Na	wt. %	4,780	214	<0.01	0.27	0.70	0.82	1.14	5.54	0.64	0.69
Nb	mg/kg	4,780	2	<0.1	6.3	9.2	10.2	12.3	289	4.4	8.2
Ni	mg/kg	4,780	8	<0.5	9.8	16.7	22.6	24.9	2,870	10.8	66.8
P	mg/kg	4,780	119	<50	220	430	508	640	27,400	311	626
Pb	mg/kg	4,780	4	<0.5	11.1	14.9	16.6	19.2	681	6.1	18.5
Rb	mg/kg	4,780	3	<0.2	47.0	67.2	69.8	89.5	267	31.7	35.5
S	wt. %	4,780	1,061	<0.01	0.01	0.02	0.11	0.03	16.2	0.01	0.75
Sb	mg/kg	4,780	83	<0.05	0.36	0.58	0.70	0.82	40.6	0.34	1.08
Sc	mg/kg	4,780	9	<0.1	4.8	7.3	8.4	10.4	70.8	4.0	5.8
Se	mg/kg	4,780	2,718	<0.2	<0.2	<0.2	0.28	0.3	7.5	ND	0.4
Sn	mg/kg	4,780	18	<0.1	1.0	1.4	1.5	1.8	30.9	0.6	1.0
Sr	mg/kg	4,780	1	<0.5	71.2	142	189	232	10,900	115	278
Te	mg/kg	4,780	4,567	<0.1	<0.1	<0.1	<0.1	<0.1	6.1	ND	ND
Th	mg/kg	4,780	3	<0.2	5.8	8.3	8.8	11.0	55.9	3.9	4.8
Ti	wt. %	4,780	2	<0.01	0.18	0.25	0.29	0.34	3.42	0.12	0.20
Tl	mg/kg	4,780	204	<0.1	0.3	0.5	0.5	0.6	4.3	0.15	0.2
U	mg/kg	4,780	6	<0.1	1.5	2.1	2.3	2.8	63	1.0	1.9
V	mg/kg	4,780	5	<1	41	64	73	92	1,080	37	53
W	mg/kg	4,780	140	<0.1	0.6	0.9	1.24	1.3	199	0.44	3.7
Y	mg/kg	4,780	0	0.2	10.7	15.6	16.5	20.3	288	7.0	11.2
Zn	mg/kg	4,780	17	<1	33	54	58	76	653	31	40

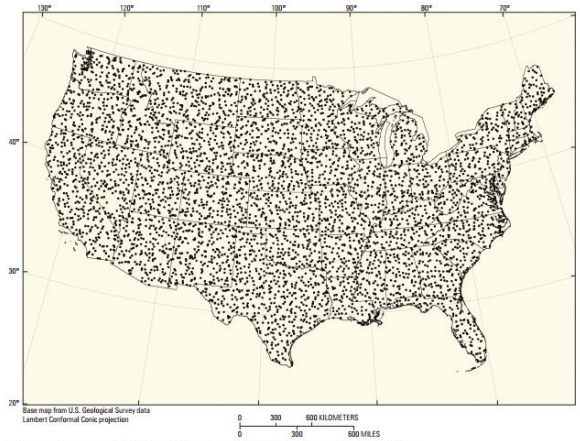


Figure 1. Map showing the location of 4,857 soil sampling sites in the conterminous United States.

Figure 2.4: Map Showing the 4,857 Soil Sampling Sites. Reprinted from ATSDR Toxicological Profile for Lead, March 8, 2016, retrieved from https://www.atsdr.cdc.gov/ToxProFiles/tp13-c6.pdf. Copyright 2005.

Absorption

Lead absorption can happen via three pathways: (1) Gastrointestinal absorption, (2) Dermal absorption, and (3) Inhalation absorption (Kalahasthi & Barman, 2016). Lead absorption in the GI tract is dependent on several factors such as the size and amount of lead ingested, the lead's source (i.e. paint, gasoline, candy, etc.), and how long the lead stays in the GI tract. The smaller the lead particle, the more percentage of lead will be absorbed. Dermal absorption is very limited due to the physical characteristics of lead (Taylor et al., 2016). Inhalation absorption may send a lead particulate to the GI tract or maybe absorbed by the lungs and dispersed throughout the body via blood (Mushak, 2003).

Distribution

When lead is not excreted it can be distributed to blood, soft tissues, and bones. When lead is not excreted from the body, it first is distributed by blood, specifically red blood cells (Patrick, 2006). Lead in RBCs can go to several organs in the body and can also go to bones and teeth. Blood lead levels are the primary measure for lead exposure, although they only measure recent exposures and are not a reliable reading for total body burden. Lead can be exchanged by soft tissues easily, but the liver, kidneys, lungs, and brain are at the highest risk of lead concentration. The bones and teeth are the primary deposit sites for the bodies lead burden (Youravong et al., 2008).

Excretion

Lead is mainly excreted through renal clearance (urine) or biliary clearance (feces), although some lead may remain long after exposure. Lead has been shown to remain in the body longer than other metals because of its affinity for hemoglobin (blood). Even with renal and

biliary clearance, medical intervention is often needed to rid the body of remaining lead. The gold standard of lead removal from the body is chelation (Thurtle et al., 2014).

Chelation is a medical procedure where chelating agents are administered to a patient to help remove heavy metals. Chelation therapy must be administered with care as there are side-effects and negative health effects of chelation therapy such as fever, nausea, headache, and vomiting (Caito & Aschner, 2015). There are several chelating agents used for a variety of heavy metals, but the gold standard for lead chelation is Ethylenediaminetetraacetic acid or EDTA. EDTA is an amino polycarboxylic acid that is colorless and water soluble. The reason why EDTA works so well as a chelating agent because it works as a hexadentate ligand that can isolate metal ions such as Ca^{2+} and Fe^{3+}. After EDTA has bound to the heavy metals, they remain in solution and exhibit lower reactivity. EDTA is on the WHO's list of essential medicines needed in a basic health system. There are other chelating agents issued in conjunction with EDTA such as Dimercaptosuccinic acid (DMSA), Dimercaprol (British anti-lewisite; BAL), and Penicillamine.

There have been studies to determine whether there is a less toxic method to help the body to reduce blood lead levels (BLL) in other species. A 2013 study used Vitamin C as a lead excretion modulator in rats. There were 36 rats used in four groups. A group with lead exposure but no vitamin C, lead exposure with a low dose of Vitamin C, and a group with lead exposure with a high dose of Vitamin C. The amount of lead administered was equal in every group. Although the study had several limitations, it was shown that a high dose of Vitamin C was effective in modulating the excretion of lead in an animal (Lihm et al., 2013). Vitamin C could be used as an alternative to other chelators as high doses are not harmful, and is relatively inexpensive to keep in a medical hospital.

Health Effects

Acute clinical toxicity

High-dose exposure to lead can lead to several maladies such as colic, fatigue, poor concentration and stupor (*Childhood Lead Poisoning*, 2010). In some severe cases, brain swelling can lead to coma and convulsions. In most cases, people survive acute lead poisoning, but unfortunately for children, acute lead poisoning may have permanent deficits in their neurodevelopmental function (*Childhood Lead Poisoning*, 2010).

Subclinical Toxicity

Low-dose exposure to lead may have harmful side effects that are not apparent at first. Low-dose exposure is also known as subclinical toxicity. Subclinical toxic effects of lead poisoning are very real and directly correlated to lead exposure amounts.

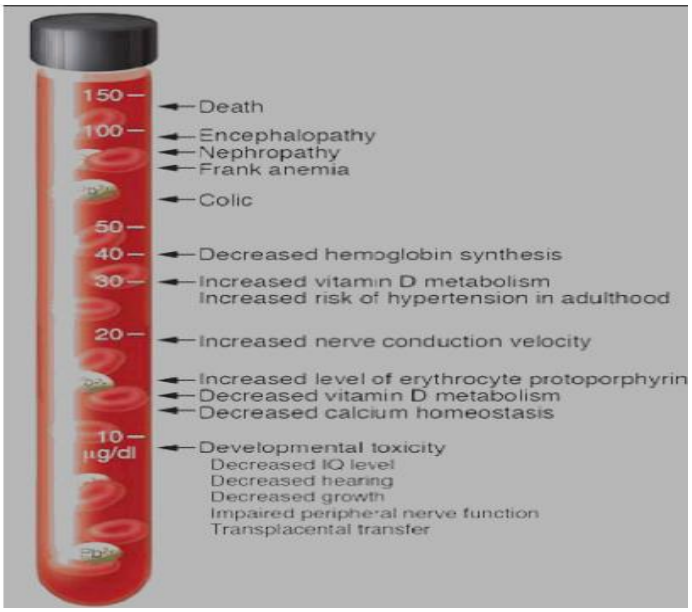


Fig 2.5: Pediatric effects of Lead Poisoning in Children. Reprinted from CDC's Childhood Lead Poisoning Data, Statistics, and Surveillance. Retrieved March 7, 2008, from https://www.cdc.gov/nceh/lead/data/index.htm.

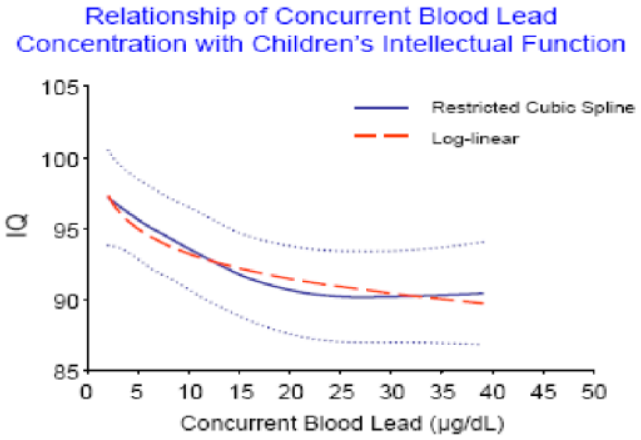
Hematological toxicity

Anemia demonstrates lead poisoning in blood cells (erythrocytes). The definition of anemia is a decreased amount of red blood cells or hemoglobin in the blood or lowered ability of blood to carry oxygen. The higher the lead levels in the blood, the seriousness of lead-induced anemia occurs (Kennedy, Yard, Digman, & Buchanan, 2016). Lead induced anemia occurs because lead has an affinity for the heme binding site on erythrocytes. The heme group in human blood consists of a charged iron ion held together in a ring. In a healthy erythrocyte (red blood cell) oxygen binds to the iron ion. However, if there is lead in the blood, lead can replace iron in the blood cell. Typically lead exists at a Pb^{3+} ionic state in blood. When lead replaces iron in the heme group, it has a very low affinity for oxygen. Oxygen binding is very difficult to impossible to occur in the affected heme site leading to anemia (Kennedy et al., 2016).

Neurological toxicity

Both the peripheral and central nervous systems are affected by lead poisoning. Motor axons in the PNS are the primary target of lead toxicity. Lead exposure in the CNS can lead to demyelination which is the shedding of the myelin that surrounds the neurons. Demyelination can lead to delayed neurological response as the myelination decreases; the neural signal slows. The classic form of lead neuropathy consists of weakness that primarily involves the wrist and finger extensors but which later spreads to other muscles (Kennedy et al., 2016). However, these side-effects only occur with chronic exposure to lead and are typical of acute lead exposure.

In the CNS, lead exposure can be asymptomatic but can cause neurobehavioral impairment. In some cases, exposure in children may not display encephalopathy but may have lowered IQ scores as compared to children from the same community that have a lower level of lead exposure or no exposure at all. Schwartz et al. (1994) determined that about a quarter to a half an IQ point lost for each one µg/dl increase in blood lead level for children who have current blood levels of 10-20 µg/dl. An increase in a population's blood lead levels leads to lowered IQ's. Lowered IQ's lead to children doing poorly in school, and in underserved communities, these children may not get the extra help they need resulting in adults who may not be able to contribute to society as a whole.



. *Source:* Lanphear et al. (2005).

Fig 2.6: Relationship of Concurrent Blood Lead Concentration with Children's Intellectual Function. Reprinted from "Low-Level Environmental Lead Exposure and Children's Intellectual Function: An International Pooled Analysis" by B. Lanphear, 2005, *Environmental Health Perspectives, 113,* 895-899. Copyright 2005 by Environmental Health Perspectives.

Case Studies

The following case studies are from the CDC's Childhood Lead Poisoning Prevention Department in California between the years 1999-2001 ("Childhood Lead Poisoning Associated with Tamarind and Folk Remedies--California, 1999-2000," 2002). The following case studies focus on lead ingestion and the medical care that each child received after lead exposure.

- In March of 1999, two Hispanic children residing in Stanislaus County, California identified as having a blood lead level (BLL) of 88.0 g/dL and 69.0 g/dL during a routine health screening in California. The CDC's blood lead level of concern at that time was 10 mg/dL, meaning both children had blood lead level nearly seven factors higher than the recommended levels. Both children received chelation therapy to remove the lead and

any other heavy metals that may have been present in their bodies. The parents had been administering Greta to the children, which contains high levels of lead. Greta is a Mexican folk remedy that for stomach pain or intestinal illness. The CDC further tested their homes for lead and found that there were high levels (770,000 ppm) of lead found on the blinds in the home. There were also some candies found at the home that had high levels of lead. Pottery and paint in the home were also tested for lead but showed no signs of lead contamination.

- In May of 2000, a Hispanic boy in Fresno County identified as having a BLL of 26 µg/dL through routine testing at the state's health department. The CDC's investigation of the child's home found no lead contamination in the dust, paint, or soil, but did confirm that candies from Mexico had lead levels of nearly 16,000 ppm.

- In June of 2000, a Hispanic boy in Orange County identified as having a BLL of 26 µg/dL through routine screening by the state's health department. Tests on the home and around the home did not reveal any high lead levels. However, the child had been given both Greta and azarcon by his mother and also had eaten candies later to be determined to have been contaminated by lead. The FDA confirmed that these candies were contaminated by lead and issued a public health warning.

- In August of 2000, a Hispanic boy in Los Angeles County identified as having a BLL of 22 µg/dL. The child had been tested three years prior and had a BLL of 5 µg/dL, which was of no concern at the time. An investigation revealed that there was no lead contamination in any of the paint or soil, the child had been given any folk remedies or used any imported pottery. The child had been eating imported candies from Mexico

known for having high levels of lead contamination. The CDC recommended that children not eat the Mexican candies anymore.

The following case studies are from the British Journal of Clinical Pharmacology (Gordon, Taylor, & Bennett, 2002). The following case studies show the different routes of lead exposure/contamination in adults.

- A 40-year-old painter admitted himself to the hospital with a series of medical impairments. He had been working in an area to remove old paint with a blowtorch and sander but did not wear a respirator during the process. He also ate, drank, and smoked in the same building while other workers removed paint. The patient's BLL was 75.24 mg/dL. Recommendation of treatment with sodium calcium edetate and succimer for 14 days. After 14 days the patients BLL had dropped.

Methods to Reduce Exposure & Prevent Spread of Contamination

Lead exposure to both children and adults exists through several sources and pathways. However, the lowering of lead exposure in both can be beneficial to the health and well-being of everyone involved. Lowering lead exposure to reduce blood lead levels should be a concern of health scientists and researchers. This paper will look at both primary and secondary procedures to decrease lead exposure and prevent the spread of contamination. Primary prevention consists of preventing contact with lead, avoiding ingestion, and remediation once lead is present. Secondary prevention consists of a collection of responses to existing problems.

Primary Prevention

Several environmental and biological factors attribute to lead exposure. Lead-based paint is the most common source of lead exposure. Primary lead exposure can also be from several other components such as leaded gas, dust, soils, drinking water, and foods.

The U.S. Housing and Urban Development (HUD) and U.S. Consumer Product Safety Commission (CPSC) have set forth federal mandates controlling the exposure to lead-based paint. However, there remains the problem of the old stock paint made before 1977, and any household that may have used this paint. The CPSC controls the amount of lead in newly produced paint and HUD is involved with leaded paint in public housing or any housing involving federal assistance (Mushak, 2003).

The EPA has set standards for the amount of lead in gasoline to help reduce the ambient air pollution from lead. In 1975, EPA classified lead as a criteria pollutant, a designation reserved for pollutants whose public impact is such that control is required by ambient standards rather than by site-specific emission controls (Mushak, 2003). Since 1973 the EPA has reduced the amount of lead in gasoline to 0.1 g per liquid gallon. The reduction of lead in gasoline from the EPA's standards have lowered the amount of ambient lead pollution. Due to the 2008 clean air act, the EPA has set the ambient air standard for lead at 0.15 $\mu g/m^3$ (McClellan, 2012).

The EPA has set drinking water standards for two levels of protection, primary and secondary protection by The Safe Water Drinking Act (SFDA) 1974. The primary protection level sets standards for drinking water at maximum contaminant levels (MCL) which are enforceable by law. The EPA sets MCLs for lead as close as they can to maximum containment level goals (MCLGs). The MCLG for lead is zero, and the MCL is 0.015 mg/L (McClellan,

2012). If drinking water reaches the 0.015 mg/L MCL, then the EPA must take action in reducing the contaminated water. The EPA and the CDC both agree that no amount of lead in water is safe. In most cases, the entering and water leaving the treatment plant are lead-free. Water usually becomes contaminated when it enters residential piping. More than 7 million U.S. homes are thought to have surface lines that contain lead that can leach into the water. If the home was built before 1986, there is a chance that there are solder and fixtures on the pipes that can leach lead. Lead leaching can be reduced in many treatment plants add anti-corrosion chemicals that create a protective coating inside pipes. Some water utility companies have programs that replace old lead service lines, but will only replace the lines that they own. The homeowner is then left to replace the lines on their property with costs from the hundreds to thousands of dollars. Often the homeowners refuse to replace the old pipes in their homes because it is just too expensive. Only replacing part of the plumbing is dangerous because vibrations from construction can loosen the protective coating and release lead into the water system at home.

Secondary Prevention

Secondary prevention of lead contamination and poisoning deals with screening programs and other interventions of lead exposure. Typically, a lead screening program or intervention will only exist in an area that has a high lead contamination level or previous cases where there were several cases of lead poisoning (Etchevers et al., 2015). Screening and early detection of lead contamination can greatly decrease the number of lead poisoning. However, secondary prevention methods such as these have little to no effect on chronic exposure cases.

When cases of lead contamination are found, such as lead contamination due to leaded paint, there is an “no occupancy’ period in the contaminated home. Paint is replaced or removed from the home. In a prospective study, Chisolm et al. found that when lead poisoned children return to “lead abated” structures, their blood lead levels increase to unacceptable level.

Table 2.7: List of Prevention Methods and the Components of each Method. Reprinted from the EPA’s Lead Fact page. March 7, 2016, retrieved from https://www.epa.gov/lead/protect-your-family-exposures-lead#sources.

Type of prevention method	Components of method
Primary	
Environmental	Lead in paint
	Lead in ambient air
	Leaded gasoline combustion
	Point source emissions
	Lead in dusts/soils
	Lead in drinking water
	Lead in foods
Environmental/biological	Source controls augmented by community-nutrition interventions, i.e., nutritional supplementations, for calcium and iron
Secondary	
Environmental	Case finding
	Screening programs
	Environmental follow-up
	Event-specific exposure abatement
Environmental/biological	Nutritional assessment and follow-up on ad hoc identification basis
Extra-environmental	Legal actions and strictures

Development & Effectiveness of Health Education Materials & Campaigns

Prevention of exposure to lead poisoning is of great concern to several federal & state agencies. The CDC has a National Lead Poisoning Prevention Week (NLPPW) in October. The CDC’s goal along with other government agencies is to raise awareness about lead poisoning, which includes:

- Stress the importance of screening highest children that are younger than six years of age (preferably by ages 1 and 2).
- Highlight partners' efforts to prevent childhood lead poisoning; and

- Urge people to take steps to reduce lead exposure.

During NLPPW, many states and communities offer free blood-lead testing and conduct various education and awareness events. The CDC also conducts a town hall on Twitter that involves the CDC, EPA, HUD, and other representatives from the HHS.

The CDC also offers several posters and flyers that are downloadable and modifiable for the NLPPW. The posters are in English, Spanish, Russian, French, and Chinese. The CDC also offers a downloadable sample press release for NLPPW and a sample newspaper article for NLPPW. Both the press release and newspaper article are found in Appendix A.

Health Education

Over the last century, there has been an increase in efforts to strengthen health education to prevent disease (Williams, Carter, & Eng, 1980). There is a long history of health campaigns directed towards maternal and prenatal health, communicable diseases, and immunization in developed countries (Muscat et al., 2016). These health education programs initially were based on the transmission of information in which communication of the health education would bring upon a change in behavior. What was not realized at the time was the fact that only the educated would benefit from this model of health intervention, and that there would be little to no impact on those who were less educated or illiterate (Weyers, Dragano, Richter, & Bosma, 2010).

The 1980's saw an increase in new health interventions programs directed towards helping people make better health & behavior choices (Muscat et al., 2016). These interventions were primarily focused changing the way people were taught about health & wellness, despite their SES, with most of the health intervention programs being taught in school.

Epidemiological analysis of health has shown us that the economic, social, and environmental factors heavily influence disease and adverse health effects from disease (Winkleby, Jatulis, Frank, & Fortmann, 1992). The relationships between these factors have been studied very easily but are poorly understood. Once government agencies understand the relationships between these factors, health prevention techniques such as fact sheets or flyers will become more useful as an intervention method. The more underserved areas that have less educated populations will probably not understand a laundry list of health effects due to an environmental exposure (Weyers et al., 2010). However, if the fact sheet was more understandable and easier to read, there may be an increase in positive health interventions which will, in turn, provide a healthier community.

The Use of Fact Sheets in Intervention

Fact sheets can be created as problem-solving tools and could be integral to interventions. A fact sheet is often one page in length, with the key information listed in bullet points, graphs, or tables. Fact sheets have been used in several disciplines to relay pertinent information to a specific audience. Typically, a fact sheet is a preventive tool to deter negative outcomes. The use of fact sheets is paramount in environmental health, especially in environmental health interventions.

Fact sheets are an early health prevention tool. Health preventions utilize procedures that improve both mental and physical health as well as discourages against any negative health effects. There are two major methods of intervention, medical and behavioral. Medical intervention begins with a clinical trial and typically includes a drug, surgery, or device (Anderson et al., 2014). However, environmental health medical interventions clinical trials

aren't typical. The most direct method of environmental health intervention is the removal of contaminants which will in turn eliminate them from the exposure pathway. Behavioral intervention focuses on the patient's behaviors and how to change them, which includes avoiding preventable diseases to racial inequalities health. Cutler (2004) says that behavioral interventions can occur on three levels: The personal level, community level, and the national level. Each level has its benefits to the behavioral interventions, and each level is used appropriately according to the status of the intervention.

Fact sheets have been and used in all three levels of behavioral intervention. Fact sheets used on the personal level could be anything from informing the reader about the benefits of daily exercise to the harms of smoking cigarettes. Facts sheets used on the community level reach a larger audience and have been used to reach a particular sub-population that has been or could be affected by a negative health outcome. Fact sheets used at the community level could warn a community of potential water contamination or poor air quality due to a local factory. Fact sheets used on the national level have been used to change the behaviors of the entire population of a country. In America, fact sheets warning of the potential dangers of smoking tobacco, drinking alcohol, or diet change due to high cholesterol have been used in the past with varying degrees of success.

In the past, National level behavioral interventions have had better success than those of individual and community level. It is difficult to determine why this is, but one could postulate that people may judge one another on behaviors. If a peer deems a particular behavior undesirable, this peer will often judge and condemn those around them that participate in this behavior. People fear the judgment of their peers and often seek change to avoid judgment and to seek acceptance. Another theory on why a national level intervention works better than personal

and community are that national level intervention typically lasts longer than personal and community level intervention (Ruadze & Todadze, 2016).

Community Engagement

Community engagement is a vital tool for spreading information on hot topics in the community. The North-Birmingham project (35th Avenue) and other projects have set up several community outreach programs to engage the citizens of the affected Superfund site. Monthly meetings are set up for anyone to attend and involve community action panels (CAP). These CAPs help involve both federal agents of the EPA and the local citizens to help educate each other (Alvarado & Smolenski, 1996). The citizens get to learn what is happening right now in their community and become aware of the vital information. Community action panels are a great way to help spread the word of what's going on among citizens. Often, some people just don't like to get out or get involved. These CAPs are a way of reaching them via friends and relatives by getting them the information they need to know second hand.

There are also community outreach members who go out with and without EPA representatives to the resident's households. Often, these outreach members are trusted and well known and often liked members of the community (O'Mara-Eves et al., 2015). Community Outreach members are crucial when dealing with mistrust of government officials or occupancy. The community has a local voice, a member relaying information to and from the EPA or other government agency and this leads them to feel like they have a voice. These community outreach members are the ones themselves handing out flyers and fact sheets to the community directly.

Chapter III Methodology

The Methodology section will focus on 1) How the fact sheets are chosen, 2) Reading Analysis, 3) SAM, 4) Development of a New Fact Sheet. Following the review of these four areas, a new fact sheet will be made from all pertinent information obtained.

Fact Sheets

Fact sheets used during the 35th Avenue Superfund cleanup, Omaha Lead Cleanup Superfund, Colorado Smelter cleanup site, and various other lead fact sheets were used for this study. The ATSDR and EPA lead fact sheets are used at both the 35th Avenue and Omaha Superfund site. When the CDC's, OSHA, and HUD are involved in a lead contamination site, their respective fact sheets are available to the general public. The other lead fact sheets are used in their respective agencies when deemed necessary. The remaining lead fact sheets were chosen for this study to determine the strength and weaknesses of said lead fact sheets to help determine the content for a new lead fact sheet. All fact sheets that were chosen were done so based on the availability and accessibility of each fact sheet to myself. All fact sheets are online, and a hyperlink is available for each in the appendix. Table (3.1) summarizes the content of the twelve lead fact sheets used in this study.

Reading Analysis

For the reading analysis portion of the project, the Flesch-Kincaid analysis was chosen to test the readability of each fact sheet. The Flesch-Kincaid readability test determines how hard a

particular line of text in English is to comprehend. Flesch-Kincaid uses a mathematical formula [0.39 (total words/total sentences) + 11.8 (total syllables/total words) – 15.59]. The result of the formula correlates with an American grade school level. So, if the formula gave a readability score of 7, then the material tested could be understood by people with at least a 7th-grade education. Each fact sheet was typed into Microsoft Word and tested using Flesch-Kincaid. The test omitted subject headings and references. Each of the twelve fact sheets received a Flesch-Kincaid score. A summary of the scores is in Table 4.1.

Suitability Assessment of Materials

SAM is a metric of determining the appropriateness of health information for a particular set of people. SAM helps you determine the difficulty of the words in a document and whether or not the reader could understand the meaning of the document. SAM Covers six areas: 1) Content, 2) Literacy Demand, 3) Graphics, 4) Layout & Type, 5) Learning Stimulation & Motivation, 6) Cultural Appropriateness (Lampert, Wien, Haefelii, & Siedling, 2016). There is a high correlation between the readability level of material and the SAM score as seen in figure 4.12.

Several factors contribute to a document's readability, but the grade level at which it's written at is among the highest. To assess a document's reading level, Doak and Doak created the suitability of assessment tool to understand the readability of a document better. SAM can be used to identify shortcomings in health document. SAM scores vary from observer to observer and should be replicated among many observers to eliminate bias. Also, having more than one observer review the document using SAM will help eliminate bias. Learning stimulation & motivation were not chosen as a part of the assessment because the fact sheets, overall were not

long enough to stimulate or motivate the reader to the next page. Most of the fact sheets were two pages, with a majority of the information on the first page. Also, the fact sheets did not ask any questions of the reader, and they did not have any problems for the reader to solve, deeming the learning stimulation & motivation unnecessary at this time. The cultural appropriateness portion of the SAM was also not included. The cultural appropriateness portion isn't included because each government & private agency will only make one fact sheet since one fact sheet is all that will be given out. Making several fact sheets for every culture and creed would be far too expensive and unnecessary for each agency to accomplish. However, translating each fact sheet to Spanish would be potentially helpful to larger Spanish speaking communities.

The content section of SAM focused on three factors: Purpose, Content Topics, and Summary & Review. For the purpose factor, if the purpose of the content is in the title, cover illustration or introduction the fact sheet would receive a score of superior. If the purpose was not explicit or implied multiple purposes, the fact sheet got a score of adequate. If no purpose is stated in the title, a score of not suitable is given to the fact sheet. For the content topics factor if most of the material is intended to increase desirable reader behavior, then the fact sheet received a score or superior. If the fact sheet focused on 40% of content topics or desirable behaviors and actions, then the fact sheet received a score of adequate. If most of the topics focused on non-behavior facts, then a score of not suitable was given to the fact sheet. For the summary & review factor, a score of superior was given to the fact sheet if summaries retold the lesson in a different way. If the fact sheet only covered some of the key topics, then a score of adequate was given to the fact sheet. If there was no summary or review, the fact sheet received a score of not suitable.

The Literacy Demand section focused on five factors: Reading Grade Level, Writing Style, Sentence Construction, Vocabulary, and Learning Enhancement. The results from the Flesch-Kincaid test were used to complete the reading grade level portion of SAM. If a fact sheet was comprehensible to 5th Reading Grade Level factor or lower, it received a score of superior. A score of adequate was given to a fact sheet if the readability was in the 6th to the 8th-grade reading level range. The fact sheet received a score of not suitable when the material is at a 9th-grade level or higher. For writing style factor, a score of superior was given to a fact sheet if it contained conversational style and active voice throughout. If half the text was conversational style and the other half was long complex phrases, then a score of adequate was given to the fact sheet. If the fact sheet contained passive voice, then a score of not suitable was given to the fact sheet. For vocabulary factor a score of superior was given if the fact sheet followed three factors: 1) common words are used all the time. 2) Technical, concept, category, value judgment words (CCVJ) are explained. 3) Contains appropriate imagery words. A score of suitable is given if the document used common words frequently, technical CCVJ words, and some jargon. A score of not suitable is given if the fact sheet frequently used uncommon words and gave no explanation of technical and CCVJ words and extensive jargon.

The Layout and Typography section of SAM focused on three factors: Typography, Layout, and Subheadings. For typography factor a score of superior was given if the fact sheet had at least 3 of the following four factors are present: 1) Text type is in uppercase and lowercase. 2) Type size is at least 12 point (This is a 12-point type). 3) Typographic cues (bold type, color, the size of type). 4) No ALL CAPS for long headlines and running text. A score of adequate was given if only two of the previously mentioned factors were present. A score of not suitable was given if one or none of the previous factors were present. For layout factor, a score

or superior was given to the fact sheet if at least 5 of the following eight factors are present: 1) Illustrations are adjacent to the related text. 2) Layout and sequence of information are consistent, making it easy to predict the flow of information. 3) Visual cueing devices (boxes, arrows, shading) are used to direct attention to key content. 4) Pages do not appear cluttered. 5) Use of color supports and is not distracting to the message. Readers need not learn color codes to understand and use the message. 6) Line length is 30 to 50 characters and spaces. 7) There is high contrast between type and paper. 8) The paper has a non-gloss or low-gloss surface. The fact sheet received a score of adequate if the fact sheet contained three of the previous factors. If two or fewer of the previous factors were present, the fact sheet received a score of not suitable.

Each factor is given a point value to obtain a final SAM score. Superior received two points; adequate received one point and not suitable received zero points The total score for each fact sheet is a combination of each factor it received credit. The total score is then divided by the number of factors used times two.

$$\text{SAM \%} = \frac{Total\ Score\ of\ Fact\ Sheet}{(Number\ of\ Factors\ Used\ X\ 2)}$$

Fact sheets that scored between 70-100% received a score of superior. Fact sheets that scored between 40-69% received a score of adequate. Fact sheets that scored 39% and below received a score of not suitable (Shieh & Hosei, 2008).

To assess a document using SAM, first read throughout the SAM factor list and the evaluation criteria on the SAM score sheet. Evaluate each SAM factor by using the evaluation criteria and scoring system. Calculate the total score. The highest score is 44 points. A more detailed description of SAM and interpretations can be found at https://dhhs-healthliteracy.sproutlabs.com.au/assets/B-08B-2013-1120-SAM-Scoresheet.pdf.

Development of New Fact Sheet

The information found in this project was used to create a new fact sheet. Results from the Flesch-Kincaid, SAM, and the literature review were all taken into account when creating the new fact sheet. The new fact sheet will use these factors to achieve a superior score on SAM and achieve a score of 6 on the Flesch-Kincaid scale. The new fact sheet is in the appendix.

Chapter IV

Results

The following reports are all from the EPA Superfund Website. The three sites listed are currently EPA Superfund sites or have been previously listed until deemed unnecessary. All of the following Superfund sites had a lead contamination in the soil that was deemed detrimental to the health of the community in and around the site. Clean up, and restoration of lead contaminated sites is very expensive and can take up to several years. In addition to the costs of the cleanup, other indirect costs such as loss of business, bad publicity, and loss of residence can occur in a Superfund cleanup site. Superfund cleanup sites are necessary to ensure the health and well-being of the citizens involved but do not come without its burdens.

North Birmingham Environmental Collaboration Project

Background- For more information visit **https://www.epa.gov/north-birmingham-project**

The EPA and ATSDR are focusing on six neighborhoods, three of which are in the EPA's designated Superfund site. The EPA is using the Superfund to access these communities for the possible presence of pollutants. The EPA has begun seeking permission from residential owners to sample their properties. Of the 1100 sampled properties, 260 sites have had

contaminated soil removed. The current theory on how the soil became contaminated with lead and other volatile compounds is the adjacent Walter Coke Energy possibly allowed contaminated soil to be used as fill dirt in surrounding resident's properties some years back. Unknowingly at the time, the residents agreed to let the Walter Coke Factory dump soil in their yard as fill dirt, and in some cases even paid them to do so. Currently, the EPA is in a lawsuit with Walter Coke Energy to pay for the current removal of contaminated sites.

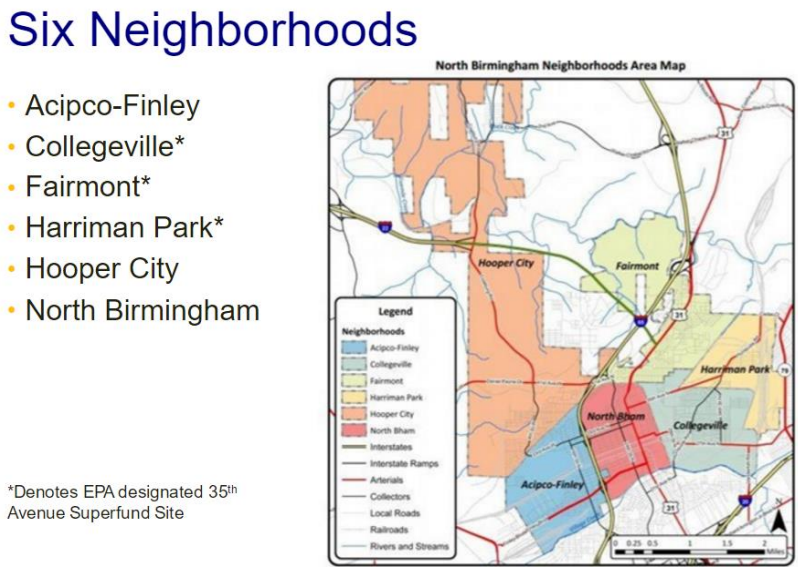


Image retrieved from https://www.epa.gov/north-birmingham-project

Colorado Smelter, Pueblo Colorado

For more information, visit https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0802700

Image retrieved from https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0802700

Background

Pueblo Colorado has been home to several ore smelters and steel mills over the last 150 years. The slag left over from ore refining was dumped into ravines, used a railroad track ballast, and even used to make bricks for buildings and schools. The site was discovered to be potentially harmful after another site; a culvert tested positive for lead and other contaminants. The Colorado Department of Public Health began testing sites around the smelter in 2010. The tests revealed that there are high levels of lead and arsenic in the soil that could potentially be harmful to the public's health.

The EPA has the Colorado Smelter site on its National Priorities List of Superfund Sites. The CColorado Smelter Site consists of two sections: community properties and former smelter area. Eleven of the twelve properties tested positive for soil lead contamination. All twelve of the properties tested in the area tested positive for arsenic soil contamination. The EPA is currently

investigating the site-specific characteristics of the area and determining the proper methods for cleanup.

Omaha Lead Superfund Site, Omaha Nebraska

For more information, visit https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0703481

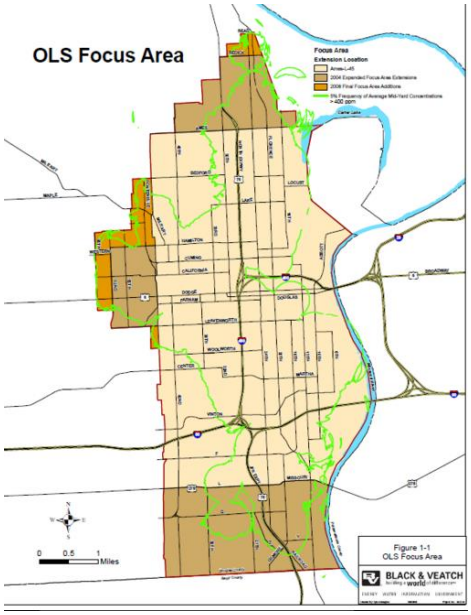


Image retrieved from https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0703481

Background

The Omaha Lead Superfund Site located in downtown Omaha, where two lead-processing factories used to operate. The site includes residential, child care facilities, and other facilities frequented by the public. Testing has shown that one in three of the residential yards has soil lead contamination that exceeds 400 parts per million (PPM), which is an EPA screening level.

The investigation of the site began in 1998 when several children in the Omaha city limits tested positive for high blood lead levels (BLLs). The EPA is currently cleaning up the

contaminated site. Of the nearly 38,000 properties tested, the EPA has cleaned 12,500 residential yards. However, there is still risks at the site, especially to children under the age of seven. The EPA hopes to finish cleanup by the end of 2016.

Table 4.1: Summary of information in each of the twelve fact sheets

Fact Sheet	Summary	Target Audience
2007 ATSDR Lead Fact Sheet	• Physical properties and uses of Lead. • Lead in the environment • Lead exposure pathways • Negative health effects of lead exposure • Possible link to cancer • Risks to children • Ways to reduce lead exposure • Lead exposure medical test facts • Federal regulations concerning lead exposure • Additional information to be found on the website and a phone number	• Communities
2003 HUD Lead Fact Sheet	• Exposure pathways • Risks to children • Risks to pregnant women • Effects of lead poisoning • Where lead-based paint is found • Lead exposure tests • Lead hazards • Reducing lead hazards • Additional information to be found on the website and a phone number	• Construction Workers
CDC Lead Fact Sheet (Infographic).	• Risks to children (cognitive and behavioral) • Where lead can be found in the home • Lead exposure impacts (several facts and numbers) • Tips to prevent exposure • Website info for additional information.	• Communities

2005 OSHA Lead Fact Sheet	• Lead exposure pathways • Operations that generate lead dust • OSHA's lead standard • Web sites and contact number for additional information.	• Construction Workers
1996 EPA Lead Fact Sheet	• Hazards in paint • Lead-contaminated dust • Lead-contaminated soil • Lead testing • Additional information to be found on the website and a phone number	• Communities
Colorado Smelter Lead Fact Sheet	• Contamination in the area • Possible health effects from lead • Lead-contaminated soil • How to protect your family from lead exposure • Additional information to be found on the website and a phone number	• Communities
Idaho Department of Health and Welfare Lead Fact Sheet	• Lead-based paint facts • Health effects of lead • Sources of lead • Reducing the risks of lead • Web sites and contact number for additional information.	• Communities
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	• Ways to reduce incidental soil inhalation and ingestion • Additional information to be found on the website and a phone number	• Communities
2010 35th Avenue Lead in Yard Fact Sheet	• How to protect your family from lead exposure • Additional information to be found on the website and a phone number	• Communities
2007 Omaha Superfund Site Lead Fact Sheet	• EPA & ATSDR agency information • Omaha lead site background • Health effects of lead • EPA's role in the cleanup • Yard & Soil information • Web sites and contact number for additional information.	• Communities
2013 Associated	• Lead renovation, repair, and painting rule (LRRP).	• Construction Workers

General Contractors of America Lead Fact Sheet	• Importance of LRRP rule • Who must follow LRRP rule • Lead testing (on-site) • Lead-Safe Work Practice Requirement • Control and Dispose of the Waste Properly information • Additional information to be found on the website and a phone number	
2012 UMASS Extension (Soil and Plant Tissue Testing Laboratory) Lead Fact Sheet	• Soil Lead contamination facts • Soil lead levels, distribution, and sampling procedures • Practices to reduce lead exposure • Additional information to be found on the website and a phone number	• Trade Groups

Reading Assessment

Each fact sheet was assessed using the Flesch-Kincaid Reading Level tool. Each fact sheet was also assessed using the SAM tool. The length of each fact sheet and illustration coverage was assessed and reported as well. The average number of characters and spaces were also tallied and compared to the respective Flesch-Kincaid score to determine if there was a correlation between length of the fact sheet and Flesch-Kincaid score. These analyses were performed to determine if each fact sheet conveyed the necessary information to the public.

For the Flesch-Kincaid analysis each fact sheet was copied into a word document. Microsoft word has a built-in Flesch-Kincaid analysis tool. After each fact sheet was copied into a Microsoft word document, the Flesch-Kincaid analysis tool recorded a score and each score was then logged. Other Flesch-Kincaid analysis tools are available, but due to financial limits,

the Microsoft word version was utilized. Flesch-Kincaid scores can vary from each version of the tool and should be noted in the study.

For the SAM analysis each fact sheet was evaluated by specific criteria in a SAM score sheet. Select the appropriate score using the evaluation criteria. Superior scores receive 2 points, adequate scores receive 1 point, and not suitable scores receive 0 points. Then the total suitability score is calculated. A total of 22 SAM factors can be used, but for the purpose of this study, only 20 SAM factors were used. The highest score possible is 44 if all 22 SAM scores are used. So if a document scores a 29, then the SAM percentage rating would be 29/44 (66 %). Pre-determined SAM percentage ratings are interpreted as follows: (1) 70-100 % – superior material (2) 40-69 % - adequate material (3) 0-39% - not suitable material. For more information on how to assess a document using SAM go to https://dhhs-healthliteracy.sproutlabs.com.au/assets/B-08B-2013-1120-SAM-Scoresheet.pdf.

Critical Information for Fact Sheet

From the data provided by the readability assessments and the literature review, the critical information necessary for a lead fact sheet are: lead facts, how you can be exposed to lead, symptoms of lead exposure, and who to call incase of exposure to lead. Background information should include where lead contamination can occur and where to look for it. Exposure pathways should focus on ingestion. Although inhalation of lead is much more detrimental to health, ingestion is the most common exposure pathway. The fact sheet should also list the signs of lead exposure and their symptoms. The fact sheet should also contain a directory of numbers, website, and emails that a person can contact if he/she believes that lead exposure occurred. Along with all of the critical information previously mentioned, the fact sheet

should score lower than a 6th grade reading level on the Flesch-Kincaid readability test. The fact sheet must also receive a score greater than 70% on SAM assessment.

Assessment Results

Each lead fact sheet was evaluated using the Flesch-Kincaid reading level tool. The reading levels ranged from 5.5 to 16. The average level for the twelve fact sheets was 9.9. Seven fact sheets are below the 10th-grade level. Consequently, more that 50% of Americans would not be able to understand the twelve fact sheets used in this study, because more than 50% of Americans do not have a reading level higher than the 8th grade (Doak et al., 1996).

Table 4.2 Summary of Flesch-Kincaid Levels of Each Lead Fact Sheet.

Source	Flesch-Kincaid Level
Centers for Disease Control	
2007 ATSDR Lead Fact Sheet	9.2
CDC Lead Fact Sheet (Infographic).	8.1
Environmental Protection Agency	
2010 35th Avenue Lead in Yard Fact Sheet	6
Colorado Smelter Lead Fact Sheet	10.2
1996 EPA Lead Fact Sheet	12.1
2007 Omaha Superfund Site Lead Fact Sheet	9.8
State Level	

Idaho Department of Health and Welfare Lead Fact Sheet	9.2
Educational	
2013 Associated General Contractors of America Lead Fact Sheet	13.2
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	5.5
2012 UMASS Extension (Soil and Plant Tissue Testing Laboratory) Lead Fact Sheet	11.2
United States Department of Housing and Urban Development	
2003 HUD Lead Fact Sheet	8.4
United States Department of Labor	
2005 OSHA Lead Fact Sheet	16

Flesch-Kincaid

The Flesch-Kincaid reading level tool evaluated each fact sheet to obtain a readability score. The reading levels ranged from 5.5 to 16. The University of Arizona Garden Roots Lead fact sheet received the lowest score on the Flesch-Kincaid test with a score of 5.5. The most obvious reason that the UA fact sheet received such a low score is that it is an

infographic, meaning that most of the important information are pictures and graphs/tables instead of lengthy or wordy paragraphs. An infographic may be the best mode of information exchange when a public health official is organizing a fact sheet.

The 2005 OSHA lead fact sheet received the highest Flesch-Kincaid score of 16. The 2005 OSHA lead fact sheet is only two pages long, but there were zero illustrations utilized. The 2005 OSHA lead fact sheet also had use of more technical jargon and more advanced verbiage than the other fact sheets. The OSHA fact sheet may have received a better score on the Flesch—Kincaid test had it utilized some illustration and used less technical jargon and focused the verbiage on more commonly used vernacular as the OSHA fact sheet was designed for workers involved in construction.

Overall the twelve fact sheets received an average score of 9.9 on the Flesch-Kincaid analysis, meaning that those individuals with less than a 10^{th} -grade education would find it difficult or impossible to understand and retain any knowledge from these fact sheets. The average level for the twelve fact sheets was 9.9. Seven fact sheets can are below the 10^{th}-grade level. Consequently, more that 50% of Americans would not be able to understand the twelve fact sheets used in this study (Doak et al., 1996).

Suitability Assessment of Materials

Throughout the SAM assessment, only one fact sheet received a superior score. Ten fact sheets received a score of adequate. Only one fact sheet received a SAM score of not suitable. The Centers for Disease Controls Lead Fact Sheet Infographic received the highest score at 75%, while the UMASS Extension Soil & Plant Tissue Testing Laboratory Lead fact sheet scored the

lowest with a score of 38%. Adjusting the reading level to a 6th-grade level would improve each fact sheet. SAM assessments are in the appendix.

Only two of the fact sheets had a length of one page. Six of the fact sheets had a length of two pages. The 2003 HUD Lead Fact Sheet had the most pages at seventeen. All fact sheets used different font and font size. The two fact sheets that were only one page had a font size of 12 point.

Only two fact sheets utilized illustrations to convey facts about lead. The CDC & Colorado smelter Fact sheet dedicate 70% and 40% of the fact sheet to illustrations to convey information, respectively. Out of the twelve fact sheets assessed, only two utilized illustrations to convey information, while the other ten relied on text only to convey information. Table 4.2 displays the results of the assessment.

Content Section

All of the fact sheets contained an understandable purpose, and the content topics of all of the fact sheets focused on lead. The fact sheets scored poorly on summary & review as only one fact sheet, UMASS, contained a summary & review. Table 4.3 contains the results of the SAM assessment for the Content Section.

Table 4.3 SAM Results for Content Section

Source	**Purpose**	**Content Topics**	**Summary & Review**
Centers for Disease Control			

2007 ATSDR Lead Fact Sheet	Adequate	Superior	Not Suitable
CDC Lead Fact Sheet (Infographic).	Superior	Superior	Not Suitable
Environmental Protection Agency			
2010 35th Avenue Lead in Yard Fact Sheet	Superior	Superior	Not Suitable
Colorado Smelter Lead Fact Sheet	Adequate	Adequate	Not Suitable
1996 EPA Lead Fact Sheet	Adequate	Adequate	Adequate
2007 Omaha Superfund Site Lead Fact Sheet	Superior	Adequate	Not Suitable
State Level			
Idaho Department of Health and Welfare Lead Fact Sheet	Superior	Superior	Not Suitable
Educational			

2013 Associated General Contractors of America Lead Fact Sheet	Not Suitable	Adequate	Not Suitable
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	Not Suitable	Adequate	Not Suitable
2012 UMASS Extension (Soil and Plant Tissue Testing Laboratory) Lead Fact Sheet	Superior	Adequate	Adequate
United States Department of Housing and Urban Development			
2003 HUD Lead Fact Sheet	Superior	Superior	Not Suitable
United States Department of Labor			

2005 OSHA Lead Fact Sheet	Superior	Adequate	Not Suitable

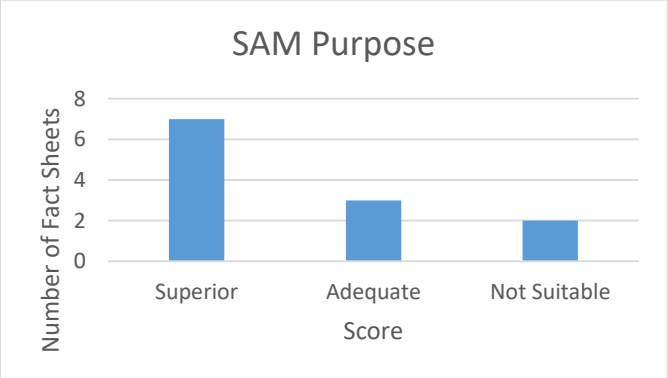


Figure 4.1 Fact Sheets SAM Scores for Purpose.

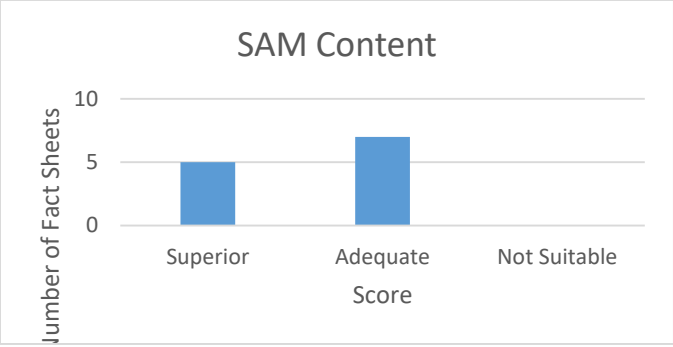


Figure 4.2 Fact Sheets SAM Scores for Content

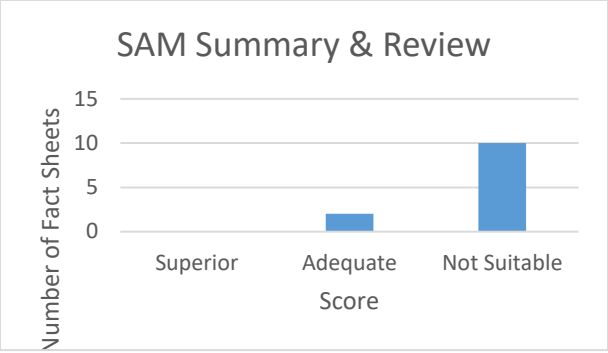


Figure 4.3 Fact Sheets SAM Score for Summary & Review

Literacy Demand Section

The fact sheets in the literacy demand section scored poorly in all factors except the sentence construction and learning enhancement factors. The fact sheets received mediocre scores on the Fry reading level factor except for the University of Arizona's fact sheet, which received a score of superior. Only two fact sheets received a superior score in writing with the rest receiving a score of adequate or not suitable. The fact sheets also received poor scores on vocabulary except for the University of Arizona's fact sheet receiving a score of superior. The University of Arizona's Fact Sheet was the only fact sheet to register less than a 6th grade reading level on the Flesch-Kincaid readability test. Table 4.4 summarizes the results from the SAM assessment on the Literacy Demand Section.

Table 4.4 SAM Results from Literacy Demand Section

Source	**Reading Grade Level**	**Writing Style**	**Vocabulary**	**Sentence Construction**	**Learning Enhancement**

Centers for Disease Control					
2007 ATSDR Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Adequate
CDC Lead Fact Sheet (Infographic).	Adequate	Superior	Adequate	Adequate	Superior
Environmental Protection Agency					
2010 35th Avenue Lead in Yard Fact Sheet	Adequate	Adequate	Adequate	Adequate	Adequate
Colorado Smelter Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Superior
1996 EPA Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Adequate
2007 Omaha Superfund Site Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Adequate

State Level					
Idaho Department of Health and Welfare Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Adequate
Educational					
2013 Associated General Contractors of America Lead Fact Sheet	Not Suitable	Not Suitable	Not Suitable	Adequate	Adequate
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	Superior	Superior	Superior	Adequate	Superior
2012 UMASS Extension (Soil and Plant	Not Suitable	Not Suitable	Not Suitable	Adequate	Adequate

Tissue Testing Laboratory) Lead Fact Sheet					
United States Department of Housing and Urban Development					
2003 HUD Lead Fact Sheet	Adequate	Adequate	Adequate	Adequate	Superior
United States Department of Labor					
2005 OSHA Lead Fact Sheet	Not Suitable	Adequate	Not Suitable	Adequate	Adequate

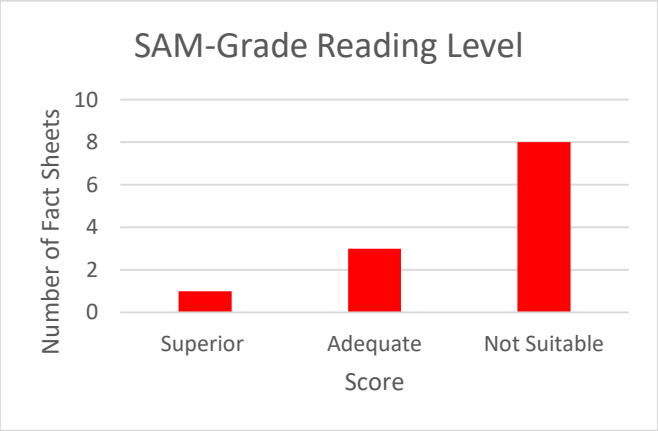


Figure 4.4 Fact Sheets SAM scores for Grade Reading Level

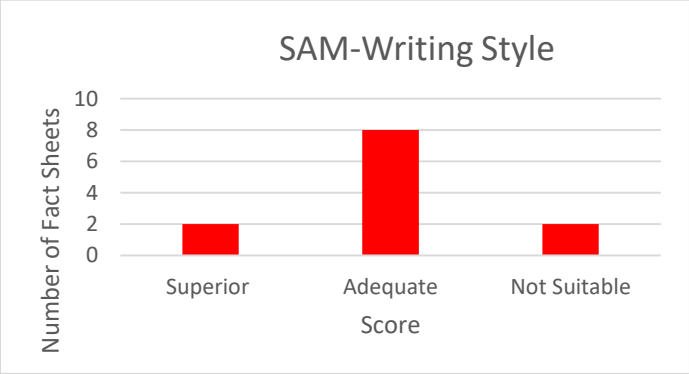


Figure 4.5 Fact Sheets SAM Score for Writing Style

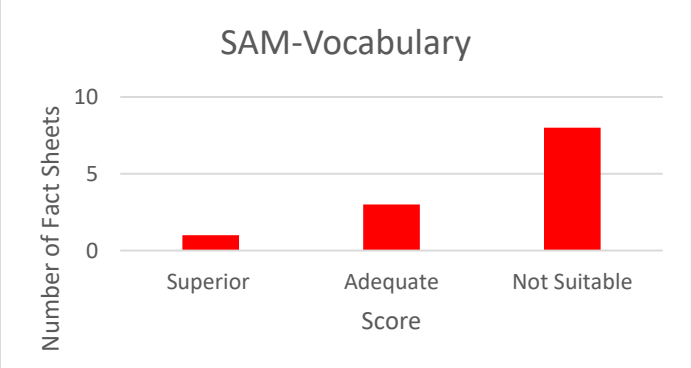


Figure 4.6 Fact Sheets SAM Score for Vocabulary

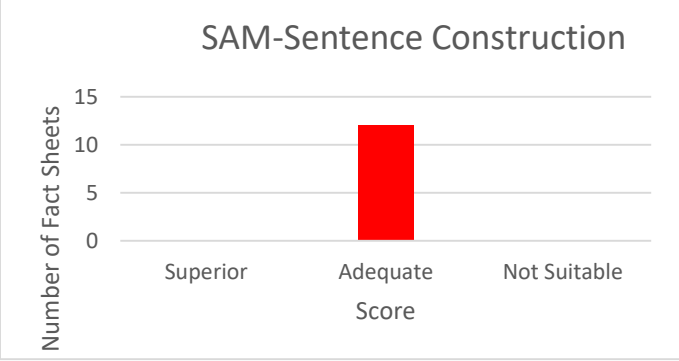


Figure 4.7 Fact Sheets SAM Score for Sentence Construction

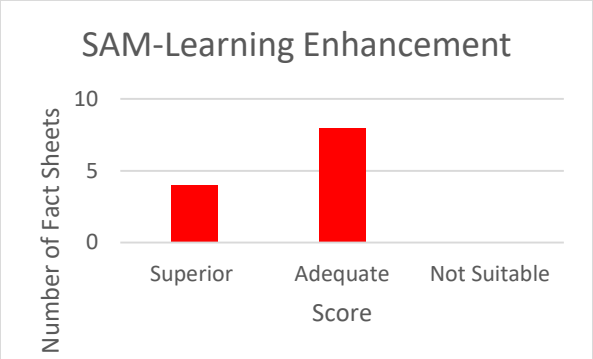


Figure 4.8 Fact Sheets SAM Scores for Learning Enhancement

Graphics, Learning Stimulation, and Layout & Topography Sections

Every fact sheet received a score of superior on the typography section in the SAM assessment. The fact sheets also did well in the layout section of the assessment with eight fact sheets receiving a score of superior and four fact sheets receiving a score of adequate. Overall the fact sheets scored poorly on the relevance of illustrations with only two fact sheets receiving a score of superior. Lead fact sheets should only include illustrations about lead and lead-based facts. Table 4.5 is a summary of the SAM assessment on Graphics, Learning Stimulation, and Layout & Topography.

Table 4.5 Summary of Sam Scores from Graphics, Learning Stimulation, and Layout & Topography Sections.

Source	**Relevance of Illustrations**	**Layout**	**Typography**	**Desired Behavior Patterns**
Centers for Disease Control				
2007 ATSDR Lead Fact Sheet	Not Suitable	Superior	Superior	Not Suitable

CDC Lead Fact Sheet (Infographic).	Superior	Adequate	Superior	Superior
Environmental Protection Agency				
2010 35th Avenue Lead in Yard Fact Sheet	Not Suitable	Superior	Superior	Adequate
Colorado Smelter Lead Fact Sheet	Superior	Superior	Superior	Superior
1996 EPA Lead Fact Sheet	Not Suitable	Adequate	Superior	Adequate
2007 Omaha Superfund Site Lead Fact Sheet	Adequate	Adequate	Superior	Adequate
State Level				
Idaho Department of Health and Welfare Lead Fact Sheet	Not Suitable	Superior	Superior	Adequate

Educational				
2013 Associated General Contractors of America Lead Fact Sheet	Adequate	Superior	Superior	Adequate
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	Not Suitable	Superior	Superior	Adequate
2012 UMASS Extension (Soil and Plant Tissue Testing Laboratory) Lead Fact Sheet	Not Suitable	Adequate	Superior	Not Suitable
United States Department of Housing and Urban Development				

2003 HUD Lead Fact Sheet	Adequate	Adequate	Superior	Superior
United States Department of Labor				
2005 OSHA Lead Fact Sheet	Not Suitable	Superior	Superior	Adequate

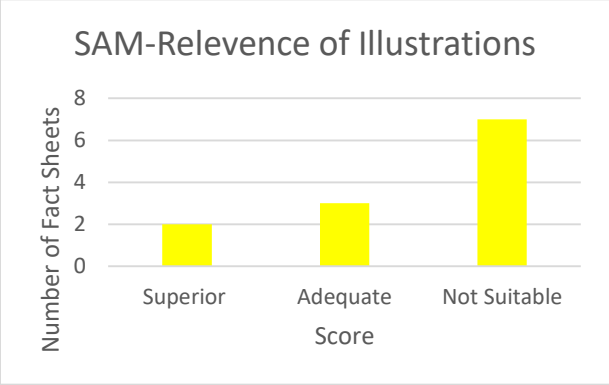


Figure 4.9 Fact Sheets SAM Scores for Relevance of Illustrations

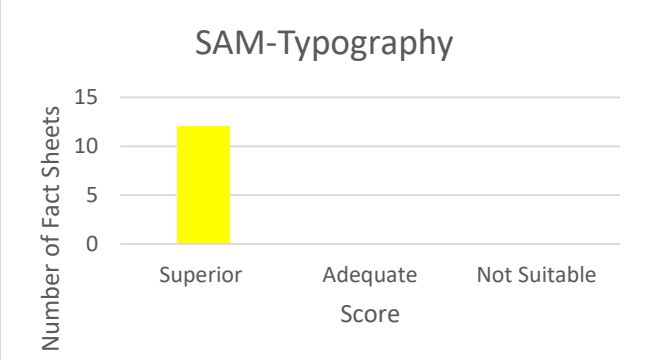


Figure 4.10 Fact Sheets SAM Scores for Typography

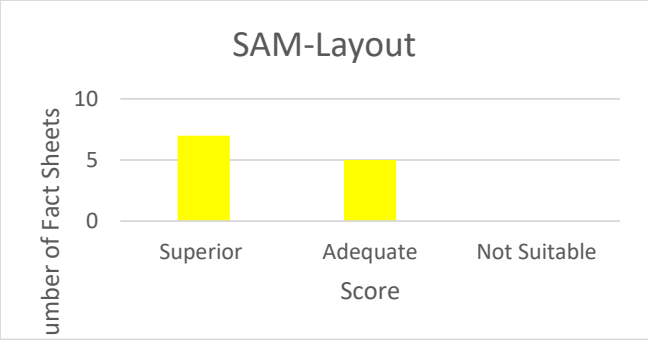


Figure 4.11 Fact Sheets SAM Scores for Layout

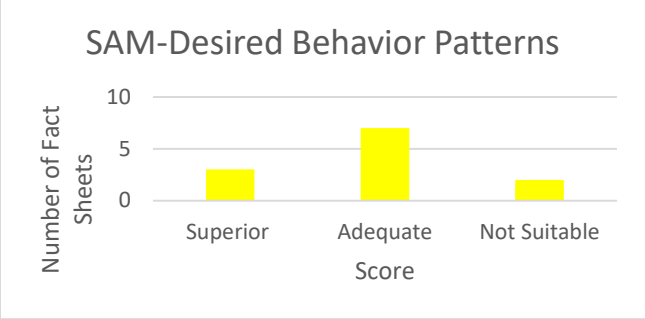


Figure 4.12 Fact Sheets SAM Scores for Desired Behavior Patterns

Table (4.6) Average number of characters and spaces of sentences evaluated with SAM

Fact Sheet	**Average Number of Characters and Spaces**
Centers for Disease Control	
2007 ATSDR Lead Fact Sheet	100
CDC Lead Fact Sheet (Infographic).	76
Environmental Protection Agency	

2010 35th Avenue Lead in Yard Fact Sheet	93
Colorado Smelter Lead Fact Sheet	124
1996 EPA Lead Fact Sheet	134
2007 Omaha Superfund Site Lead Fact Sheet	139
State Level	
Idaho Department of Health and Welfare Lead Fact Sheet	
Educational	
2013 Associated General Contractors of America Lead Fact Sheet	156
2012 University of Arizona Garden Roots Lead Fact Sheet (Infographic).	4
2012 UMASS Extension (Soil and Plant Tissue Testing Laboratory) Lead Fact Sheet	133
United States Department of Housing and Urban Development	
2003 HUD Lead Fact Sheet	95
United States Department of Labor	

2005 OSHA Lead Fact Sheet	174

Suitability Assessment of Materials

Each fact sheet was evaluated by using SAM, which assesses the appropriateness of educational material of each fact sheet. The SAM assessment evaluated three sections of each fact sheet: Content, Literacy Demand, Layout & Typography, each face sheet received a score of either superior, adequate, or not suitable. Each section of the fact sheet was given a final score. The final score was then used in the formula below to determine the SAM % score. Fact sheets that scored between 70-100% received a score of superior. Fact sheets that scored between 40-69% received a score of adequate. Fact sheets that scored 39% and below received a score of not suitable (Shieh & Hosei, 2008).

$$\text{SAM \%} = \frac{Total\ Score\ of\ Fact\ Sheet}{(Number\ of\ Factors\ Used\ X\ 2)}$$

The content section focused on purpose, content topics, and summary & review. Seven out of the twelve fact sheets received a score of superior, three scored adequate, and two scored not suitable for the purpose section. Five of the twelve fact sheets received a score of superior, seven scored adequate, and not one of the fact sheets obtained a score of not suitable for the content topics section. Only two of the twelve fact sheets received a score of adequate on the summary & review portion as they were the only face sheets to include a summary. The rest of the fact sheets did not have a summary or review and received a score of not suitable.

The fact sheets scored higher on purpose and content topics than it did on summary & review because only two of the twelve fact sheets included a summary & review. Most of the

fact sheets scored high on the purpose portion because they were specifically created for the use as a lead fact sheet. The highest scores in the content section were in the content topics portion. This is due to the fact that each of the fact sheets included some information pertaining to lead and any pertinent information that may be needed. Only two fact sheets received a score or adequate on the summary & review. The two fact sheets that received the adequate score had a summary, but there could have been a better use of it and more of a review of all necessary facts that should be known. The revised fact sheet should have a better summary & review section to receive a higher SAM score in the content section. Public health officials should also look to add a summary & review section in the updated fact sheets to ensure that all pertinent facts about the dangers of lead are understood and acknowledged.

The literacy demand section focused on five sections of literacy: 1) Reading Grade Level, 2) Writing Style, 3) Vocabulary, 4) Sentence Construction, and 5) Learning Enhancement. Only one fact sheet (Arizona Garden Roots) received a score of superior on the Reading Grade level, two fact sheets (35th avenue & CDC Fact Sheet) received an adequate score on the Reading Grade Level. The other nine fact sheets received a score of not suitable for the Grade Reading Level portion of the literacy demand section.

Two of the fact sheets (CDC & Garden roots) received a score of superior on the writing style portion of the literacy demand section. Eight of the fact sheets received a score of adequate on the writing style portion of the literacy demand section. Two of the fact sheets (General Contractors & UMASS) received scores of not suitable for writing style. The two fact sheets that received a superior score on the writing style were both infographics. Infographics make use of graphics to display the information as opposed to traditional paragraph formed material. Infographics make use of the graphics displayed and only include the necessary verbiage needed

to convey the message. The new fact sheet should consist of a hybrid infographic and traditional fact sheet to make use of the strengths of both versions of fact sheets.

Only one fact sheet (Garden Roots) received a superior score on the vocabulary portion of the literacy demand section. The 35th Avenue and CDC lead fact sheet both received an adequate score on the vocabulary section of the literacy demand section. The remaining nine face sheets all received a score of not suitable on the vocabulary portion of the literacy demand section. The majority of the fact sheets received such a low score on the vocabulary portion because they tended to use college-level vocabulary and technical jargon that wouldn't be recognized by the average American. Some public health officials find it difficult to portray information in the common vernacular as opposed to the vernacular they are used to relaying information. The newly revised fact sheet should make use of a vocabulary that anyone with a sixth-grade education could understand.

All of the fact sheets received an adequate score on the sentence construction portion of the literacy demand section of SAM. The scores are all adequate because they make use of traditional sentence structures used in scientific writing and they are structured so that the information flows from one topic to another easily. The newly revised fact sheet should follow the previously revised fact sheet's sentence structure.

Only four of the fact sheets received a score of superior on the Learning Enhancement portion of the literacy demand section. The remaining eight fact sheets received a score or adequate on the learning enhancement portion. None of the face sheets received a score of not suitable. Each fact sheet made the best use of the learning enhancements in their respective information section. There was little or no doubt where the information was leading the reader.

The newly revised fact sheet will make use of the same road signs used in the learning enhancement of the literacy demand section of SAM.

The remaining scores for the SAM section are in one section. This section contained relevance of illustrations, layout, typography, and desired behavior patterns. Only two fact sheets (CDC & Colorado) received a superior score on the relevance of illustrations. Three of the fact sheet received an adequate score on the relevance of illustrations. The remaining seven fact sheets received a score of not suitable on the relevance of illustrations. The seven fact sheets that received the low score were due in part to the fact that either they had no illustrations or the illustrations they used were not relevant to the information conveyed. The illustrations in the seven low scoring fact sheets were typical clip art pictures used as filler for an otherwise unnecessary image in the fact sheet. The newly revised fact sheet should utilize necessary and pertinent images as to direct the reader towards the information that they need to know and not misdirect or mislead them into information they do not need to know. As previously stated, the newly revised fact sheet will be an infographic/traditional fact sheet hybrid.

The next portion of the SAM assessment was to determine what the average number of characters and spaces for each fact sheet. The average number of characters and spaces ranged from 4 to 174 per sentence. There was a direct correlation between the average number of characters and spaces in each fact sheet and that fact sheets Flesch-Kincaid score. The lower the average number of characters per sentence also had a lower Flesch-Kincaid score and vice-versa. Figure 4.12 summarizes the findings of these two scores. The new fact sheet should have a low amount of characters and spaces as its going to be an infographic/traditional fact sheet hybrid. Along with the other factors in the creation of the new fact sheet, the newly revised fact sheet should receive a low Flesch-Kincaid score.

Reading Level & Sentence Length

The average number of characters per sentence in each fact sheet was compared to each fact sheets Flesch-Kincaid Reading Level Score. The graph below is not a statistical test, but a scatter plot showing the relationship between reading level and sentence length.

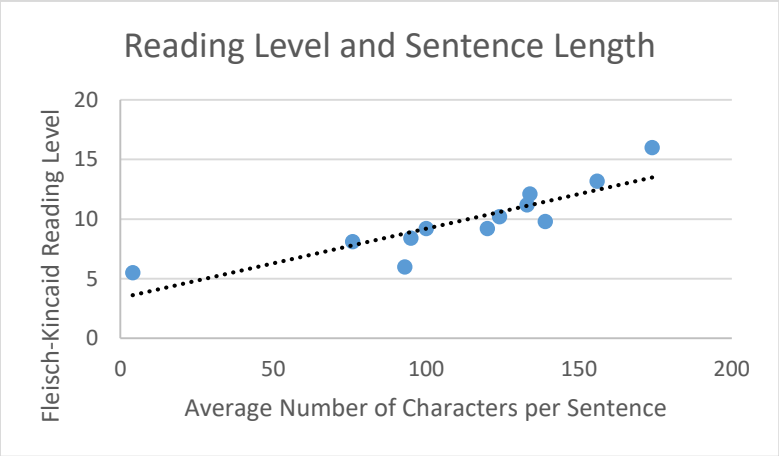


Figure 4.12 Correlation of Sentence Length & Reading Level

Chapter V

Discussion and Conclusion

Discussion

The United States Environmental Protection Agency began monitoring lead and other contaminants in residential properties the 35th Avenue district of Northern Birmingham in October of 2012. The EPA sampled eleven-hundred homes for lead and other contaminants, and in 2014 the EPA began cleanup on 400 sites. Residents have refused cleanup here and in other sites such as the Colorado smelter site and the Omaha City Superfund site due to lack of knowledge of the harms of lead poisoning, general mistrust of government agencies, or apathy. A complete and concise lead fact sheet for residents from the community outreach may

encourage the remaining residents to allow the EPA to sample and cleanup. Lead contamination and poisoning are serious threats that can adversely affect people's health and lives.

Major Findings

The study first asked what information is vital to the lead fact sheet. The literature review, background information, and readability tests helped determine that a lead fact sheet should contain information about the harms of lead poisoning, what to do if you think you are suffering from lead poisoning, and whom to contact in case of a lead poisoning emergency. The essential information of a lead fact sheet is:

- A description of lead and its physical and chemical traits
- A list of items that may contain lead around the house such as dirt, paint, toys, and some candy.
- Potential symptoms related to lead exposure
- Disposal and removal of potentially lead-contaminated items such as lead paint. Lead paint removal and disposal at local household hazardous waste collection sites.
- What to do if you believe that lead has contaminated your soil. Lead remediation of soil can be costly and take could take a great deal of time to accomplish.
- The EPA's or ATSDR's website for lead education should also be included

The review of literature indicated what facts a lead fact sheet needed to increase the likelihood that whomever is reading the fact sheet will understand the dangers of lead

contamination. The review of exposure routes deemed it necessary to include a list of items that may contain lead. The review of health effects shoed that it is necessary to include potential symptoms related to lead exposure. In the literature review, the methods to reduce lead exposure section showed what to do if you believe your yard has been contaminated with lead. All of these factors were carefully selected after intense literature review to increase the likelihood that a lead fact sheet contains all vital material necessary to warn people of the effects of lead poisoning.

The next question in the study directed itself at the reading level of each fact sheet and whether or not the majority of US citizens would be able to understand the material. The fact sheet must have a superior score on SAM and be written at the 6th-grade reading. Achieving a superior score on SAM and obtaining a 6th-grade reading level will increase the likelihood that 75% of adults in the US could comprehend the information provided (Doak et al., 1996). The fact sheets in this study had an average reading level of 9.9, and only one fact sheet received a superior score. Ten of the fact sheets received a score of adequate, and one fact sheet received a score of not suitable. The fact sheets received impressive scores on content and typography. The fact sheets overall scored poorly on the literacy demand section with exceptions in the sentence construction and learning enhancement factor sections. The fact sheets should be no more than one page in length to ensure that adults will read the entirety of the content. Any more than one page of material would leave the risk of important information not being read (Shieh & Hosei, 2008). Only two of the fact sheets were one page and the rest of the fact sheets contained more than one page. One fact sheet contained more than 17 pages.

Challenges

Addressing the public about lead and lead contamination has several difficulties, but getting the public to understand the dangers of lead contamination are among the most crucial The first is getting the public to understand the dangers of lead contamination. Many adults don't seem to think that lead contamination in the soil surrounding their household is dangerous as they typically don't play in it. However, a fact sheet that clearly states how lead from the soil can be tracked into the house from shoes could potentially raise concern. Levels may be small and may not cause an adult harm, but they could potentially be detrimental to children as their blood-brain barrier isn't as formed or complex as an adult.

Importance of Findings

The importance of this study was to determine what would be the necessary information for a lead fact sheet and is the information in the fact sheet written at a level which could be understood by a majority of adults. The background information and both the SAM and Flesch-Kincaid test revealed what information ought to be in a lead fact sheet, how long it ought to be, and what reading level an ideal fact sheet should maintain. By using these metrics, a public health official would be able to put together a fact sheet that would be easy to read by the greater part of a population.

Study Strengths

It has been proven time and time again when instructive resources are written at a 6th-grade reading level, the majority of adults in the US will understand them (Albright et al., 1996). The same studies have shown that when educational materials are written at a 9th-grade level or higher, they will not be understood by the reader (Hobbie, 1995). Additional studies have revealed that visual aids and illustrations can help enforce the information which in turn helps

the reader understand the material better (Anglin, 1987, Doak et al., 1996). Information obtained from the EPA, ATSDR, CDC, and other websites have all shown the same basic information on the hazards of lead and lead contamination.

Study Limitations

Results from the SAM assessment are subjective. The SAM assessment tool (found in Appendix A) relies on the reader to score based on their reading apprehension. As reading apprehension can vary from one person to another, SAM scores can vary from reader to reader. This study only used one reader and results may be biased. Future studies should use more than one reader to eliminate bias. However, the SAM scores and Flesch-Kincaid scores showed a direct correlation (Fig 4.12), so the results from this paper should be accurate.

Recommendations

Fact sheets should be analyzed with both the Flesch-Kincaid analysis and SAM. Analysis of the new fact sheet with both SAM and Flesch-Kincaid will assure that the majority of adults in the United States understand the material in the new fact sheet. To ensure a fair score, each fact sheet should be reviewed by different readers to ensure a truly unbiased SAM score. Using these recommendations will ensure that the new lead fact sheet will be useful to the public.

Conclusion

Fact sheets are an affordable way to inform the public about lead and lead contamination. Fact sheets can be used in the event of a response to inform the public about what the EPA or another government agency is doing there as well as serve as a tool help prevent any further contamination and for prevention. The lead fact sheet should contain information on lead

and its physical and chemical traits, a list of items that may contain lead around the house such as dirt, paint, toys, and some candy, potential symptoms related to lead exposure, disposal, and removal of potentially lead-contaminated items such as lead paint. Lead paint removal and disposal at local household hazardous waste collection sites and not just thrown away in the garbage, what to do if you believe that lead has contaminated soil or water. Lead remediation of soil and or water can be costly and take could take a great deal of time to accomplish. The fact sheet should be understood by the majority of adults, score high on SAM, and be one page in length. By following these steps, a new fact sheet can be will be a useful metric to help educate the public on the dangers of lead contamination.

New Lead Fact Sheet

What is Lead?

- Lead is naturally occurring metal in the environment.
- Sometimes large amounts of lead can pollute the water and soil around your home.
- However, small amounts of lead can make you sick, even if you can't see it.

Lead Contamination

- Lead can pollute your home, yard soil, and drinking water.
- There are many ways that lead can pollute your home, yard, and water.
- Paint, candy, and toys may also be polluted with lead.
- Do not remove items believed to have lead in them yourself, contact the EPA for suggestions on lead remediation.

Symptoms of Lead Exposure

- Symptoms can differ in children & adults
- Symptoms for Children:
    - Vomiting
    - Tiredness
    - Irritability
    - Weight loss
- Symptoms for Adults:
    - Headache
    - Muscle & Joint Pain
    - High blood pressure
    - Memory loss

Who to call if you think you have been exposed

- If you believe you have been exposed contact your local hospital immediately
- If you believe there is contamination on your property, contact the EPA or ATSDR immediately.
- The EPA can be contacted at https://www.epa.gov/lead/forms/contact-us-about-lead
- The ATSDR can be contacted at https://www.atsdr.cdc.gov/

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