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Patron: Mielke, Howard

Journal Title: Journal of environmental science and health. Part A, Environmental science and engineering.

Volume: 29 **Issue:** 5
Month/Year: 1994 **Pages:** 909-919

Article Author:

Article Title: BRINKMANN,; LEAD POLLUTION IN SOILS IN MILWAUKEE COUNTY, WISCONSIN

Imprint: [New York, M. Dekker]

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LEAD POLLUTION IN SOILS IN MILWAUKEE COUNTY, WISCONSIN

Keywords: lead, soil contamination, pollution, Milwaukee

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ABSTRACT

An analysis of 372 samples collected throughout Milwaukee County, Wisconsin demonstrates that a significant lead pollution problem exists. A summary of the data broken down by neighborhood reveals that lead contamination is greatest in the Central City neighborhood of the Milwaukee County and that the magnitude and extent of the pollution decreases away from the Central City toward the suburban fringe. It is important to note, however, that soil samples containing hazardous levels of lead were found in all neighborhoods of the county. These data suggest that although lead is concentrated in the central portions of cities, lead education, abatement, and monitoring may be necessary in all portions of cities. This suggested approach is in conflict with current strategies of lead monitoring that target one geographic area or that select a population for monitoring based upon socioeconomic status.

INTRODUCTION

Lead pollution in soil has been studied in a number of cities including Cincinnati (1), Toronto (2), Washington D.C. (3), Minneapolis, St. Paul, and Duluth (4,5,6, and 7), and New Orleans (8). In all of these cities lead was found in levels hazardous to human health. Most of these reports focus on certain neighborhoods or sections of the cities. Often, the studies are undertaken in the central portion of cities, places often correlated with older neighborhoods or with a high percentage of minority residents. Although in most of the cited studies, large portions of the cities were analyzed, none focused on lead in soil throughout the entire urbanized setting. It is the goal of this paper to demonstrate that lead pollution exists throughout all portions of an urbanized county. As expected, the highest concentrations of lead are found in the most central neighborhoods of the city.

METHODS

In order to assess the lead pollution problem in Milwaukee County, Wisconsin, a program of subsidized soil lead testing was undertaken by the University of Wisconsin-Milwaukee Soils and Physical Geography Laboratory in the Department of Geography (Figure 1). Area residents were informed by newspaper and television reports that the laboratory would analyze lead for a cost of \$3.00. The public was encouraged to collect the soil samples from the upper inch of soil in areas covered by bare ground or from gardens adjacent to a house or a garage. Once the samples were taken to the laboratory, they were air dried, gently ground using a mortar and pestle, and sieved through a 1 mm mesh screen. Lead was extracted from a 1.0 gram soil sample using a dual extraction of 1:1 HNO_3 with 30% H_2O_2

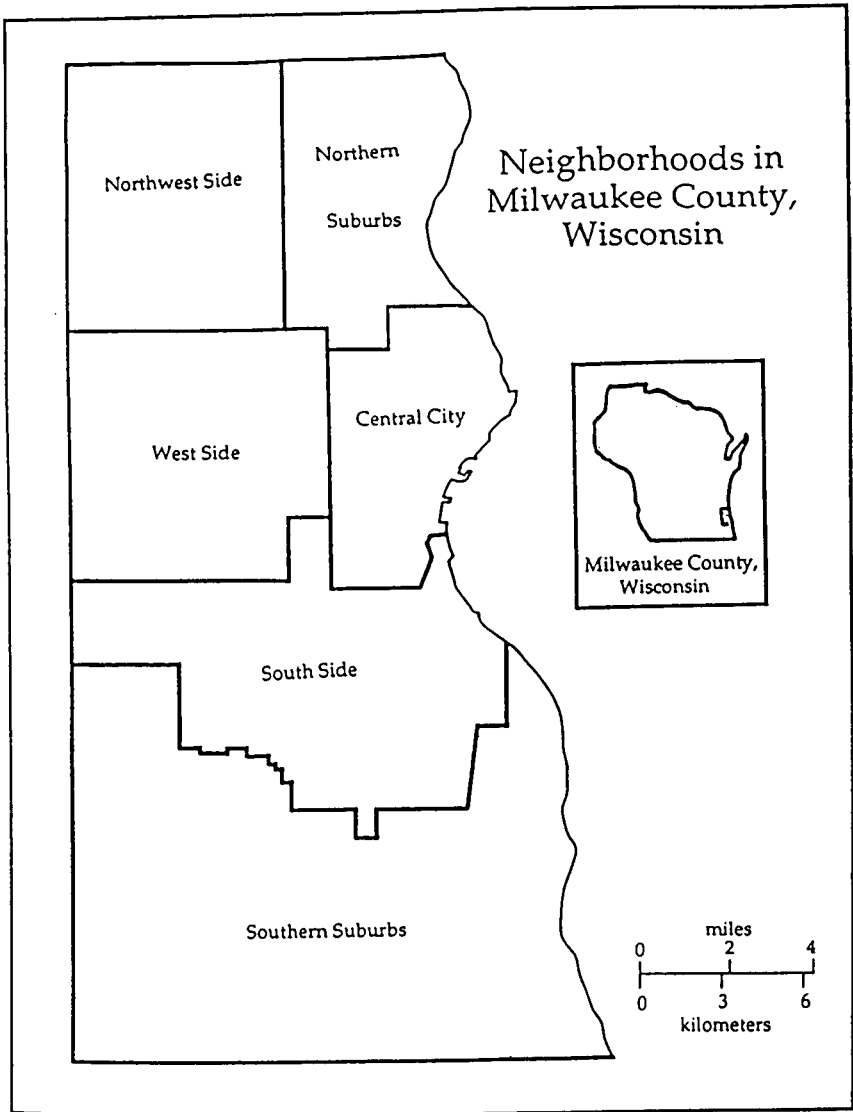


FIG 1. Neighborhoods in Milwaukee County, Wisconsin.

followed by 1:1 HCl. The extraction procedures aggressively remove lead from the soil and place it into an acid solution and are similar to those outlined by McGrath and Cunliffe (9). Statistical analysis of the data was performed using methods suggested by Sinclear (10) and Davies (11).

RESULTS

Summary statistics of the lead content in soils are listed in Tables 1, 2, and 3.

Three-hundred and sixty-four samples were collected in Milwaukee County. The range of lead levels in $\mu\text{g/g}$ is shown in Table 1. To aid interpretation, the results are subdivided by neighborhood. The summary statistics for the sample population are displayed in Table 2. The values are summarized for the entire county and by county neighborhoods. Statistical treatments of the transformed data are shown in Table 3.

Of the 372 samples, 283 (76%) were found to be less than 500 $\mu\text{g/g}$, a level set as hazardous to human health by the Centers for Disease Control. Eighty-one samples (24%) contained levels of lead of more than 500 $\mu\text{g/g}$ lead (Table 1). The lead content ranged from 0-8800 $\mu\text{g/g}$. The quartile values are 60 $\mu\text{g/g}$, 160 $\mu\text{g/g}$, and 460 $\mu\text{g/g}$ (Table 1). The mean of all samples was 440 $\mu\text{g/g}$ with a median of 160 $\mu\text{g/g}$. (Table 2). The standard deviation was 880. The sample population was not normally distributed. For this reason, the data were transformed using a base 10 logarithmic transformation. Transformations of these types are typically completed prior to statistical analysis of geographic samples of contaminated soils. When the data are transformed the mean is 2.10 (126 $\mu\text{g/g}$) and the

TABLE 1

The range of soil lead levels of the sample population of soils collected adjacent to homes in Milwaukee County, Wisconsin. Lead values are summarized for the entire county and by neighborhood.

Range of lead levels in $\mu\text{g/g}$

<500 N>500 & <1000 N>1000 % <2000 >2000

All Samples

N	283	48	25	16
%	76	13	8	4
Quartiles		1	2	3
		60	160	460

Central City

N	80	21	14	8
%	65	17	11	7

West Side

N	70	12	7	4
%	75	13	8	4

Northern Suburbs

N	74	6	2	0
%	90	7	2	0

South Side

N	27	9	1	3
%	68	23	3	8

Southern Suburbs

N	21	0	1	0
%	95	0	5	0

Northwest Side

N	11	0	0	1
%	92	0	0	8

TABLE 2

Non-transformed summary statistics of soil lead levels measured in soil samples collected adjacent to homes in Milwaukee County, Wisconsin. Lead values are summarized for the entire county and by neighborhood.

	N	Range ($\mu\text{g/g}$)	Mean ($\mu\text{g/g}$)	Median ($\mu\text{g/g}$)	Standard Deviation ($\mu\text{g/g}$)
All Samples	372	0-8800	440	160	880
Central City	123	0-7220	640	280	1000
West Side	93	0-8800	520	200	1100
Northern Suburbs	82	0-1680	157	60	260
South Side	40	0-3860	510	240	745
Southern Suburbs	22	0-1780	140	40	380
Northwest Side	12	0-3200	340	100	900

TABLE 3

Log-transformed summary statistics of soil lead levels measured in soil samples collected adjacent to homes in Milwaukee County, Wisconsin. Lead values are summarized for the entire county and by neighborhood.

	Mean	Median	Standard Deviation
All Samples	2.10	2.20	0.87
Central City	2.44	2.45	0.67
West Side	2.21	2.30	0.81
Northern Suburbs	1.63	1.78	0.89
South Side	2.28	2.38	0.81
Southern Suburbs	1.29	1.60	0.99
Northwest Side	1.87	1.95	0.77

median is 2.20 (158 $\mu\text{g/g}$). The standard deviation is 0.87 (Table 3).

Tables 1, 2, and 3 display the results of the analysis of lead content of soils broken down by the neighborhood in which they were collected. Most of the samples were collected from the Central City, West Side and Northern Suburbs. South Side, Southern Suburbs, and Northwest Side residents did not respond to the request for samples to the extent that other residents responded.

Central City. Of the 123 samples collected in this downtown portion of Milwaukee, 43 (35%) were found to contain over 500 $\mu\text{g/g}$ of lead. The lead content of the sample suite ranged from 0 to 7220. The transformed mean and median of the population is 2.44 (275 $\mu\text{g/g}$) and 2.45 (282 $\mu\text{g/g}$) respectively.

West Side. A total of 93 samples were collected in this residential portion of Milwaukee. The range in the lead content of this sample suite is 0 to 8800 $\mu\text{g/g}$ within which 23 (25%) contain over 500 $\mu\text{g/g}$ of lead. The transformed mean and median of this population are 2.21 (162 $\mu\text{g/g}$) and 2.30 (200 $\mu\text{g/g}$).

Northern Suburbs. In this older, suburban portion of Milwaukee County 82 samples were collected. Only eight samples (10 %) within the suite contain more than 500 $\mu\text{g/g}$ lead. The amount of lead in the samples range from 0 to 1680 $\mu\text{g/g}$. The transformed mean and median are 1.63 (43 $\mu\text{g/g}$) and 1.78 (60 $\mu\text{g/g}$) respectively.

South Side. Forty samples were collected in this older, residential/industrial Milwaukee neighborhood. Of these, thirteen (32 %) contain more than 500 $\mu\text{g/g}$ of

lead. The range of lead within this suite is 0-3860 $\mu\text{g/g}$ and the transformed mean and median are 2.28 (191 $\mu\text{g/g}$) and 2.38 (240 $\mu\text{g/g}$).

Southern Suburbs. A total of twenty-two samples were collected in this newly developing portion of Milwaukee County. Here, only one sample contains over 500 $\mu\text{g/g}$ lead. The range of lead within this area is 0 to 1780 $\mu\text{g/g}$. The transformed mean is 1.29 (19 $\mu\text{g/g}$) and the transformed median is 1.60 (40 $\mu\text{g/g}$).

Northwest Side. Twelve samples were collected in this newly developed portion of Milwaukee County. One sample contains over 500 $\mu\text{g/g}$ of lead. The lead content of soil samples in this suite ranges from 0-3200 $\mu\text{g/g}$. The transformed mean is 1.87 (74 $\mu\text{g/g}$) and the transformed median is 1.95 (89 $\mu\text{g/g}$).

DISCUSSION

One of the assumptions often made by researchers of lead pollution in cities is that lead is predominantly located in older, central portions of cities. This study was undertaken, in part, to test this assumption. The data obtained in this study demonstrate that lead contamination is concentrated in the older central portion of Milwaukee County, but that hazardous levels of lead are present to some degree throughout all urbanized portions of the study area. The number of contaminated samples and the magnitude of the contamination decreases from the Central City portion of Milwaukee to the suburban fringe.

The assumption that lead pollution in cities is located in older, central portions of cities is proven partially true in this study. Certainly most of the contamination is present in the portion of Milwaukee

where most researchers would expect such pollution. However, it is important to note that soil lead contamination is present in residential areas throughout the county and that one cannot delineate lead-free zones.

These data are significant in that they provide a regional analysis of the location of soil lead data collected in an urban area. Current public health policy in many municipalities focuses lead abatement strategies in older neighborhoods in the central portions of cities and lead screening based upon demographic criteria such as income or race. In light of the data presented in this paper suggesting that lead pollution is a problem in all neighborhoods of cities, this approach may need modification in order to fully assess lead contamination problems in urbanized areas.

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Date Received: January 20, 1994

Date Accepted: February 25, 1994