NATIONAL BUREAU OF STANDARDS REPORT

10 499

THE NATURE OF THE LEAD PAINT POISONING HAZARD

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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THE NATURE OF THE LEAD PAINT POISONING HAZARD

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Abstract

This report describes the nature and extent of the lead paint poisoning problem in the United States as described in current literature and in conversations with recognized experts. The report contains 1) a description of the disease, 2) a report on the geographical extent, 3) a list of the environmental factors associated with lead poisoning, and 4) a description of the characteristics of the population most susceptible to lead poisoning.

THE NATURE OF THE LEAD PAINT POISONING HAZARD

Introduction

Lead poisoning resulting from the ingestion of lead based paint is a serious illness that has recently been recognized as a major pediatric disease. In January 1971, Congress enacted the "Lead Based Paint Poisoning Prevention Act" to provide federal assistance to help eliminate this disease. Title III of this act calls for research to determine the nature and extent of this problem. This research will be coupled with analysis of lead detection procedures and removal methods to provide a set of recommendations that will form the basis for future action against lead poisoning.

In order to assess the nature and extent of the lead paint poisoning hazard it has been necessary to review published literature and to talk to knowledgeable people working in the field. Particular emphasis has been on determining those factors which identify the characteristics of residents and housing which cause and/or accompany lead poisoning. This task has been made more difficult by the fact that the extent of lead poisoning in children in the United States has only recently begun to be evident and the experts disagree on many important issues. Most testing and treatment programs have been initiated and funded at the city level although in the last few months some states and the federal government have started programs. All programs have suffered from lack of money with only the New York and Chicago ones funded at the level to do mass screening of large numbers of children. Therefore much of what is known today about the characteristics of housing and the population associated with lead poisoning is colored by the characteristics of those areas which have programs. However in this report we will attempt to describe those factors on which most of the experts agree and to indicate those others which are more controversial.

The Disease

Lead poisoning is a disease which primarily afflicts children 1 to 6 years old[1]*, although some cases of adult poisoning are reported. These latter fall mainly into two groups: industrial or work related, such as painters who have worked for many years with lead paints, and families poisoned from eating or drinking an acidic substance such as orange juice stored in a pottery container from which the acid leached lead contained in the glaze. Experts with whom we spoke in the cities of Philadelphia, New Haven, New York and Chicago all stated that, in their experience, more than ninety percent of the lead poisoning cases resulted from eating peeling, cracking or flaking paint or painted plaster inside their homes[2]. (Plaster itself does not contain lead but the upper layers absorb the lead-containing oil from paint.) Other sources of lead which have led to poisoning include putty and caulking, lead painted gutter pipes, fences,

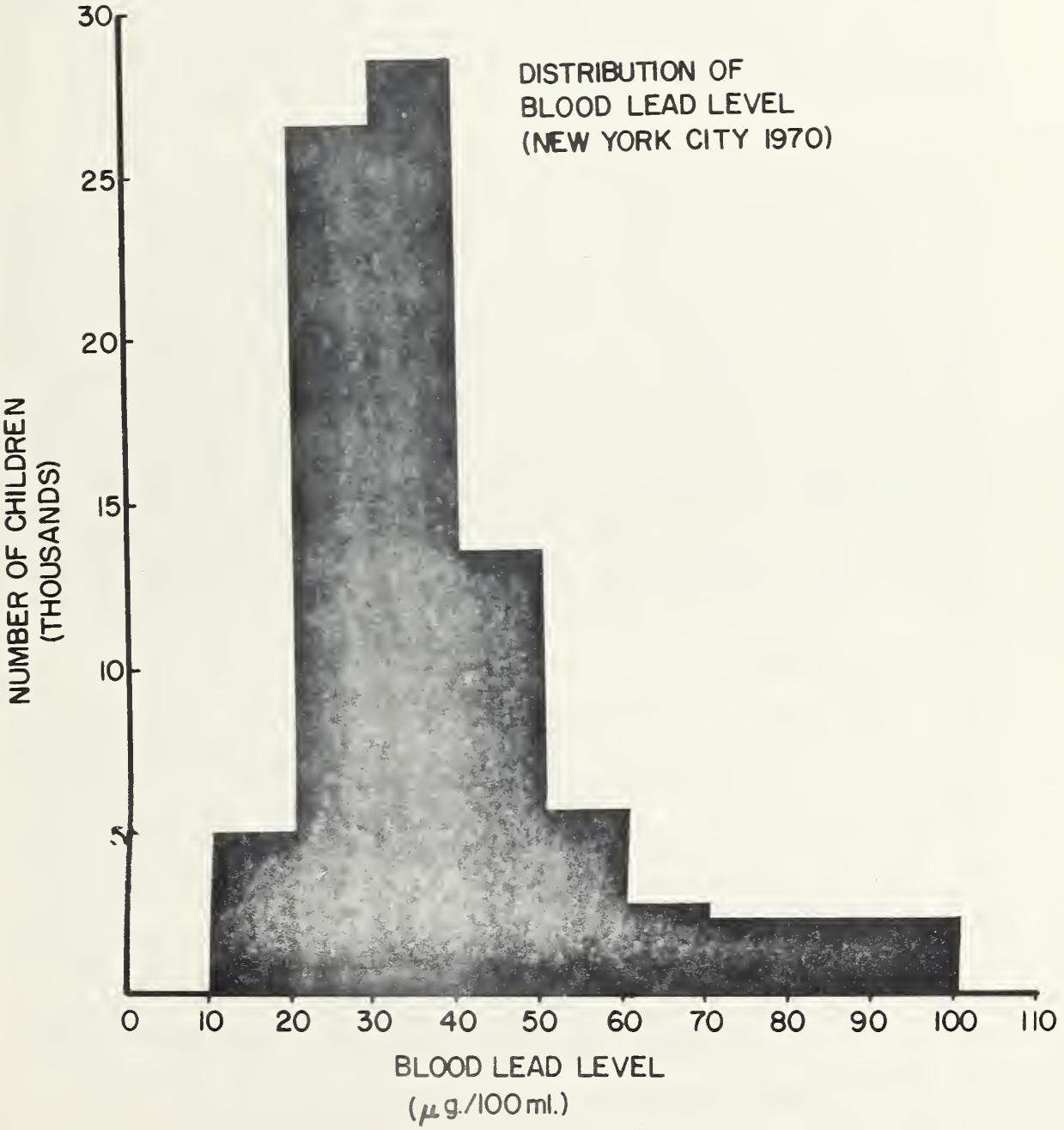
*These numbers used throughout the text of this report indicate footnotes which are contained in Appendix A.

and cheap imported toys, toothpaste tubes, lead shot in beanbags, fishing sinkers, pottery and automobile exhaust fumes. The experts believe that this latter, automobile exhaust fumes, is not a source of danger by itself but may raise the mean level of lead in the body so that it takes less from another source to cause acute poisoning[3]. It is known that the level of lead found in rural children is significantly less than that found in urban children[4]. However the experts all agree that cases of lead poisoning resulting from sources of lead other than residential paint are minor, and that ingestion of lead paint is far and above the greatest cause of lead poisoning.

The initial symptoms of lead poisoning are very vague and might be due to many other agents. They include anorexia, nausea and vomiting, abdominal pain, constipation, anemia, irritability, and lethargy[5]. If untreated the disease may lead to central nervous system involvement, termed lead encephalopathy, which may result in blindness, paralysis, and mental retardation. Cardiovascular and renal damage may result from the disease although the experts do not agree on this point[6]. Most experts believe that as much as 25 percent of all children who develop lead poisoning will suffer permanent brain damage[7]; although some experts would put this at a much higher figure. As many as five percent of the children who develop lead poisoning may die of the disease[8]. This figure is decreasing as a result of the efforts of early detection and treatment.

The physiology of lead poisoning is incompletely known and much study is being conducted on it. It is known that about 10 percent of lead ingested is retained in the soft tissues, blood and bones[9]. The average daily intake of lead by persons in the United States is estimated at 0.3 mg[10]. It should be noted that a single paint chip the size of a postage stamp may contain more than ten times this average daily dose. Experts have stated that a child must eat lead paint regularly for a period of at least three months before he has lead poisoning[11]. However, in conversation with Dr. J. Julian Chisholm of Baltimore City Hospital, he revealed that this time estimate is based on the assumption that oral activity begins at about 12 months and the youngest child he has seen with lead poisoning in Baltimore was 15 months old. Therefore it is not really known how much paint eaten over what time period will lead to lead poisoning.

The definition of lead poisoning itself varies from place to place. Some experts define it solely in terms of blood lead level, setting the cutoff at any point between 40 micrograms per 100 milliliters and 80 μg./100 ml. Others require symptoms of the disease to be present, while still others use a combination of blood lead level and symptoms[12]. Figure 1 shows the distribution of blood lead levels in children screened in New York City[13] It should be noted that New York screens primarily in high risk areas so this curve should not be interpreted as necessarily representing the distribution among all children in New York City.


DISTRIBUTION OF
BLOOD LEAD LEVEL
(NEW YORK CITY 1970)
NUMBER OF CHILDREN
(THOUSANDS)
30
25
20
15
10
5
0
10
20
30
40
50
60
70
80
90
100
110
BLOOD LEAD LEVEL
(μg./100 ml.)

Blood lead determination requires drawing about 5 milliliters of blood which is a large amount to be drawn from a small child. There are other tests, such as the ALA urine test, but none is as reliable as the blood lead test[14]. HEW is currently evaluating a micro-test which requires only a drop or two of blood which can be gotten by a finger prick. This should simplify screening and thus facilitate screening much larger numbers of children.

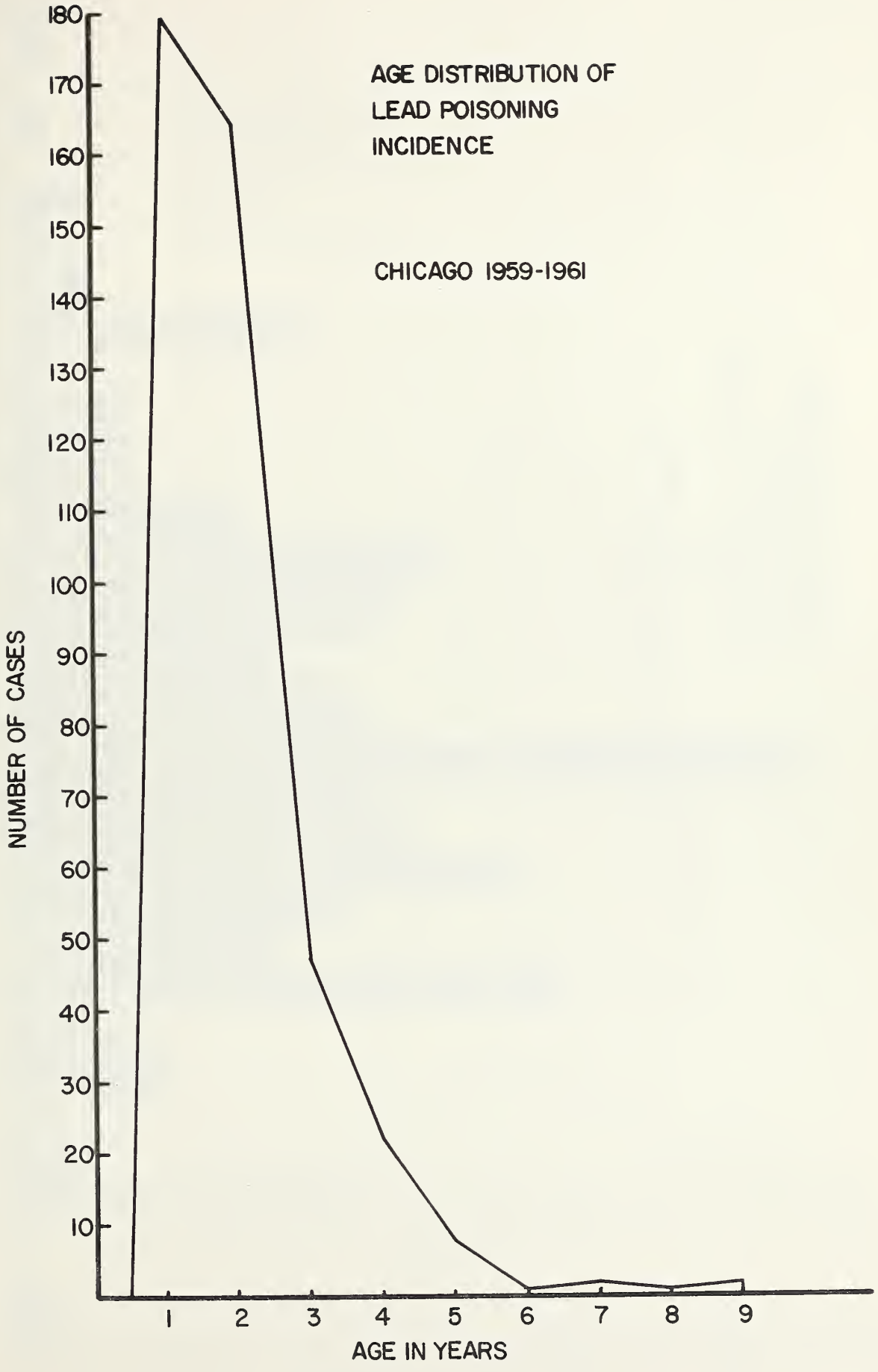
Lead poisoning occurs primarily in children between the ages of 1 and 6. Figures 2 and 3 show the distribution of the incidence of lead poisoning by age of child in Chicago and Philadelphia respectively[15]. About 85% of the cases of lead poisoning occur in children under 3 years of age[16] and Dr. Harold Jacobziner, former Assistant Commissioner, New York City Department of Health, estimates that 54 percent of all deaths occur in two year old children[17].

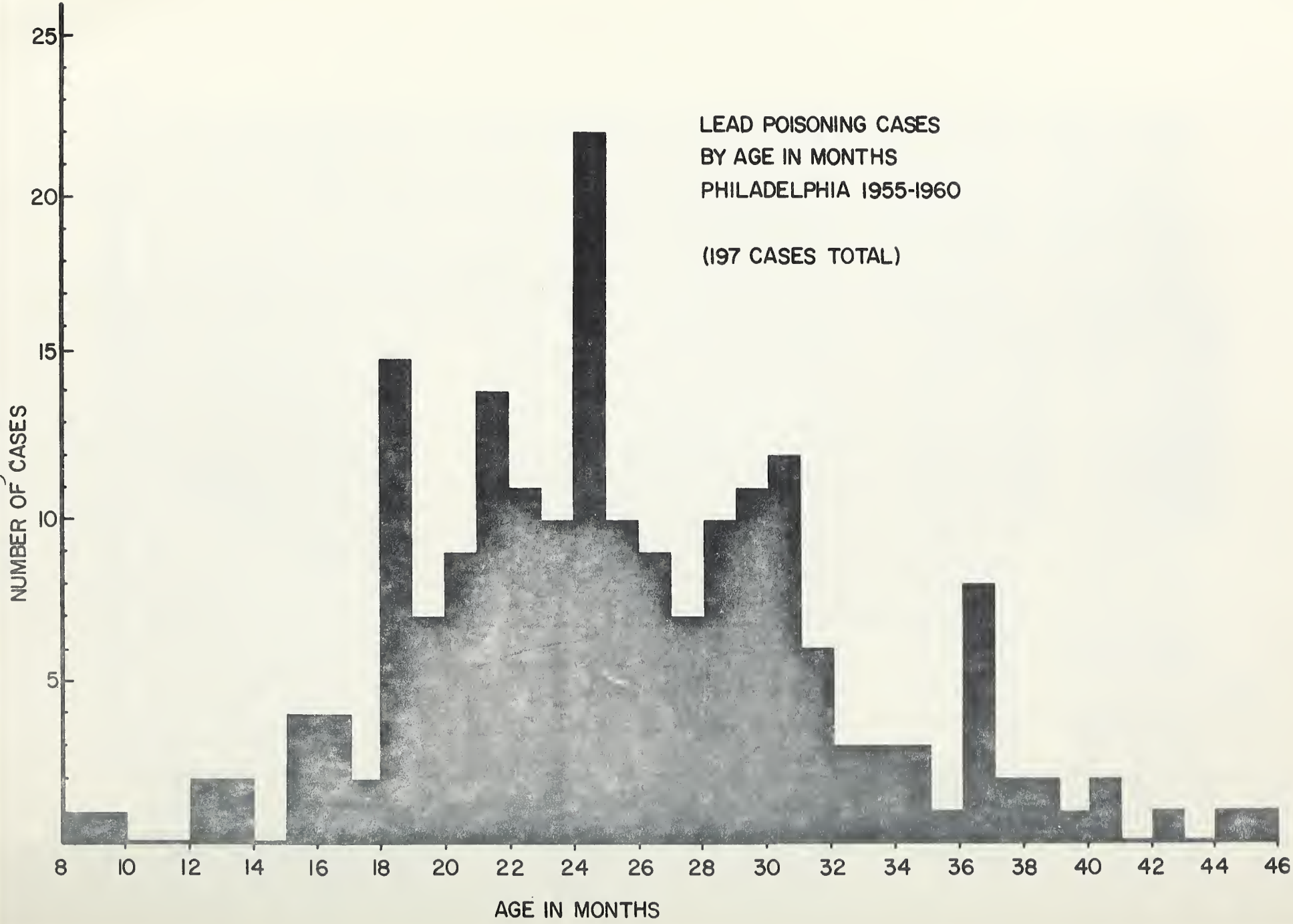
Although lead poisoning occurs all year round, a higher proportion of cases are found in the summer months than are found in winter. Figure 4 shows the distribution of lead poisoning by month of the year in Chicago[18]. In New York City from 1954 to 1964, 45 percent of the reported cases occurred between June and September[19]. The exact reason for this phenomenon is not known. It is probably in part due to the fact that most programs have more volunteers in the summer and can go out into the community to screen for the disease. In addition there is some speculation that there is a relationship between the amount of ultraviolet rays and increased absorption of lead[20]. Lead follows the same metabolic path as calcium which is absorbed more in the presence of ultraviolet light. Some experts have also hypothesized that lead stored in bone tissue is released into the blood under the stimulus of ultraviolet light. The exact physiological reactions are not yet understood, but there does seem to be evidence of a correlation between blood lead levels and ultraviolet light. Whatever the cause, physiological or social, the incidence of reported lead poisoning rises in the summer.

Geographical Extent

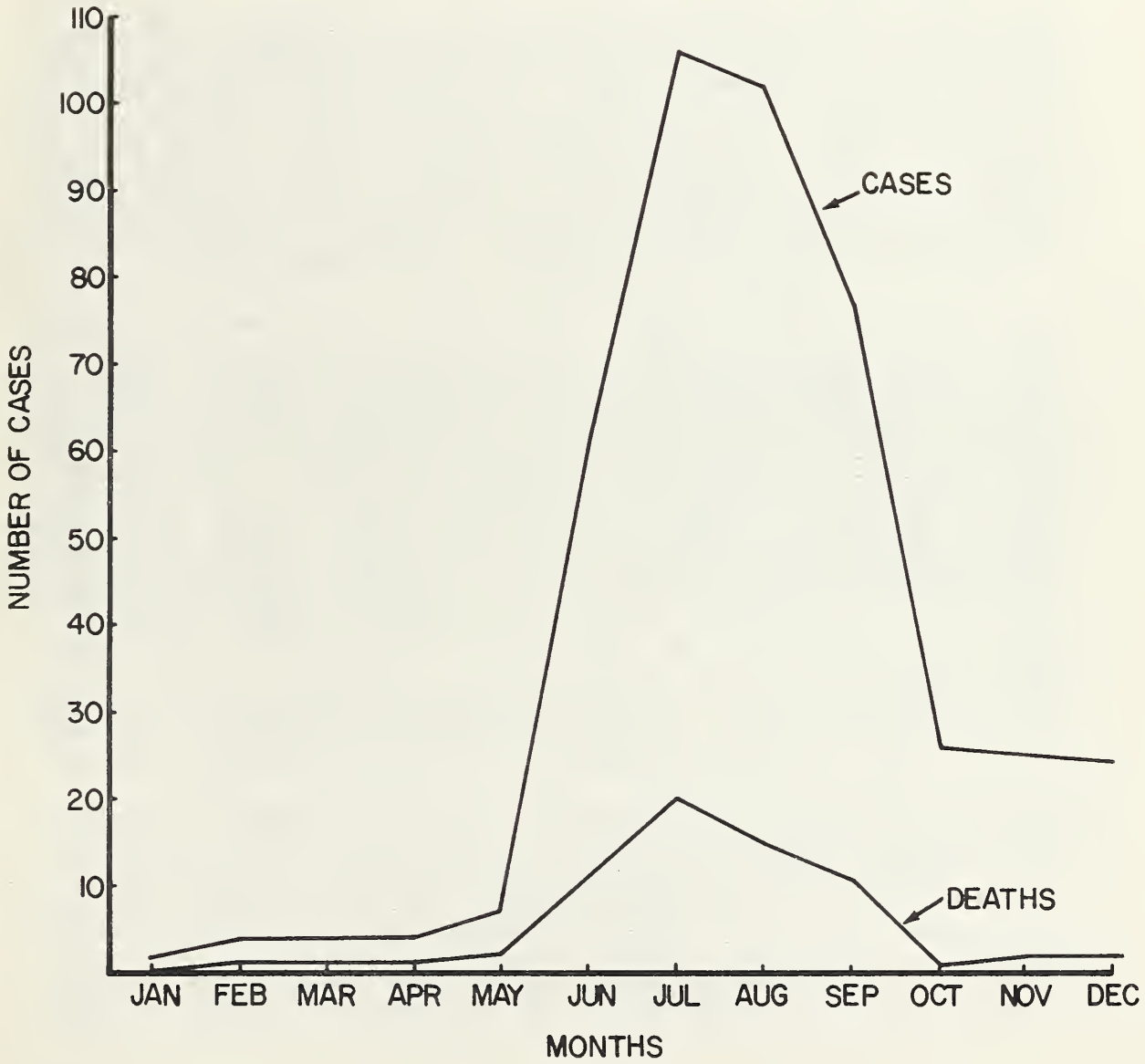
Since lead poisoning has only recently been recognized as a major childhood problem there are only a few city programs which have been in existence long enough to produce meaningful data on the incidence of lead poisoning. Project staff visited people in Washington, D.C., Baltimore, Philadelphia, New Haven, Chicago, New York City, and the State of Illinois. Of these programs only Chicago and New York have large scale screening efforts, although New Haven did some screening in 1970 and the State of Illinois has recently begun a small scale screening effort in 10 cities. HEW has just started a program, screening 50 to 100 children and testing at least 25 homes in each of 28 cities throughout the nation.

All of the screening programs pre-select children to be screened on the basis of various assumptions about what constitutes a high-risk area,


AGE DISTRIBUTION OF
LEAD POISONING
INCIDENCE
CHICAGO 1959-1961
NUMBER OF CASES
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
AGE IN YEARS


LEAD POISONING CASES
BY AGE IN MONTHS
PHILADELPHIA 1955-1960
(197 CASES TOTAL)
NUMBER OF CASES
25
20
15
10
5
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
AGE IN MONTHS

DISTRIBUTION OF
LEAD POISONING CASES
BY MONTH
CHICAGO (1959-1961)



usually innercity poverty areas. It is therefore difficult to assess the nationwide magnitude based on representative screenings from all economic levels of society and from all locations of residence.

Estimates of the fraction of high-risk children (those between 1 and 6 who live in an environment where lead paint chips are easily available to them) with elevated blood lead levels vary from below 5 to 25 percent[21]. New York estimates 3 percent of the children first tested have blood lead levels of more than 50 μg/100 ml[22]. Chicago estimates it is finding 10 to 15 percent with more than 40 μg/100 ml[23]. These figures illustrate one of the great problems of comparing data obtained from different cities, namely the difference in the definition of cutoff blood lead level. Acual treatment of children differs more markedly since this is usually determined by individual physicians.

Lead poisoning has been described as an "iceberg problem", only a small part of it is visible and most lies hidden under the surface to be discovered when one ventures close[24]. It is true that every city which has initiated a lead poisoning screening program has had a dramatic increase in reported cases as a result. Because the early symptoms are so vague and can be mistaken for other common illnesses, lead poisoning is often overlooked or misdiagnosed. As physicians and laymen become more conscious of the disease it can be correctly diagnosed at an earlier stage and treatment initiated before permanent brain damage occurs.

Lead poisoning has been thought of as primarily a disease of the large urban centers of the Northeast. Although reported incidence figures to date indicate this area still produces the greatest number of cases, screening programs in other regions of the country are also finding significant levels of lead poisoning[25]. It is found not only in the large cities such as New York and Chicago but in the smaller cities such as Aurora, Illinois and Nashua, New Hampshire. HEW has tested children in Denver, Colorado, and found it in this region also. During the month of October, HEW will be testing in several west coast cities also, although now the disease has been thought not to exist west of the Mississippi. HEW has so far found lower incidence in the West in areas similar to Eastern high risk areas, but some lead poisoning is still found there. The reasons for this lower incidence rate are unknown. Possibly less lead paint was used there or maybe climatic conditions lead to less peeling and chipping paint. At this time incidence rates for the Far West are unknown and differences between west and east are unexplained.

Many areas in the East and Midwest, which have environments similar to those of the Chicago and New York areas which have a high incidence of lead poisoning, have not yet noticed lead poisoning, but may actually have the problem. A recent case in point occurred in Aurora, Illinois[26]. The state is screening in selected neighborhoods in several Illinois cities. The local public health officer in Aurora was quoted as saying there was no lead poisoning problem in his city. Ninety children were

found to have elevated blood levels, five were high enough to require hospitalization and one of these has since died. It is thus probable that in most areas where peeling and chipping lead painted surfaces are accessible to children, there is likely to be lead poisoning whether it has been found before or not.

Environmental Factors

The most critical environmental characteristic is the presence of lead based paint. Before 1940 lead based paint was the main good quality interior paint and most buildings built before 1940 and painted at all will contain lead. Titanium-based paints started becoming popular in the 40's but it was not until 1955 that the American Standards Association (now ANSI) adopted a voluntary standard eliminating lead based paint for interior use[27]. Since then many municipalities have enacted laws prohibiting the sale of paints containing more than one percent lead for interior use. These laws also prohibited the use of paint containing more than one percent lead on toys or children's furniture. Some laws also required leaded paints to be labeled with a warning that they should not be used on surfaces accessible to children[28]. In spite of these regulations a sampling in August 1971 of 76 interior paints then being sold in New York City showed that eight, or approximately 10 percent, contained more than one percent lead[29]. As late as 1960, Federal Housing Projects in Boston were required to have lead-base paint on interior walls. In this case, however, inspectors found that the contractor had used a cheaper grade of paint which did not contain lead[30].

Although there are laws prohibiting the sale of lead-based interior paints, exterior paint may contain lead. Homeowners may use left-over paint labeled "For exterior use only" on interior surfaces, or they may buy surplus paint whose contents they do not know. Voluntary standards and unenforced laws do not assure that lead paint is not used on interior surfaces. In addition even if interior surfaces are not painted with lead based paint, exterior surfaces, to which the laws do not apply, may be painted with lead paint. Children, therefore, who have access to peeling and chipping paint on porches and exterior window sills are exposed to the danger of lead poisoning.

Many authorities believe that housing built before 1940 offers a potential lead poisoning hazard because most will contain some interior lead paint[31]. The city of Philadelphia estimates that 80 percent of its 650,000 dwelling units were built before 1940 and thus may be expected to contain lead paint[32]. Of those units built between 1940 and 1955, authorities suggest that about 40 percent, may offer a hazard[33]. Although some of those built after 1950 may have lead paint these are believed few in number and are ignored in preliminary estimates. Thus, these figures may, slightly underestimate the potential hazard.

Although any house containing lead based paint is a potential hazard, the greatest danger is presented by those homes where lead paint is peeling or flaking and is thus easily accessible to a child. The high risk

situation is thus a deteriorating or dilapidated house that was built when lead based interior paints were in use. Exposed lead painted areas, such as window sills and doors which present a chewable surface to a child also represent an immediate danger. According to the 1960 census, of the 30.6 million occupied housing units constructed before 1939, 5.6 million were deteriorating and 1.8 million were dilapidated. Therefore allowing for the destruction of some units by urban renewal and the deterioration of other units, about 7 million dwelling units are in a dilapidated or deteriorating state. In Chicago 750,000 of the 1,200,000 dwelling units were built before 1950, and the city estimates that 200,000 of these units are dilapidated. Few of these units are now owner occupied. Most are rented, often from a marginal landlord who cannot afford to make major repairs[34].

All this does not mean that all dilapidated housing will contain lead paint. One would not find it for example, in the unpainted shacks of the rural South. It also is not found in the tenements of New York's Lower East Side which were not painted with good quality paint since they have always been in a poor neighborhood[35]. In Philadelphia and Chicago many bedrooms and living rooms were wallpapered until after World War II, so that lead is found primarily in bathrooms and kitchens and on woodwork[36]. However, on the whole lead poisoning is closely associated with housing built before 1940 and now in a dilapidated state.

Population Characteristics

Children who have lead poisoning tend to come from families which are poor. Such families of course are the ones most likely to live in dilapidated housing. Few such families own their own homes. They live under crowded conditions, have a high transiency rate and have a low educational level. Because mothers in low income families are often heads of households and the sole or primary support of their family, their children are often left at home or with a baby sitter while the mother works, often with poor or inadequate supervision. In addition the crowded conditions, with many children competing for attention, mean that it is difficult for a mother to continuously guard a child against chewing on easily accessible paint chips.

However, not all children of such families living in dilapidated housing get lead poisoning. This fact brings us to one of the most controversial subjects associated with the lead poisoning problem, that is, the topic of pica which is an unreasonable craving for non-food substances such as dirt, matches, or paint. The extent of the influence of pica on lead poisoning is disputed by the authorities, some believing it all important, others believing it of little relevance[37]. The cause of pica is unknown. It was once considered to be evidence of a nutritional deficiency, but studies at Children's Hospital have failed to find a correlation between the two[38]. Instead they have found significant evidence of emotional disturbance resulting from family stress among the children with pica[39]. To

corroborate this the director of the lead poisoning prevention program in New Haven stated that children with lead poisoning almost always come from multi-problem families; that the public health nurse or community aid who visits the family to talk about lead poisoning usually finds unemployment, alcoholism, drug addiction or marital problems[40]. Doctors have also found a high cultural acceptance of pica among the mothers of children with pica. Eating clay and laundry starch is a habit of many mothers, particularly blacks born in the Southeastern United States. Many of these mothers when questioned about the substances their child eats, say "all children eat dirt".

Most cities which now have lead screening programs find an overwhelming proportion of their cases among the non-white population. Whether this is mainly because of the high correlation between being non-white and the recognized causal factors, such as dilapidated housing and low income, is not clear and will not be clear until mass screening is used on a wider scale. In New York, eighty-six percent of the cases of lead poisoning in 1969 were among children from black and Spanish-speaking families although children from these groups made up less than half of the city's population for that age range[41]. The director of the Philadelphia Lead Poisoning Control Program stated that there are areas of Philadelphia in which white families live in dilapidated housing but do not have lead poisoning, while black families living in equally deteriorated housing have a high incidence of lead poisoning. He attributed this difference to a high cultural acceptance of pica among blacks[42]. However Chicago's Appalachian whites exhibit this same cultural acceptance and also have a high incidence of lead poisoning[43]. Therefore, it is difficult to see race as a major causative factor. Since minority groups tend to be poor, to have a lower educational level, and to live in dilapidated housing, their children are unquestionably exposed to a greater risk than white middle-class children.

Conclusion

Lead poisoning resulting from the ingestion of lead based paint is a serious national problem affecting a significant number of children in all parts of the nation. Although once considered to be prevalent only in the large urban centers of the Northeast, recent studies have indicated it exists wherever young children live in old dilapidated housing, most of which was once painted with lead based paint. Existing data sources, however, only include lead poisoning incidence in the central cities. Children who get the disease are usually from families which are poorly educated, have a low income and are highly transient. Many such families have a female household head and are living under crowded conditions, and some have a high cultural acceptance of pica. The two main factors (1) low income multi-problem families and (2) dilapidated housing in urban areas combine to provide the atmosphere under which lead poisoning fluorishes.

APPENDIX A

Footnotes

1. (27)*
2. Conversations with Ray Tyler, Chief of the Accident Control Division, Philadelphia Department of Public Health, Mrs. Elaine Whitmire, Coordinator of the Lead Paint Poisoning Program, New Haven, Connecticut, Dan Still, Lead Poisoning Control Bureau, New York City, and Dr. Herbert L. Slutsky, Lead Program Coordinator, Chicago Board of Health.
3. (18)
4. (27)
5. (4), (18), (23), for example.
6. Freeman, Ronald, "Chronic Lead Poisoning in Children Diagnosed in Sidney, 1948-1967", The Medical Journal of Australia, March 1970.
7. (47), (27)
8. (47)
9. (11)
10. (11), (40)
11. (27)
12. (27) and conversations in New York, Philadelphia and Chicago.
13. (26)
14. (18), (9)
15. (13), (29)
16. (39)
17. (30)
18. (13)
19. (40)
20. (40) and conversations with Dr. Thomas Dolan, Director of the Pediatrics Clinic of Yale-New Haven Hospital and with Dr. Laurence Finberg, Chief of Pediatrics at Montefiore Hospital, New York City.
21. (27), (40)
22. Conversation with Dan Still of the Lead Poisoning Control Bureau of the City of New York.
23. Conversation with Dr. Herbert Slutsky on Chicago and (27).
24. (26) and conversations in New Haven, New York, Chicago, and Philadelphia.
25. Conversation with Dr. Jim Simpson of the Bureau of Community and Environmental Management of HEW.
26. Chicago Daily News, 8/3/71.
27. Lead Paint and Other Special Labelling, American Standard Specifications to Minimize Hazards to Children from Residual Surface Coating Materials.
28. (27) and copies of city laws for Baltimore, Chicago, Cincinnati, Jersey City, New Haven, New Orleans, New York City, Philadelphia, St. Louis, Washington, and Wilmington and state laws for California, Connecticut, Kansas and New York.

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* Numbers in parentheses () refer to references contained in Appendix B.

29. New York Times, 7/24/71.
30. Conversation with Irwin Billick of HUD.
31. (27), (28), (30), (47), (40)
32. Conversation with Ray Tyler in Philadelphia.
33. (18)
34. Conversations with Dan Still in New York, William Burke, Department of Buildings in Chicago, and Ray Tyler in Philadelphia.
35. Conversation with Dan Still in New York City.
36. Conversation with William Burke of the Department of Buildings in Chicago and Ray Tyler in Philadelphia.
37. Conversations in New York, Chicago, and Washington and (27).
38. Lourie, Reginald S., Emma M. Layman, and Frances K. Millican, "Why Children Eat Things that are Not Food", Children, Vol. 10, No. 4, July-Aug. 1963.
39. Also (44) and (15).
40. Conversation with Mrs. Elaine Whitmire in New Haven.
41. New York Times, 5/12/71.
42. Conversation with Ray Tyler in Philadelphia.
43. Conversation with Dr. Herbert Slutsky in Chicago.

APPENDIX B

Bibliography

1. Bachman, Gaylen D., Jacqueline M. Schwartz, and Vernon E. Weckwirth, "A Report on Lead Poisoning in Children and Youth Projects," Systems Development Project, School of Public Health, University of Minnesota, Oct. 1970.

2. Barltrop, Donald and N. J. P. Killala, "Factors Influencing Exposure of Children to Lead", Arch. Dis. Childh., Vol. 44, No. 476, Aug. 1969.

3. Bazell, Robert J., "Health Programs: Slum Children Suffer Because of Low Funding", Science, Vol. 172, May 1971.

4. Berg, J. M. and M. Zappella, "Lead Poisoning in Childhood with Particular Reference to Pica and Mental Sequelae", J. of Mental Deficiency Research, Vol. 8, June 1964.

5. Byers, R. K., "Lead Poisoning Review of the Literature and Report on 45 Cases", Pediatrics, Vol. 23, March 1959.

6. Challop, Roger, "Lead Poisoning in Children - National Evaluation Proposal", HEW, April 1971.

7. Chisolm, J. Julian, "Childhood Lead Intoxification: A Preventable Summertime Disease", Pediatrics Digest, Vol. 6, July 1964.

8. Chisolm, J. Julian, "Lead Poisoning", Scientific American, Vol. 224, No. 2, Feb. 1971.

9. Chisolm, J. Julian, "Treatment of Lead Poisoning", Modern Treatment, Vol. 4, July 1967.

10. Chisolm, J. Julian, "The Use of Chelating Agents in the Treatment of Acute and Chronic Lead Intoxification in Childhood", J. of Pediatrics, Vol. 73, No. 1, July 1968.

11. Chisolm, J. Julian and Harold E. Harrison, "The Exposure of Children to Lead", J. of Pediatrics, Vol. 18, Dec. 1956.

12. Chisolm, J. Julian and Eugene Kaplan, "Lead Poisoning in Childhood-Comprehensive Management and Prevention", J. of Pediatrics, Vol. 73, No. 6, Dec. 1968.

13. Christian, Joseph R., Bohdan S. Celewyez and Samuel L. Andelman, "A Three-year Study of Lead Poisoning in Chicago", AJPH, Vol. 54, No. 8, Aug. 1964.

14. Clark, Alan J. and George W. Hallett, "Lead Poisoning Survey--Portland Maine", J. of Maine Medical Association, Vol. 62, Jan. 1971.

15. Cohen, George J. and Walter E. Ahrens, "Chronic Lead Poisoning", J. of Pediatrics, Vol. 54, No. 3, March 1954.

16. Cohen, George J., Reginald S. Lourie, and William Abernethy, "Grand Rounds: Pica and Lead Poisoning", Clinical Proceedings Children's Hospital of the District of Columbia, Vol. XXI, Nos. 7 and 8, July-Aug. 1965.

17. Conn, Robert H. and Dudley Anderson, "D.C. Mounts Unfunded Program of Screening for Lead Poisoning", HSMHA Health Reports, Vol. 86, No. 5, May 1971.

18. "Control of Lead Poisoning in Children", HEW, PHS, BCEM, Dec. 1970.

19. Deeths, Tony M. and James T. Breeden, "Poisoning in Children--A Statistical Study of 1057 Cases", J. of Pediatrics, Vol. 78, No. 2, Feb. 1971.

20. "Facts About Lead and Pediatrics", Lead Industries Association Inc.

21. Fine, Philip R., "A Lead Poisoning Surveillance Program Proposal", Division of Disease Control, Illinois Department of Public Health, May 1971.

22. Fisher, Martha, "Lead Poisoning in Children", Journal of Housing, Vol. 6, 1970.

23. Greengard, Joseph, "Lead Poisoning in Childhood: Signs, Symptoms, Current Therapy, Clinical Expressions", Clinical Pediatrics, Vol. 5, No. 5, May 1966.

24. Griggs, Robert C., Irving Sunshine, Vaun A. Newill, Burritt W. Newman, Stuart Buchanan and Cleo A. Rasch, "Environmental Factors in Childhood Lead Poisoning", J. of the AMA, Vol. 187, No. 10, March 1964.

25. Guinee, Vincent F., "Lead Poisoning in New York City", paper presented at New York Academy of Sciences, Dec. 1970.

26. Guinee, Vincent F., "The Position of New York City on the Level of Appropriations for Control of Childhood Lead-Paint Poisoning", papers submitted to the Sub-committee on Labor and Public Welfare of the Senate Committee on Appropriations, July 1970 and July 1971.

27. "Hearing Before the Subcommittee on Health of the Committee on Labor and Public Welfare, U. S. Senate, Ninety-first Congress", Nov. 1970.

28. "Hearings Before the Subcommittee on Housing of the Committee on Banking and Currency", House of Representatives, Ninety-first Congress, July 1970.

29. Ingalls, Theodore H., Emil A. Tiboni, and Milton Werrin, "Lead Poisoning in Philadelphia 1955-1960", Archives of Environmental Health, Vol. 3, Nov. 1961.

30. Jacobziner, Harold, "Lead Poisoning in Childhood: Epidemiology, Manifestations, and Prevention", Clinical Pediatrics, Vol. 5, No. 5, May 1966.

31. Jacobziner, Harold and Harry W. Raybin, "The Epidemiology of Lead Poisoning in Children", Archives of Pediatrics, Feb. 1962.

32. Jacobziner, Harold and Harry W. Raybin, "Lead Poisoning in Young Children - Fatal and Nonfatal", N. Y. State J. of Med., Jan. 1960.

33. Jenkins, C. David and Robert B. Mellins, "Lead Poisoning in Children--A Study of Forty-six Cases", AMA Archives of Neurology and Psychiatry, Jan. 1957.

34. Kehoe, Robert A., "The Metabolism of Lead in Man in Health and Disease", J. of the Royal Institute of Public Health and Hygiene, 1961.

35. Kehoe, Robert A., "Normal Metabolism of Lead", Archives of Environmental Health, Vol. 8, Feb. 1964.

36. "Lead Poisoning in Children: Diagnostic Criteria", HEW, May 1959.

37. "Lead Poisoning in Children from Paint", BCEM, Aug. 1969.

38. Lin-Fu, Jane,"Childhood Lead Poisoning", Children, Vol. 17, No. 1, Jan.-Feb. 1970.

39. Lin-Fu, Jane, "Lead Poisoning in Children", HEW Children's Bureau Publication No. 452-1967, 1967.

40. Lutz, Garson A., Arthur A. Levin, Sanford G. Bloom, Kaj L. Nielsen, Jack L. Cross, and David L. Morrison, "Technical, Intelligence, and Project Information System for the Environmental Health Service, Volume III", Lead Model Case Study, Battelle Memorial Institute, June,1970.

41. McLaughlin, Mary, "Two Health Problems--One Solution", Bull. N. Y. Acad. Med., Vol. 46, No. 6, June 1970.

42. "Medical Aspects of Childhood Lead Poisoning", HSMHA Health Reports, Vol. 86, No. 2, Feb. 1971

43. Meigs, J. Wister and Elaine Whitmore, "Epidemiology of Lead Poisoning in New Haven Children--Operational Factors", Connecticut Medicine, Vol. 35, No. 6, June 1971.

44. Mellins, Robert B. and C. David Jenkins, "Epidemiological and Psychological Study of Lead Poisoning in Children", J. of AMA, Vol. 158, No. 1, May 1955.

45. Oberle, Mark W., "Lead Poisoning: A Preventable Childhood Disease of the Slums", Science, Vol. 165, Sep. 1969.

46. Public Law 91-695, Ninety-first Congress, H. R. 19172, Jan. 13, 1971.

47. Rait, J. R. and C. Teng, "Lead Poisoning Issue Study", New York City Rand Institute, Feb. 1970.

48. "Report of Governor's Task Force on Lead Poisoning", State of Connecticut, Dec. 1970.

49. Sachs, Henrietta K., Lorry A. Blanksma, Edward F. Murray, and Morgan J. O'Connell, "Ambulatory Treatment of Lead Poisoning, Report of 1155 Cases", Pediatrics, Vol. 46, No. 3, Sep. 1970.

50. Schucker, George W., Edward H. Vail, Elizabeth B. Kelly, and Emanuel Kaplan, "Prevention of Lead Paint Poisoning Among Baltimore Children", Public Health Reports, Vol. 80, No. 11, Nov. 1965.

51. Smith, Hugo Dunlap, "Pediatric Lead Poisoning", Archives of Environmental Health, Vol. 8, Feb. 1964.

52. "The Surgeon General's Policy Statement on Medical Aspects of Childhood Lead Poisoning", Nov. 1970.

53. "Symposium on Environmental Lead Contamination", Public Health Service Publication No. 1440, March 1966.

54. Tiboni, Emil A., "Control of Childhood Lead Poisoning", Public Health Reports, Vol. 79, No. 2, Feb. 1964.

55. Tyler, Raymond L., "Philadelphia Combats 'Silent Epidemic' in the Ghetto", J. of Environmental Health, Vol. 33, No. 1, July-Aug. 1970.

56. Williams, Huntington, Emanuel Kaplan, Charles E. Couchman and R. R. Sayers, "Lead Poisoning in Young Children", Public Health Reports, Vol. 67, No. 3, March 1952.


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