Open Access

Family Medicine and Primary Care: Open Access

Research Article

Mielke HW, et al. J Family Med Prim Care Open Acc 3: 140.

DOI: 10.29011/2688-7460.100040

Primary Health Care Consequences of Cultural Differences between New Orleans, Louisiana, USA and Oslo, Norway: Lead Contamination at Children's Play Areas

Howard W. Mielke[1*], Christopher R Gonzales[1], Rolf Tore Ottesen[2], Marianne Langedal[3], Morten Jartun[4], Eric T Powell[5]

[1]Department of Pharmacology, Tulane University School of Medicine, New Orleans LA, USA

[2]Geological Survey of Norway, Trondheim, Norway

[3]Municipality of Trondheim, Trondheim, Norway

[4]Norwegian Institute for Water Research (NIVA), Oslo, Norway

[5]Lead Lab, Inc., New Orleans, LA, USA

[*]**Corresponding author:** Howard W. Mielke, Department of Pharmacology, Tulane University School of Medicine, 1430 Tulane Avenue 8683, New Orleans, Louisiana, USA

Citation: Mielke HW, Gonzales CR, Ottesen RT, Langedal M, Jartun M, et al. (2019) Primary Health Care Consequences of Cultural Differences between New Orleans, Louisiana, USA and Oslo, Norway: Lead Contamination at Children's Play Areas. J Family Med Prim Care Open Acc 3: 140. DOI: 10.29011/2688-7460.100040

Received Date: 10 December, 2019; **Accepted Date:** 24 December, 2019; **Published Date:** 31 December, 2019

Abstract

New Orleans, Louisiana (USA) and Oslo (Norway) are similarly sized urban areas. Both cities provide play facilities for children. This study evaluates the lead (Pb) content of soils at children's play are in parks and childcare facilities located in communities near the city centers. The median soil Pb in New Orleans (N=104) and Oslo (N=97) play areas measure 418 mg/kg vs. 25 mg/kg, respectively. The median soil Pb content at children's play areas in Oslo (25 mg/kg or ppm) is about 17 times smaller than the median soil (418 mg/kg) in New Orleans play areas. Culture refers to attitudes, values, beliefs, and behaviors shared by members of a society. The cultural attitudes of the US and Norway regarding the use of Pb in two commercial products, lead-based paint and Pb additive in gasoline, indicates several reasons for the unusual differences in soil Pb at children's play areas of New Orleans and Oslo. The consequences on life expectancy, learning, and behavioral issues are severe for unduly Pb-exposed children. From the primary care whole-of-society perspective, if play areas are safe for children, then they are safe for everyone.

Keywords: Children's play areas; Soil Pb; Cultural attitudes; The Cochrane Collaborative; Lead-based paint; Lead additives in gasoline

Introduction

New Orleans, founded in 1718, and Oslo, Norway, founded in 1040, are similarly sized metropolitan areas of 439 and 454 km^2, respectively. The population of New Orleans was 484,670 in 2000 and after August 29, 2005, after Hurricane Katrina flooded and the entire city evacuated, the population gradually returned and is currently 391,006 [1,2]. The current population of Oslo, Norway is 538,411. New Orleans and Oslo have play areas covered with soil at children's childcare centers and parks, and the quality of soils are the subject of this primary care evaluation of the two cities.

Soils in urban environments are susceptible to lead (Pb) contamination because of the various commercial uses of Pb [3]. Previous soil research in US cities described differences in quantities of soil Pb contamination within inner-city vs. outlying rural areas [4], and sizes of towns and cities [5]. Soil Pb is positively associated with children's blood Pb [6]. In New Orleans during a span of two of decades' soil Pb and blood Pb have declined concurrently [7].

This study evaluates the Pb content of surface soils at city parks and childcare centers of New Orleans and Oslo. Lead consumption exists within the cultural context of shared national and local socio-economic values and policies [8]. In addition to quantifying soil Pb at children's play areas in New Orleans and Oslo the study also considers family medicine, primary care, and the whole-of-life consequences of contamination at play areas and early childhood Pb exposure.

Methods

The soils were collected in selected parks and daycare centers in New Orleans and Oslo. Dr. Morten Jartun was involved in collecting children's playground soils in New Orleans (N=104) and Oslo (N=97). Different wet lab methods were used for metal extraction and analyses for New Orleans and Oslo soil samples. As a result, it was necessary to determine the agreement between the different methods of analyses. The Oslo samples were shipped to the Tulane University laboratory where they were analyzed with the methods use on the New Orleans samples. In addition, the soil samples were also analyzed by Energy Dispersive X-Ray Fluorescence (ED-XRF).

New Orleans (NO), the Chaney/Mielke 1 molar HNO_3 22°C extraction. To compare soil Pb results, the Oslo soil samples were analyzed by the revised Chaney/Mielke extraction protocol [9]. The NO extraction method uses a sample weight of 0.4 g in 20 mL of 1 M HNO_3 1:50) with 2 hours shaking time at room temperature (~22°C). After shaking the solution, the extracts were centrifuged and filtered through Fisherbrand™ P4 paper into 20 mL scintillation vials. The ICP-AES is calibrated with NIST traceable standards and internal references are analyzed at a rate of 1 per 15 samples. Duplicate extractions are included with every 15 samples. A Spectro CIROS CCD Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) is used for metal analysis. Analysis is for 8 metals (Pb, Zn, Cd, Mn, Ni, Cu, Cr, V), however only Pb is reported here.

Oslo, NGU 7 molar HNO_3 autoclave 120°C extraction method. The Geological Survey of Norway, (Norges Geologiske Undersokelse or NGU) uses this method. A sample weight of 1 g was leached with 20 mL 7 M HNO_3 (1:20) in an autoclave for 30 min at 120°C, according to NS 4770 [10]. Although the determination was for multiple metals (As, Cd, Cu, Ni, Pb and Zn), only Pb is reported here. Analysis is performed by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) or Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

Energy Dispersive X-Ray Fluorescence (ED-XRF) analysis

In addition to the wet chemical analysis by NGU extraction methods conducted on the Oslo playground soil samples (N=97) and methods use in our laboratory in New Orleans, each of the Oslo samples was also measured with a handheld Thermo Scientific Fisher Niton XL2 ED-XRF Analyzer. The analysis of dry and sieved soil samples was conducted directly on their polyethylene sample bags for 30 second readings.

The 97 Oslo playground soil samples were the basis for comparing three analytical methods: two wet chemistry analyses, and ED-XRF. If the analysis provides similar results across three methods, then the original NGU results for the 97 Oslo soil samples can be used for comparison with the original Chaney-Mielke results for the 104 New Orleans soil samples. Data analysis was conducted with permutation statistical methods.

Statistical analysis

Universal Agreement R

The analysis calculates the Berry-Mielke Universal R coefficient of agreement and effect size [6,11]. It is a generalization of Cohen's kappa statistic. Cohen's kappa statistic measures inter-rater reliability (or inter-observer agreement). Inter-rater reliability occurs when the results of different analytical methods give similar scores to the same soil samples. With categorical data, R is equivalent to a linearly weighted kappa statistic. R is chance-corrected and appropriate for the measurement of reliability. R is based on Euclidean distances in a multivariate framework, and its significance is tested using Pearson Type III distribution. In addition to multiple observations, this function can handle multiple aspects or dimensions of observations per collector. If one of the analytical methods represents a "gold standard", then that observation can be flagged, and a slightly different calculation is performed. For this study the NGU analytical method is the "gold standard" for soil Pb analysis.

Multi-Response Permutation Procedure

Ordinary parametric statistical analysis of data frequently involves removal of outliers and data transformations to make the data conform to the bell-shaped curve in order to meet the assumptions of the parametric statistical model. We use the non-parametric Multi-Response Permutation Procedure (MRPP) statistical analysis that is data-dependent and uses all available, non-transformed, raw data [12,13]. MRPP calculates the exact moments of all possible arrangements of the observed data underlying the permutation distribution and provides approximate, but highly accurate, probability values without assuming normality or homogeneity of variance. The late P.W. Mielke, Jr. and others developed MRPP as part of a group of statistical tests. The procedures make statistical comparisons with distance-function based permutation tests [12].

Results

The Oslo soil results (N=97) were compared with results of the Chaney-Mielke and ED-XRF methods. The Universal Agreement R results are shown in Table 1.

Measurements of XRF, Oslo vs NOLA soils	
Number of measurements (3×97)	291
N methods (NGO, Chaney Mielke & EDXRF)	3
Number of samples	97
Number of dimensions (Pb)	1
Observed (realized) delta	16.439863
Expected (mean) delta	58.993446
Variance of delta	4.156678
Skewness of delta	-0.60961
Agreement coefficient R	0.721327
Probability	P-value <0.0001

Table 1: Universal agreement R, Soil Pb analyses (Berry-Mielke).

The agreement between the three analytical methods is 0.721 (P-value <1×10^{-4}) indicating excellent agreement between the results of the three methods. Assuming the NGU 7M HNO_3 autoclave method is the "gold standard", the results of the other two analyses for Pb in Oslo children's play area soils are sorted against the original NGU results (Figure 1).

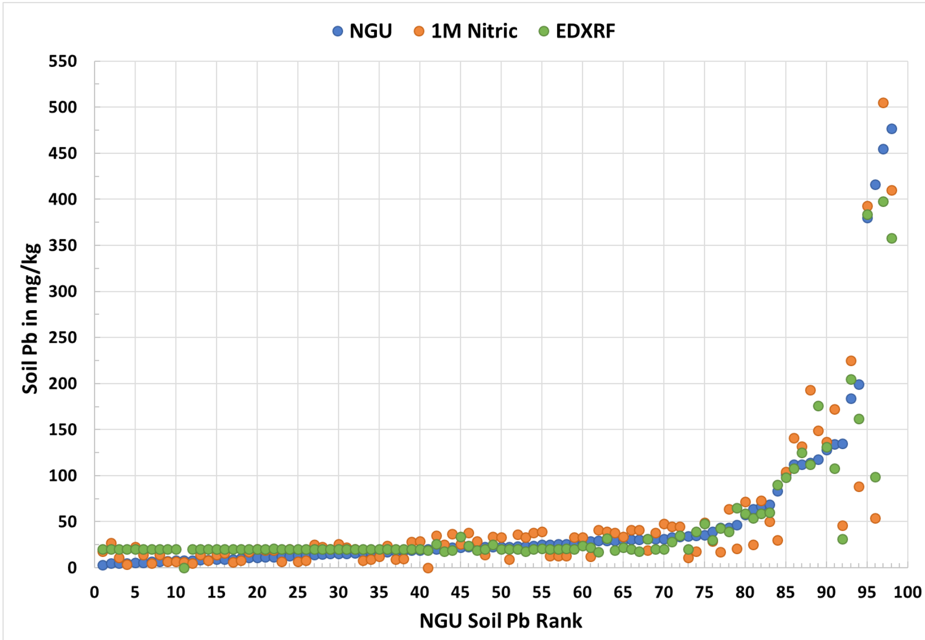

Figure 1: Graph of three analytical methods, NGU (7 molar NO_3), Chaney-Mielke (1 molar NO_3) and EDXRF measured in Oslo soil samples (N=97). Note the similarity of the results throughout the curves. The largest differences occurred with the highest NGU rankings (i.e., the largest soil Pb values).

Table 2 lists the percentiles of the Pb results of the soil samples from play areas in Oslo (N=97) and New Orleans (N=104). The differences are extreme as indicated from direct observation and the statistical results (P-value = 2.0×10^{-20}). Chance alone cannot explain the differences in the two sets of playground soils.

All Soil Samples	**Soil Pb (mg/kg)**	
	Oslo*	**NO#**
N Soil Samples	97	104
N Locations	10	18
minimum	4	6
10%	8	26
25%	14	115
median	**25**	**418**
75%	41	845
90%	133	1,452
maximum	505	3,142
MRPP P-value		2.0×10^{-20}
*Oslo analysis was by the NGU 7 molar HNO_3, autoclaved 30 min at 120°C. #New Orleans (NO) analysis was by the Chaney-Mielke 1 molar HNO_3, 2-hour shake at ~22°C.		

Table 2: Results of soil samples from Oslo [N=97] and New Orleans (NO) [N=104].

Discussion

The median soil Pb in children's play areas in New Orleans and Oslo are 418 mg/kg vs. 25 mg/kg, respectively. The New Orleans play areas contain a median soil Pb quantity measuring 16.7 times larger than the median soil Pb in Oslo children's play areas. Note that the maximum soil Pb in Oslo is just above the median soil Pb in New Orleans. Could cultural differences explain this disparity? Nazroo states: "Culture refers to characteristic patterns of attitudes, values, beliefs, and behaviors shared by members of a society or population. Members of a cultural group share characteristics that distinguish them from other groups." Family medicine and primary care exists in the context of the cultures that characterize the US and Norway [8]. The Pb in play area soils observed in New Orleans and Oslo occurs in the framework of Pb policies, regulations, and shared behaviors of the citizens of New Orleans and Oslo. Here the emphasis is on cultural differences in managing two commercial products, Pb-based paint and Pb additives in gasoline. We seek to understand the role of the national cultures in the widely differing legacies of Pb in children's play areas in New Orleans and Oslo. Cultural behavior and shared choices influence the use and dispersion of Pb-based paint and Pb additives in gasoline.

Lead-based paint

In the US, large quantities of Pb were used to manufacture paint. Paint is a visible coating and subject to wear, pealing, and deterioration. Current US efforts to prevent childhood Pb exposure is primarily focused on Pb-based paint and dust association with Pb-based paint. The quantity of Pb used to manufacture paint from 1880s to 1978 was around 6 million metric tons between 1880s and 1978 [14]. The amount of Pb in paint was limited to 1% in 1971, to 0.06% in 1978, and 0.009% in 2009. In New Orleans, we calculated that if all the Pb-based paint were sanded off homes, then a maximum estimate of ~1811 metric tons Pb dust from exterior Pb-based paint on 86,000 residences [14]. Parks and childcare center play areas could become contaminated by dust from Pb-based paint.

In Norway, Pb-based paints were banned for residential use in the 1920s [15]. One use of Pb-based paint was on bridges which were coated with red Pb-based paints. The coatings on all bridges were scheduled for replacement with thermally sprayed zinc duplex coatings in 1977 [16].

Lead additives (TEL) in gasoline

In the US the commercial use of Tetra-Ethyl Lead (TEL) began after US government hearings in 1925 [17]. One of the opponents to commercial use of TEL additives in gasoline was Professor Yandel Henderson, a physiologist teaching and conducting research at Yale University, New Haven, Connecticut. His opposition was stated at the hearings on May 20, 1925 in Washington, DC. Also, at a conference of engineers in New York City in April 22, 1925, Professor Henderson was quoted: "This is probably the greatest single question in the field of public health that has ever faced the American public. It is the question whether scientific experts are to be consulted, and the action of the Government guided by their advice; or whether, on the contrary, commercial interests are to be allowed to subordinate every other consideration to that of profit. The size of the financial interests involved [is] stupendous [18]".

The TEL additives were given provisional approval with the stipulation that human exposure be monitored. The producers of TEL were charged with the responsibility for monitoring exposure. Scientific discussion about the health risks associated with TEL was monitored and controlled by the manufacturers of TEL [19]. Profits, not primary health care, were the major interest of the industry.

In Oslo leaded gasoline was banned in 1996, however measurements of Pb aerosols indicated the existence of gasoline Pb. The measurements showed that gasoline Pb aerosols continued even after the removal of Pb additives [20]. The role of soil Pb resuspension from the local environment was not addressed.

Cultural attitudes about vehicle use and fuel additives in the US and Norway

After World War II, US industrial manufacturing was converted from wartime to consumer products. This entailed retooling manufacturing into the production of cars and other vehicles. In addition, the national development of the US interstate highway program provided an infrastructure for vehicles travel. The combination of the interstate highway highways and vehicle production and lead additives in gasoline resulted in a sharp increase in the atmospheric dispersion of Pb. Petroleum production is subsidized by US taxpayers. Citizens purchased and drove cars with gasoline (containing TEL), and the taxes on gasoline paid for expanding the highway system. By 2017 Motor vehicle ownership grew to 0.838 vehicles per person in the US [21]. The vehicle exhaust contained invisible particles of Pb, and the soils of all cities became contaminated [14]. In New Orleans, Pb additives in gasoline were estimated at ~12,000 metric tons yielding ~9100 tons of Pb exhausted as aerosols from vehicles; ~4850 tons were particles >10 µm and ~4200 MT were particles <0.25 µm [22]. Note that at least 10 times more Pb dust can be accounted for from TEL exhaust than from Pb-based paint. Both products were important in the contamination of the environment and exposure of children.

Figure 2 is a graph showing the quantities of gasoline Pb consumed in the US compared with selected countries of Europe. Compared to the US the amount of gasoline Pb consumed in European nations was small, and Norway's consumption of leaded gasoline was even smaller compared with other European nations.

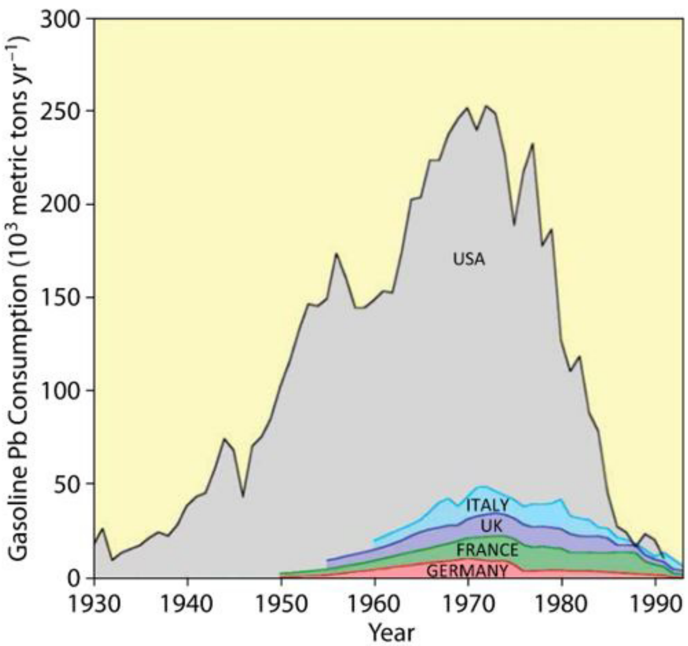

Figure 2: Leaded gasoline consumption in the USA, Germany, France, United Kingdom, and Italy from 1930 through 1993. Consumption of leaded gasoline in Norway was relatively small. In Oslo, Norway citizens were encouraged to use public transportation and drive smaller and more efficient automobiles. In the USA petroleum company subsidies and the federal highway programs enticed citizens away from public transportation and into private automobiles fueled with leaded gasoline.

In sharp contrast to the US, in Norway vehicle ownership was not encouraged [23]. Vehicle fuels and cars were taxed at least twice the level as in the US. Public transportation was subsidized, inexpensive, efficient, and well-used. Norway had a policy to extend transportation to farming districts and remote fishing villages. In 1975 links between districts and villages were generally by ferries and roads, although currently trains are non-existent. In 1975 fifty percent of Norway's workers commuted by car compared with 90% in the US [23]. Oslo has traditionally had an efficient public transport system. For example, in 2018, 23% commute by public transport, 31% by walking, 7% by bicycling (Norwegian Road Authority).

The cultural attitudes regarding car use in Norway is evolving toward ownership of electric cars without exhaust pollution [24]. By removing the 25% tax rate that applies to cars powered by internal combustion engines using fossil fuels, electric vehicles are subsidized in Norway. By 2017 motor vehicle ownership in Norway has grown to 0.514 vehicles per person [21].

Primary health care concerns about children living in Pb contaminated environments

The nervous system of children is at particularly high risk to Pb poisoning. In nature Pb is found only in minute amounts and exposures are usually small. As part of industry and commerce, Pb was mined, smelted, distributed in massive quantities, and dispersed into the environment [22]. As a toxicant, Pb contaminated the air and the dust became dispersed globally in soil and water [25].

Lead exposure has been associated with long-term health damage for centuries. While neurotoxic to both adults and children, the developing nervous system is known to be especially sensitive to persistent damage from even short-term Pb exposures. The critical issue is that Pb mimics calcium (Ca) and is readily absorbed in its place in all organ systems throughout the body. In the case of the nervous system, calcium is required for signaling across neuron synapses. If Pb is in the synapse instead of Ca, then nerve transmission signals are blocked, and the neurons become weakened and die. In this way environmental signals from exposure to Pb have dire consequences to individuals and society at large [22,26-28].

The Pb content in the parks and childcare play areas in New Orleans reveals an invisible Pb exposure risk as indicated by three lines of evidence. First, life expectancy. Even low-Pb exposure is associated with chronic cardiovascular disease and increased adult mortality [29]. In New Orleans life expectancy is around 55-58 years in the high lead communities of the city and 75-80 years in the low lead communities of the city [30]. There are many factors beyond Pb for life-expectancy differences, but Pb exposure is a factor. Secondly, childhood Pb exposure is strongly associated with learning difficulties [19,31]. In New Orleans, school achievement scores are strongly associated with the soil Pb and children's blood Pb across school districts [32]. It is also recognized that nationally US student academic achievement scores fall behind other countries. For example, in mathematics, Norway ranked 18th while the US ranked 39th. In reading Norwegian students ranked 9th and US students ranked 24th [33]. Third, it is well known that behavioral issues are related to early childhood exposure to Pb [34]. In New Orleans, aggravated assault rates from 1972-2002 were shown to lag 22 years behind the Pb aerosol increases and decreases from 1950-1990. The association indicates 85% of temporal variation in the aggravated assault rate is explained by the tonnages of Pb aerosols released into the population of New Orleans 22 years earlier [35].

If the environment is unsafe for children, then it's unsafe for everyone

As defined by World Health Organization: "Primary health care is a whole-of-society approach to health and well-being centered on the needs and preferences of individuals, families and communities. It addresses the broader determinants of health and focuses on the comprehensive and interrelated aspects of physical, mental and social health and wellbeing" [36].

In the US, lead exposure prevention is out of synch with the practice of primary care. The treatment of children for lead poisoning is predicated on the results of a blood test. If the results are above the established Centers for Disease Control and Prevention (CDC) guidelines, then secondary prevention treatment involves intervention that includes educating the parents about sources and prevention of Pb exposure, inspecting the home, and household cleaning with an emphasis on Pb-based paint and dust [37]. Even the guidelines are arbitrary because there is no known safe level of blood Pb [38]. The Cochrane Collaboration, an international organization that evaluates medical interventions, reviewed the US education and household and concluded that the US program is ineffective for reducing children's blood Pb [39]. The Cochrane Collaboration also noted that the effects of soil remediation and/ or a combination of actions requires further research and review [39]. This study indicates that cultural attitudes related to the use of Pb are an essential part of the reason for the soil Pb differences between play areas of New Orleans and Oslo.

Norway and neighboring countries have a different cultural attitude about Pb that is in harmony with the whole-of-society approach to health and well-being framework described by WHO [36]. The first author (HWM) has first-hand experience with the cultural attitude expressed by Norwegian and Swedish colleagues. In early April 2000, I was invited to present the annual *Goldschmidt Lecture* sponsored by the Norwegian Geological Survey in Trondheim, Norway. The Norwegian researchers stated that since research conducted on the association of soil Pb and children's health had already been done, the Norwegian efforts would be focused on primary prevention. Norway passed legislation on a national clean soil program to prevent exposure to soil Pb in the first place (i.e., primary prevention) [40]. In October 2006, I was invited to Uppsala, Sweden to serve as an opponent for Dr. Karin Liung's dissertation defense on the topic of soil Pb (and other metals) and their impacts on children's health. During the visit a tour was scheduled to a childcare near the center of Stockholm where a soil replacement/landscaping project was underway. I was intrigued by the project and asked about the reason for the soil landscaping activity. Without hesitation, the response of the health professionals was clear: "If the environment is unsafe for children then it's unsafe for everyone."

Primary health care requires the inclusion of the broader determinants of health and on comprehensive and interrelated aspects of physical, mental and social health and wellbeing. Children's play activities require safe environments both indoors and out-of-doors. Outdoor play environments include soils, a legacy repository for Pb dust aerosols from industries and car exhausts alike. In the US the guidance value for soil Pb is 400 mg/ kg in play areas and 1200 mg/kg in places not dedicated to play (US ATSDR). In Norway the guidance value is 60 mg/kg [40]. Given the realization that there is no safe level of lead exposure known for children, a margin of safety is essential [38]. European researchers proposed that play area soils contain no more Pb than 20 mg/kg [41]. Lead contaminated soil remediation actions were tried and successfully tested on play areas at childcare centers in New Orleans [42]. Other actions are also available for reducing Pb in surface soil of play areas [43-46].

Conclusion

WHO defines primary health care to include broader determinants of health and the comprehensive and interrelated aspects of physical, mental and social health and wellbeing. Another determinant requiring attention is the soil quality at children's play areas. The amount of Pb in soils at children's play areas reflects cultural differences between the US and Norway. A cultural divide that affects soil Pb in play areas is the shared attitude and behavior regarding the commercial use of lead-based paint and lead additives in gasoline. Norway banned lead-based paint for residential use in the 1920's. In the US lead-based paint was sold in residential housing until 1978 when restrictions were imposed. The use of lead additives in gasoline began in 1925 despite strong objections by qualified medical researchers about the wisdom of adding lead additives to gasoline, warnings were disregarded. Lead additives in gasoline increased especially rapidly between 1950 until 1975 until restrictions began. Culturally, Norway did not encourage car use while the US provided numerous incentives, including an infrastructure of highways, and the promotion of the purchase and use of cars. In this study, median New Orleans children's playgrounds contained nearly 17 times more lead than the median soil Pb in Oslo children's playgrounds. The consequences show up in the health of citizens and present as subtle symptoms of lead poisoning, including shorter life expectancies, learning problems, and behavioral issues. The removal of lead additives from gasoline provided relief, including a decline of soil lead and decreased blood lead, but lead poisoning is prevalent in some communities. The main lesson from this study for family medicine and primary care is interrelated with the whole-of-society perspective; if play area environments are unsafe for children, then they are unsafe for everyone.

Acknowledgments

Funding was from The Ling and Ronald Cheng Fund, Al French, Mary An Godshall, Allen and Laura Carmen, Paul W. Jr. and Roberta R. Mielke, Thomas Beller, Jack Eichenbaum, Gabriel Filippelli, Community Church Unitarian Universalist members, and supported by the Department of Pharmacology. In memory of my brother, Paul W. Mielke Jr., who audaciously challenged current practices of statistics.

References

1. World Population Review (2019) New Orleans, Louisiana Population 2019: 391,006.

2. Plyer A, Gardere L (2018) The New Orleans Prosperity Index: Tricentennial Edition.

3. Mielke HW, Reagan PL (1998) Soil is an important pathway of human lead exposure. Environ Health Perspect 106: 217-229.

4. Mielke HW, Anderson JC, Berry KJ, Mielke PW, Chaney RL, et al. (1983) Lead concentrations in inner city soils as a factor in the child lead problem. Am J Public Health 73: 1366-1369.

5. Mielke HW (1993) Lead dust contaminated U.S.A. communities: comparison of Louisiana and Minnesota. Applied Geochemistry 8: 257-261.

6. Mielke PW Jr, Berry KJ (2007) Permutation Methods: A Distance Function Approach (2nd Edition) (Springer, NY), USA.

7. Mielke HW, Gonzales CR, Powell ET, Laidlaw MAS, Berry KJ, et al. (2019) The concurrent decline of soil lead and children's blood lead in New Orleans. Proc Natl Acad Sci U S A 116: 22058-22064.

8. Nazroo JY (1998) Genetic, cultural or socio-economic vulnerability? Explaining ethnic inequalities in health. Sociology of Health & Illness 20: 710-730.

9. Mielke HW, Gonzales, C, Powell E, Mielke PW Jr (2005) Changes of multiple metal accumulation (MMA) in New Orleans soil: preliminary evaluation of differences between survey I (1992) and survey II (2000). Int J Environ Res Public Health 2: 308-313.

10. Standard Norge (1994) Norsk Standard 4770 Metaller i vann, slam og sedimenter. 32 pages.

11. StatsDirect Statistical Software Version 3.2.8 (9/16/2019) Copyright 1990-2019 StatsDirect Ltd.

12. Berry KJ, Johnston JE, Mielke PW Jr (2014) A Chronicle of Permutation Statistical Methods: 1920-2000, and Beyond. Springer, New York, USA.

13. Cade BS, Richards JD (2005) User Manual for Blossom Statistical Package. USGS. Open-File Report 2005-1353. U. S. Geological Survey.

14. Mielke HW, Laidlaw MA, Gonzales CR (2011a) Estimation of leaded (Pb) gasoline's continuing material and health impacts on 90 US urbanized areas. Environ Int 37: 248-257.

15. Johnson CC, Demetriades A, Locutura J, Ottesen RT (2011) Mapping the Chemical Environment of Urban Areas. John Wiley & Sons, West Sussex, UK. 140 pages.

16. Knudsen OO, Matre H, Dorum C, Gagne M (2019) Experiences with Thermal Spray Zinc Duplex Coatings on Road Bridges. Coatings 9: 371.

17. US Public Health Bulletin (1925) Treasury Department and United States Public Health Service: Proceedings of a conference to determine whether or not there is a public health question in the manufacture, distribution, or use of tetraethyl lead gasoline. Public Health Bulletin No: 158. Government Printing Office, Washington, DC, USA. 1925.

18. Henderson Y (1925) Sees deadly gas a peril in streets: Dr. Henderson Warns Public against auto exhaust of tetra-ethyl lead. New York Times (1923-Current file). ProQuest Historical Newspapers: The New York Times, page 25.

19. Needleman H, Gee D (2013) Lead in petrol 'makes the mind give way'. In: Late lessons from early warnings: science, precaution, innovation. European Environment Agency. EEA, Copenhagen. Chapter 3.

20. Aberg G, Pacyna JM, Stray H, Skjelkvale BL (1999) The origin of atmospheric lead in Oslo, Norway, studied with the use of isotopic ratios. Atmos Environ 33: 3335-3344.

21. Wikipedia (2019) List of countries by vehicles per capita.

22. Mielke HW, Gonzales CR, Mielke PW Jr (2011b) The continuing impact of lead dust on children's blood lead: Comparison of public and private properties in New Orleans. Environ Res 111: 1164-1172.

23. Herendeen RA (1998) Ecological Numeracy: Quantitative Analysis of Environmental Issues. John Wiley and Sons, Inc. NYC, USA. 228-235 pages.

24. David N (2019) Electric Cars: Why Little Norway Leads the World in EV Usage. A look at travel and lifestyle in Europe with a focus on Norway & Scandinavia. Forbes Magazine.

25. Boyl EA, Lee J-M, Echegoyen Y, Noble AG, Moos S, et al. (2014) Anthropogenic Lead Emissions in the Ocean: The Evolving Global Experiment. Oceanography 27: 70

26. Cecil KM, Brubaker CJ, Adler CM, Dietrich KN, Altaye M, et al. (2008) Decreased brain volume in adults with childhood lead exposure. PLoS Med 5: e112.

27. Lidsky TI, Schneider JS (2003) Lead neurotoxicity in children: Basic mechanisms and clinical correlates. Brain 126: 5-19.

28. Mielke HW, Gonzales CR, Powell ET, Mielke PW (2013) Environmental and health disparities in residential communities of New Orleans: The need for soil lead intervention to advance primary prevention. Environ Int 51: 73-81.

29. Lanphear BP, Rauch S, Auinger P, Allen RW, Hornung RW (2018) Low-level lead exposure and mortality in US adults: A population-based cohort study. Lancet Public Health 3: 177-184.

30. Mielke HW, Gonzales CR, Powell ET (2017) Pharmacology Research in Environmental Signaling: Life Expectancy, Invisible Lead Dust, and Proactive Intervention to Reduce Childrens Pb Exposure in New Orleans, LA (USA). J Pharm Pharmacol Res 1: 009-018.

31. Needleman HL, Gunnoe C, Leviton A, Reed R, Peresie H, et al. (1979) Deficits in psychologic and classroom performance of children with elevated dentine lead levels. N Engl J Med 300: 689-695.

32. Zahran S, Mielke HW, Weiler S, Berry KJ, Gonzales C (2009) Children's blood lead and standardized test performance response as indicators of neurotoxicity in metropolitan New Orleans elementary schools Neuro Toxicology 30: 888-897.

33. DeSilver D (2017) U.S. students' academic achievement still lags that of their peers in many other countries. Pew Research Center.

34. Liu J, Liu X, Wang W, McCauley L, Pinto-Martin J, et al. (2014) Blood lead concentrations and children's behavioral and emotional problems: a cohort study. JAMA Pediatr 168: 737-745.

35. Mielke HW, Zahran S (2012) The urban rise and fall of air lead (Pb) and the latent surge and retreat of societal violence. Environ Int 43: 48-55.

36. WHO (2019) Primary health care fact sheet. World Health Organization.

37. Paulson JA, Brown MJ (2019) The CDC blood lead reference value for children: Time for a change. Environ Health 18: 16.

38. US Department of Health and Human Services (2012) Low level Lead exposure harms children: a renewed call for primary prevention. Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention.

39. Nussbaumer-Streit B, Yeoh B, Griebler U, Pfadenhauer LM, Busert LK, et al. (2016) Household interventions for preventing domestic lead exposure in children. Cochrane Database Syst Rev 10: CD006047.

40. Ottesen RT, Alexander J, Langedal M, Haugland T, Hoygaard E (2008) Soil pollution in day-care centers and playgrounds in Norway: national action plan for mapping and remediation. Environ Geochem Health 30: 623-637.

41. Boyd HB, Pedersen F, Cohr K-H, Damborg A, Jakobsen BM, et al. (1999) Exposure Scenarios and Guidance Values for Urban Soil Pollutants. Regul Toxicol Pharmacol 30: 197-208.

42. Mielke HW, Covington TP, Mielke PW Jr, Wolman FJ, Powell ET, et al. (2011c) Soil intervention as a strategy for lead exposure prevention: the New Orleans lead-safe childcare playground project. Environ Pollut 159: 2071-2077.

43. Laidlaw MAS, Filippelli GM, Brown S, Ferreiro JP, Reichman SM, et al. (2017). Case studies and evidence-based approaches to addressing urban soil lead contamination. Appl Geochem 83: 14-30

44. Mielke HW, Gonzales CR, Powell E, Jartun M, Mielke PW Jr (2007) Nonlinear association between soil lead and blood lead of children in metropolitan New Orleans, Louisiana: 2000-2005. Sci Total Environ 388: 43-53.

45. (2019) Norwegian Public Road Administration.

46. US Agency for Toxic Substances and Disease Registry (2019) Lead Toxicity: What are U.S. Standards for Lead Levels? Environmental Health and Medicine Education.