



Health Effects of Lead and MDH Recommendations on Occupational Lead Exposure

Stephanie Yendell, DVM, MPH | Senior Epidemiology Supervisor

Background

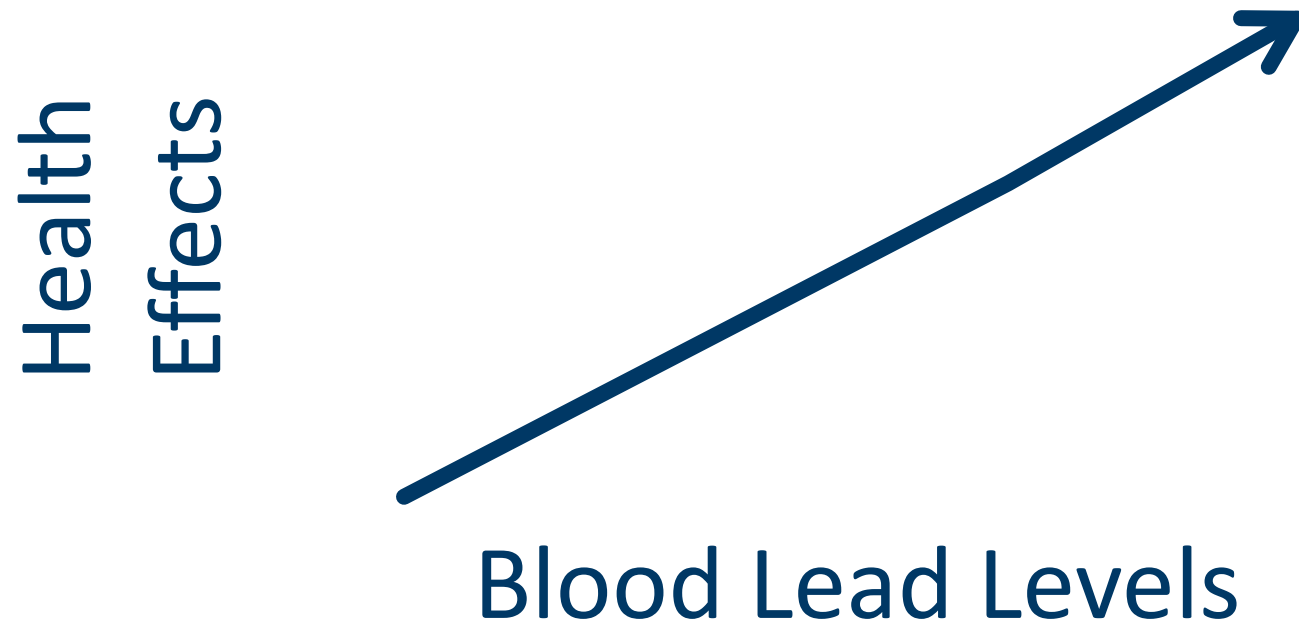
Health Effects of Lead

MDH Surveillance Data

Take-Home Lead Exposure

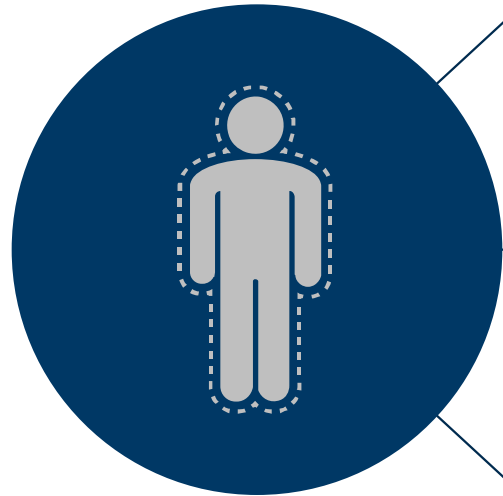
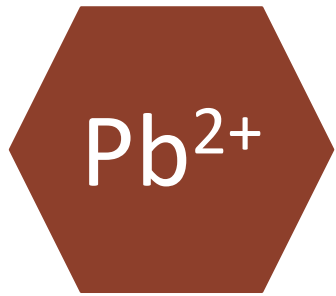
Recommendations

Lead Exposure has a Dose-Response Relationship with Health Effects

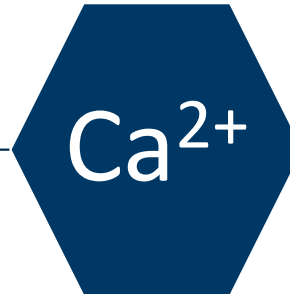


There is no safe level of lead exposure

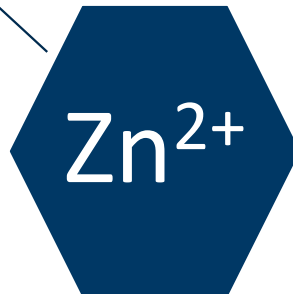
What Systems Does Lead Affect?



- Hemoglobin production
- Production of metabolic enzymes



- Structural integrity of bones
- Nerve conduction
- Muscle contraction



- Immune system function
- DNA synthesis

Can an Epidemiologist Say “Caused”?

The Bradford Hill Viewpoints

Specificity

Temporality

Strength of
Association

Consistency

Dose-
Response

Experiment

Analogy

Plausibility

Coherence

Common Data Sources

- Population-based studies
 - National Health and Nutrition Examination Survey (NHANES)
 - Nationally representative survey of about 5,000 people per year, including children and adults
 - Combines interviews and physical examinations, including blood lead tests
 - Normative Aging Study (NAS)
 - Longitudinal cohort study established by the United States Department of Veterans Affairs in 1963
 - Participants were men free of chronic disease at the time of recruitment
 - Participants provided information on medical history, lifestyle and demographic factors and underwent a physical examination and laboratory tests every 3–5 years
- Cohorts of Lead Workers

References: NHANES Studies

- Ji JS, A Elbaz, and MG Weisskopf. Association between blood lead and walking speed in the National Health and Nutrition Examination Survey (NHANES 1999–2002). *Environmental Health Perspectives*. 2013. 121(6): 711–716.
- Krieg EF, and MA Butler. Blood lead, serum homocysteine, and neurobehavioral test performance in the third National Health and Nutrition Examination Survey. *NeuroToxicity*. 2009. 30:281–289.
- Lanphear BP, S Rauch, P Auinger, RW Allen, and RW Hornung. Low-level lead exposure and mortality in US adults: a population-based cohort study. *Lancet Public Health*. 2018. 3:e177–184.
- Menke A, P Muntner, V Batuman, EK Silbergeld, and E Guallar. Blood lead below 0.48 $\mu\text{mol/L}$ (10 $\mu\text{g/dL}$) and mortality among US adults. *Circulation*. 2006. 1388–1394.
- Muntner P, J He, S Vupputuri, J Coresh, and V Bautman. Blood lead and chronic kidney disease in the general United States population: Results from NHANES III. *Kidney International*. 2003. 63:1044–1050.
- Navas-Acien A, E Selvin, R Sharrett, E Calderon-Aranda, E Silbergeld, and E Guallar. Lead, cadmium, smoking, and increased risk of arterial disease. *Circulation*. 2004. 109.
- Schober SE, LB Mirel, BI Graubard, DJ Brody, and KM Flegal. Blood lead levels and death from all causes, cardiovascular disease, and cancer: Results from the NHANES III Mortality Study. *Environmental Health Perspectives*. 2006. 114(10): 1538–1541.

References: Normative Aging Study

- Cheng Y, J Schwartz, D Sparrow, A Aro, ST Weiss, and H Hu. Bone lead and blood lead levels in relation to baseline blood pressure and the prospective development of hypertension. *American Journal of Epidemiology*. 2001. 153:164–171.
- Farooqui Z, KM Bakulski, MC Power, MG Weisskopf, D Sparrow, A Spiro III, et al.. Associations of cumulative Pb exposure and longitudinal changes in Mini-Mental Status Exam scores, global cognition and domains of cognition. *Environ Res*. 2017. 152:102–108.
- Grashow R, A Spiro, KM Taylor, K Newton, R Shrairman, A Landau et al.. Cumulative lead exposure in community-dwelling adults and fine motor function: comparing standard and novel tasks in the VA Normative Aging Study. *Neurotoxicology*. 2013. 35:154–161.
- Perlstein T, J Weuve, J Schwartz, D Sparrow, R Wright, A Litonjua, et al.. Cumulative community-level lead exposure and pulse pressure. *Environmental Health Perspectives*. 2007. 115(12): 1696–1700.
- Peters JL, L Kubzansky, E McNeely, J Schwartz, A Spiro III, D Sparrow et al.. Stress as a potential modifier of the impact of lead levels on blood pressure. *Environmental Health Perspectives*. 2007. 115(8): 1154–1159.
- Prada D, E Colicino, MC Power, MG Weisskopf, J Zhong, L Hou, et al.. *APOE* ϵ 4 allele modifies the association of lead exposure with age-related cognitive decline in older individuals. *Environmental Research*. 2016. 151:101–105.
- Rajan P, KT Kelsey, JD Schwartz, DC Bellinger, J Weuve, D Sparrow, et al.. Lead burden and psychiatric symptoms and the modifying influence of the δ -Aminolevulinic Acid Dehydratase (ALAD) polymorphism. *Am J Epidemiol*. 2007. 166(12): 1400–1408.
- Schaumberg DA, F Mendes, M Balaram, MR Dana, D Sparrow, and H Hu. Accumulated lead exposure and risk of age-related cataract in men. *JAMA*. 2004. 292(22):2750–2754.
- Weisskopf MG, RO Wright, J Schwartz, A Spiro III, D Sparrow, A Aro, et al.. Cumulative lead exposure and prospective change in cognition among elderly men. *American Journal of Epidemiology*. 2004. 160(12): 1184–1193.

References: Other US Population-Based Cohorts

- Baltimore Memory Study
 - Bandeen-Roche K, TA Glass, KI Bolla, AC Todd, and BS Schwartz. The longitudinal association of cumulative lead dose with cognitive function in community-dwelling older adults. *Epidemiology*. 2009. 20(6): 831–839.
- Nurses' Health Study
 - Weuve J, SA Korrnick, MA Weisskopf, LM Ryan, J Schwartz, H Nie, et al.. Cumulative exposure to lead in relation to cognitive function in older women. *Environmental Health Perspectives*. 2009. 117(4):574–580.
- Study of Osteoporotic Fractures
 - Khalil N, JW Wilson, EO Talbott, LA Morrow, MC Hochberg, TA Hillier, et al.. Association of blood lead concentrations with mortality in older women: a prospective cohort study. *Environmental Health*. 2009. 8(15).

References: Other International Population-Based Cohorts

- Australian Vital Statistics Data
 - Laidlaw MAS, DB Rowe, AS Ball, and MW Mielke. A temporal association between accumulated petrol (gasoline) lead emissions and motor neuron disease in Australia. *Int J Environ Res Public Health*. 2015. 12:16124–16135.
- Japan Environment and Children’s Study
 - Ishitsuka K, K Yamamoto-Hanada, L Yang, H Mezawa, M Konishi, M Saito-Abe, et al.. Association between blood lead exposure and mental health in pregnant women: Results from the Japan environment and children’s study. *Neurotoxicology*. 2020. 79:191–199.
- Malmo Diet and Cancer Study
 - Gambelunghe A, G Sallsten, Y Borne, N Forsgard, B Hedblad, P Nilsson et al.. Low-level exposure to lead, blood pressure, and hypertension in a population-based cohort. *Environmental Research*. 2016. 149:157–163.
 - Harari F, G Sallsten, A Christensson, M Petkovic, B Hedblad, N Forsgard, et al.. Blood lead levels and decreased kidney function in a population-based cohort. *Am J Kidney Dis*. 2018. 73(3):381–389.
- Nunavik Environmental Contaminants and Child Development Study
 - Boucher O, G Muckle, JL Jacobson, RC Carter, M Kaplan-Estrin, P Ayotte, et al.. Domain-specific effects of prenatal exposure to PCBs, mercury, and lead on infant cognition: Results from the Environmental Contaminants and Child Development Study in Nunavik. *Environmental Health Perspectives*. 2014. 122(3): 310-316.
- SPECT-China
 - Chen C, Q Li, X Nie, B Han, Y Chen, F Xia, et al.. Association of lead exposure with cardiovascular risk factors and diseases in Chinese adults. *Environ Sci Pollut Res*. 2017. 24:22275–22283.

References: US Occupational Studies

- Bertke SJ, EJ Lehman, SJ Wurzelbacher, and MJ Hein. Mortality of lead smelter workers: A follow-up study with exposure assessment. *Am J Ind Med*. 2016. 59(11): 979–986.
- Khalil N, LA Morrow, H Needleman, EO Talkbott, JW Wilson, and JA Cauley. Association of cumulative lead and neurocognitive function in an occupational cohort. *Neuropsychology*. 2009. 23(1):10–19.
- Schwartz BS, WF Stewart, KI Bolla, D Simon, K Bandeen-Roche, B Gordon, et al.. Past adult lead exposure is associated with longitudinal decline in cognitive function. *Neurology*. 2000. 55:1144–1150.
- Schwartz BS, B Caffo, WF Stewart, H Hedlin, BD James, D Yousem, et al.. Evaluation of cumulative lead dose and longitudinal changes in structural MRI in former organolead workers. *J Occup Environ Med*. 2010. 42(4): 407–414.
- Stewart WF, BS Schwartz, C Davatzikos, D Shen, D Liu, X Wu, et al.. Past adult lead exposure is linked to neurodegeneration measured by brain MRI. *Neurology*. 2006. 66:1476–1484.

References: International Occupational Studies

- Ademuyiwa O, RN Ugbaja, F Idumebor, and O Adebawo. Plasma lipid profiles and risk of cardiovascular disease in occupational lead exposure in Abeokuta, Nigeria. *Lipids in Health and Disease*. 2005. 4:19.
- Alasia DD, PC Emem-Chioma, and FS Wokoma. Occupational and environmental lead exposure in Port Harcourt, Nigeria: Analysis of its association with renal function indices. *Nigerian Journal of Medicine*. 2010. 19(4):407–414.
- Balasubramanian B, A Meyyazhagan, AJ Chinnappan, KK Alagamuthu, S Shanmugam, NA Al-Dhabi, et al.. Occupational health hazards on workers exposure to lead (Pb): A genotoxicity analysis. *Journal of Infection and Public Health*. 2020. 13:527–531.
- Dobrakowski M, J Zalejska-Fiolka, T Wielkoszynski, E Swietochowska, and S Kasperczyk. The effect of occupational exposure to lead on the non-enzymatic antioxidant system. *Medycyna Pracy*. 2014. 65(4):443–451.
- Karimooy HN, MB Mood, M Hosseini, and S Shadmanfar. Effects of occupational lead exposure on renal and nervous system of workers of traditional tile factories in Mashhad (northeast of Iran). *Toxicology and Industrial Health*. 2010. 26(9):633–638.
- Kim M-G, J-H Ryoo, S-J Chang, C-B Kim, J-K Park, S-B Koh et al.. Blood lead levels and cause-specific mortality of inorganic lead-exposed workers in South Korea. *PLoS ONE*. 2015. 10(10).
- Machon-Grecka A, M Dobrakowski, A Kasperczyk, E Birkner, T Pryzwan, and S Kasperczyk. The effect of subacute lead exposure on selected blood inflammatory biomarkers and angiogenetic factors. *J Occup Health*. 2018. 60:369–375.
- S R, G Vaiyakkani, S Kumar, A Ramachandran, K Rajendran, N Krishnasamy, et al.. Analysis of blood lead level and its clinical significance among occupational exposed painters in Chennai based population: A cross sectional study. *Journal of Trace Elements in Medicine and Biology*. 2023. 79.
- Weaver VM, B-K Lee, K-D Ahn, G-S Lee, AC Todd, WF Stewart, et al.. Associations of lead biomarkers with renal function in Korean lead workers. *Occup Environ Med*. 2003. 60:551–562.
- Wu Y, J-M Gu, Y Huang, Y-Y Duan, R-X Huang, and J-A Hu. Dose-response relationship between cumulative occupational lead exposure and the associated health damages: A 20-year cohort study of a smelter in China. *Int J Environ Res Public Health*. 2016. 13(328).

References: Reviews and Meta-Analyses

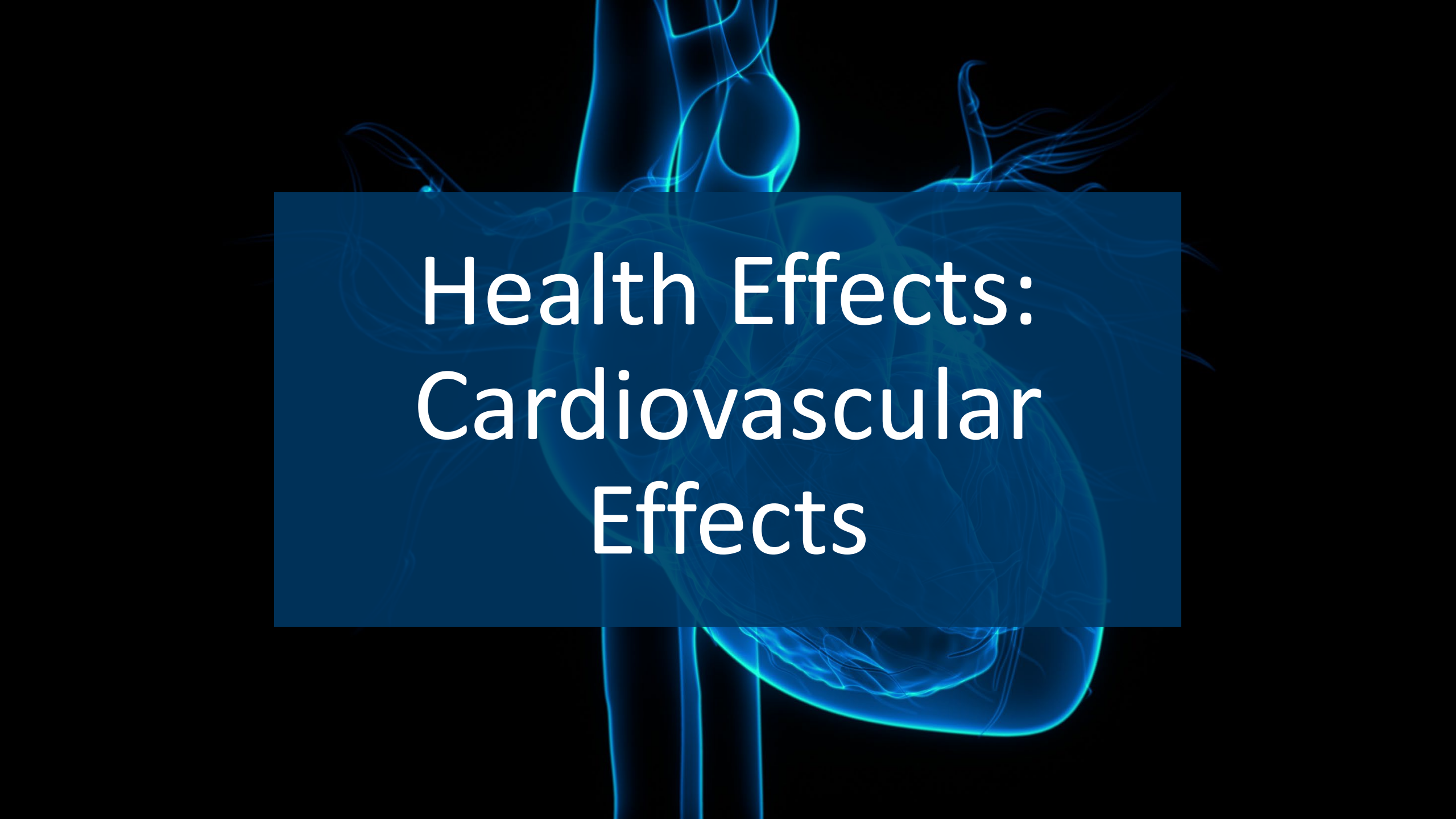
- Bakulski KM, LS Rozek, DC Dolinoy, HL Paulson, and H Hu. Alzheimer's Disease and environmental exposure to lead: The epidemiologic evidence and potential role of epigenetics. *Curr Alzheimer Res.* 2012. 9(5): 563–573.
- Bakulski KM, YA Seo, RC Hickman, D Brandt, HS Vadari, H Hu, and S KyunPark. Heavy metals exposure and Alzheimer's Disease and related dementias. *J Alzheimers Dis.* 2020. 76(4): 1215–1242.
- Ekong EB, BG Jaar, and VM Weaver. Lead-related nephrotoxicity: A review of the epidemiologic evidence. *Kidney International.* 2006. 70:2074–2084.
- Goodman M, N LaVerda, C Clarke, ED Foster, J Iannuzzi, and J Mandel. Neurobehavioral resting in workers occupationally exposed to lead: systematic review and meta-analysis of publications. *Occup Environ Med.* 2002. 59:217–223.*
- Krieg EF, DW Chrisli, CJ Crespo, WS Brightwell, RL Ehrenberg, and DA Otto. The relationship between blood lead levels and neurobehavioral test performance in NHANES III and related occupational studies. *Public Health Reports.* 2005. 120:240–251.
- Shih RA, H Hu, MG Weisskopf, and BS Schwartz. Cumulative lead dose and cognitive function in adults: A review of studies that measured both blood lead and bone lead. *Environmental Health Perspectives.* 2007. 115(3): 483–492.
- Upadhyay K, A Viramgami, BS Bagepally, and R Balachandar. Accosiation between blood lead levels and markers of calcium homeostasis: a systematic review and meta-analysis. *Scientific Reports.* 2022. 12:1850.
- Vaziri ND. Mechanisms of lead-induced hypertension and cardiovascular disease. *Am J Physiol Heart Circ Physiol.* 2008. 295:H454–H465.
- Wirth JL and RS Mijal. Adverse effects of low level heavy metal exposure on male reproductive function. *Systems Biology in Reproductive Medicine.* 2010. 56:147–167.

A modern hospital room with a bed, desk, and window. The room is clean and bright, with light-colored wood paneling and a large window with orange curtains. A blue semi-transparent box is overlaid on the center of the image, containing the text "Health Effects: Mortality".

Health Effects: Mortality

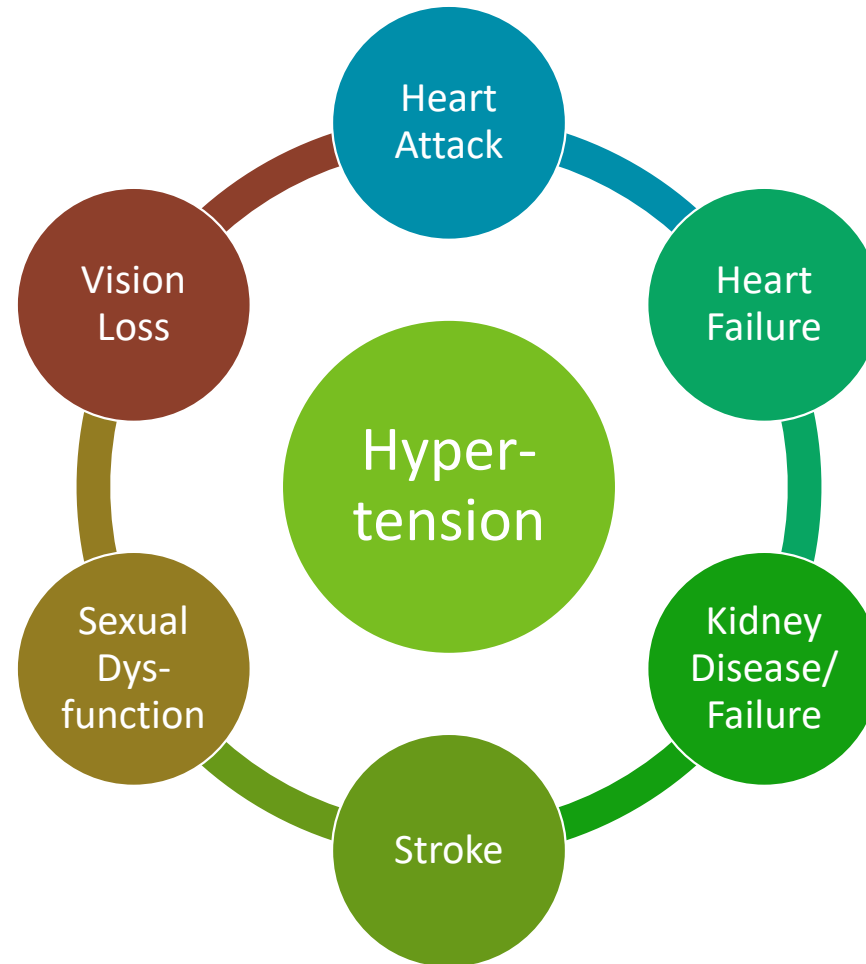
Selected Studies and Mortality

- Bertke et al., 2016
 - Analyzed mortality and exposure data for 1,990 people who worked in a lead smelter during 1940–1965. Highly exposed workers worked in departments with air lead over $200 \mu\text{g}/\text{m}^3$
 - Excess deaths occurred from cardiovascular disease and cerebrovascular disease, and kidney disease
 - Excess deaths from lung cancer more closely linked with smoking status
- Lanphear et al., 2018 used NHANES data
 - An increase in the concentration of lead in blood from $1.0 \mu\text{g}/\text{dL}$ to $6.7 \mu\text{g}/\text{dL}$ was associated with:
 - All-cause mortality hazard ratio of 1.37
 - Cardiovascular disease mortality hazard ratio of 1.70
 - Ischemic heart disease mortality hazard ratio of 2.08



Health Effects: Cardiovascular Effects

Hypertension is Inter-Connected with Other Systems



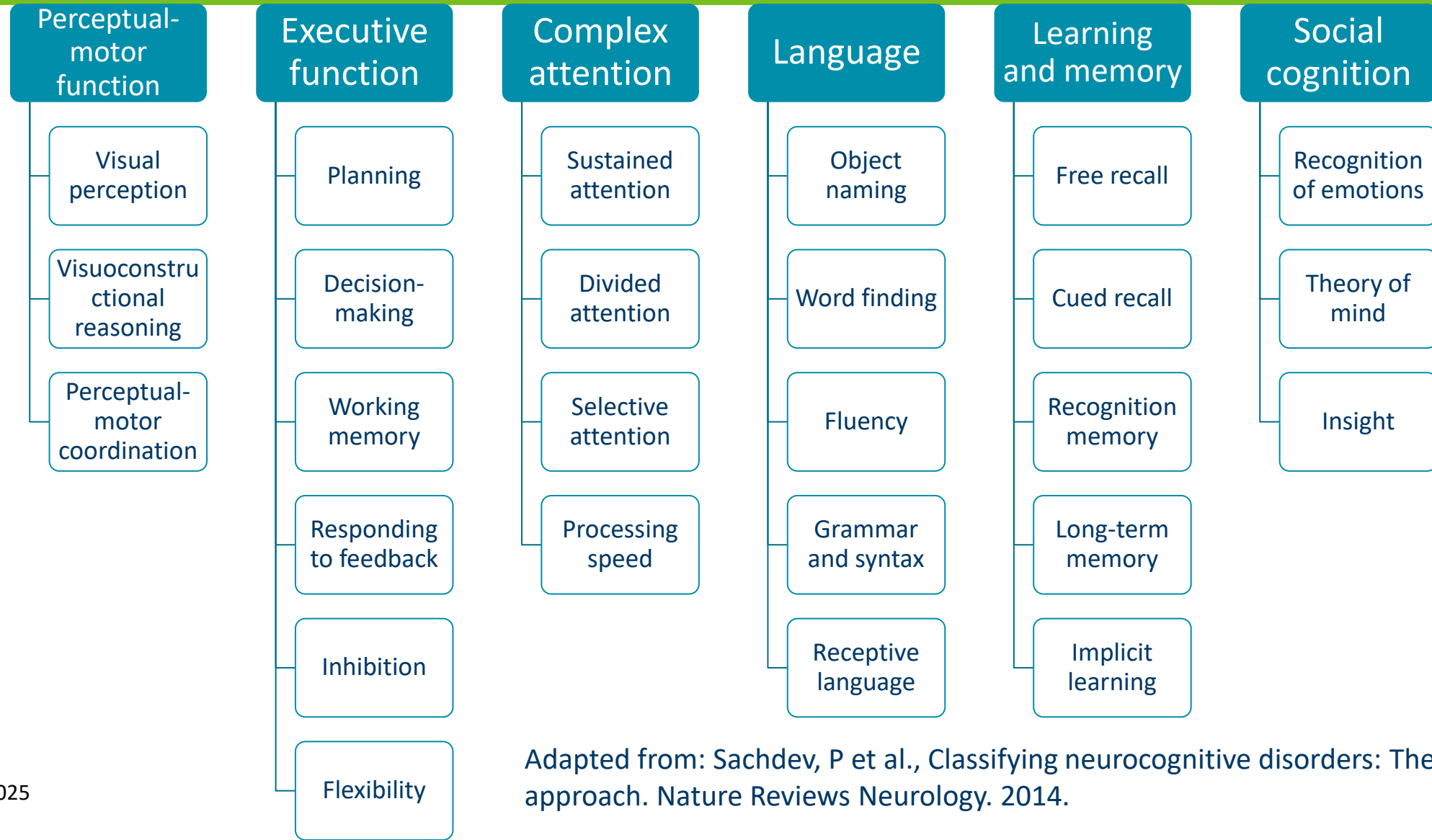
Selected Studies of Cardiovascular Effects

- Vaziri, 2008
 - Multiple studies show links between chronic lead exposure and hypertension
 - Lead can also increase the risk of arteriosclerosis, thrombosis, and cardiovascular disease through a variety of mechanisms, including:
 - Increasing inflammation
 - Disturbing smooth muscle Ca²⁺ signaling
 - Injuring the lining of blood vessels
- Navas-Acien et al., 2004 used NHANES data
 - After adjusting for smoking, age, sex, race, education, BMI, alcohol intake, and other related medical conditions, adults with BLL >2.9 µg/dL had 2.8 times the odds of having peripheral artery disease compared with adults with BLL <1.4 µg/dL



Health Effects: Neurological Effects

Neurocognitive Domains



Adapted from: Sachdev, P et al., Classifying neurocognitive disorders: The DSM-5 approach. Nature Reviews Neurology. 2014.

Neurological Effects of Lead

- Negative effects from lead have been measured across all neurocognitive domains
- Studies may look at a sub-category of a neurocognitive domain or use tests that look across multiple domains
- Many studies have looked at cumulative lead exposure using bone lead measurements with K-XRF, rather than blood lead levels
- There can be both acute and chronic neurological effects from lead

Selected Studies and Neurologic Effects

- Krieg et al., 2005
 - Compared neurobehavioral tests in NHANES to neurobehavioral tests in multiple studies of occupationally exposed adults
 - Study unable to detect significant difference in neurobehavioral test results for adults with BLL <25 mcg/dL
 - Worse performance on neurobehavioral tests detected for adults with blood lead levels 25–41 mcg/dL
- Shih et al., 2007
 - Review of studies of lead exposure and neurocognitive tests
 - Used Bradford Hill criteria to conclude causal association between lead and cognitive decline in adults
 - Significant effects found even in analysis of NAS, with mean BLL 4.5 mcg/dL



Health Effects: Other

- Ekong et al., 2006 conducted a review of lead-related nephrotoxicity.
 - 9/11 studies of the general population found associations between lead and various renal outcomes, even at mean blood lead levels $< 5 \mu\text{g/dL}$
 - People with hypertension and diabetes may be particularly susceptible
 - Bone lead had stronger association with kidney disease than blood lead
 - Studies of occupationally exposed populations show association between higher lead levels and worse kidney function
 - Some studies show a paradoxical effect, with lower creatinine at higher exposure levels

Reproductive Effects

- Wirth et al., 2010 summarized multiple studies:
 - Men with average BLL 37 $\mu\text{g}/\text{dL}$ have worse sperm density, sperm count, and sperm motility than men with average BLL 10 $\mu\text{g}/\text{dL}$
 - Changes in sperm shape and speed were associated with blood lead levels in studies with median blood lead levels of 4.9–5.7 $\mu\text{g}/\text{dL}$
 - Lead accumulates in sperm and sperm lead levels are associated with worse sperm motility, shape, viability, and concentration
 - Several small studies did not detect associations between lead and sperm measurements
- Boucher et al., 2014 examined characteristics of children born to women in a cohort study:
 - Higher cord blood levels associated with slower processing speeds among infants. Study had median cord lead levels of 3.5 $\mu\text{g}/\text{dL}$ (highest level 17.8 $\mu\text{g}/\text{dL}$)
- Hertz-Picciotto, 2000 examined data from a cohort in Mexico City
 - The odds ratio for spontaneous abortion was 1.8 for every 5 $\mu\text{g}/\text{dL}$ increase in BLL

A healthcare professional, a Black woman with her hair in a bun, wearing blue scrubs and a stethoscope, is shaking hands with an elderly Black man wearing a light blue button-down shirt. They are in a bright, clinical setting. A dark blue rectangular box is overlaid on the center of the image, containing the text "Demographics and Health Effects" in white.


Demographics and Health Effects

“Work not only is an important determinant of exposure to hazards, but also a source of income, a significant component of the psychosocial environment, and, in the United States, the primary source of health insurance and access to health services. Work therefore has significant effects on the health of workers, families, and communities.”

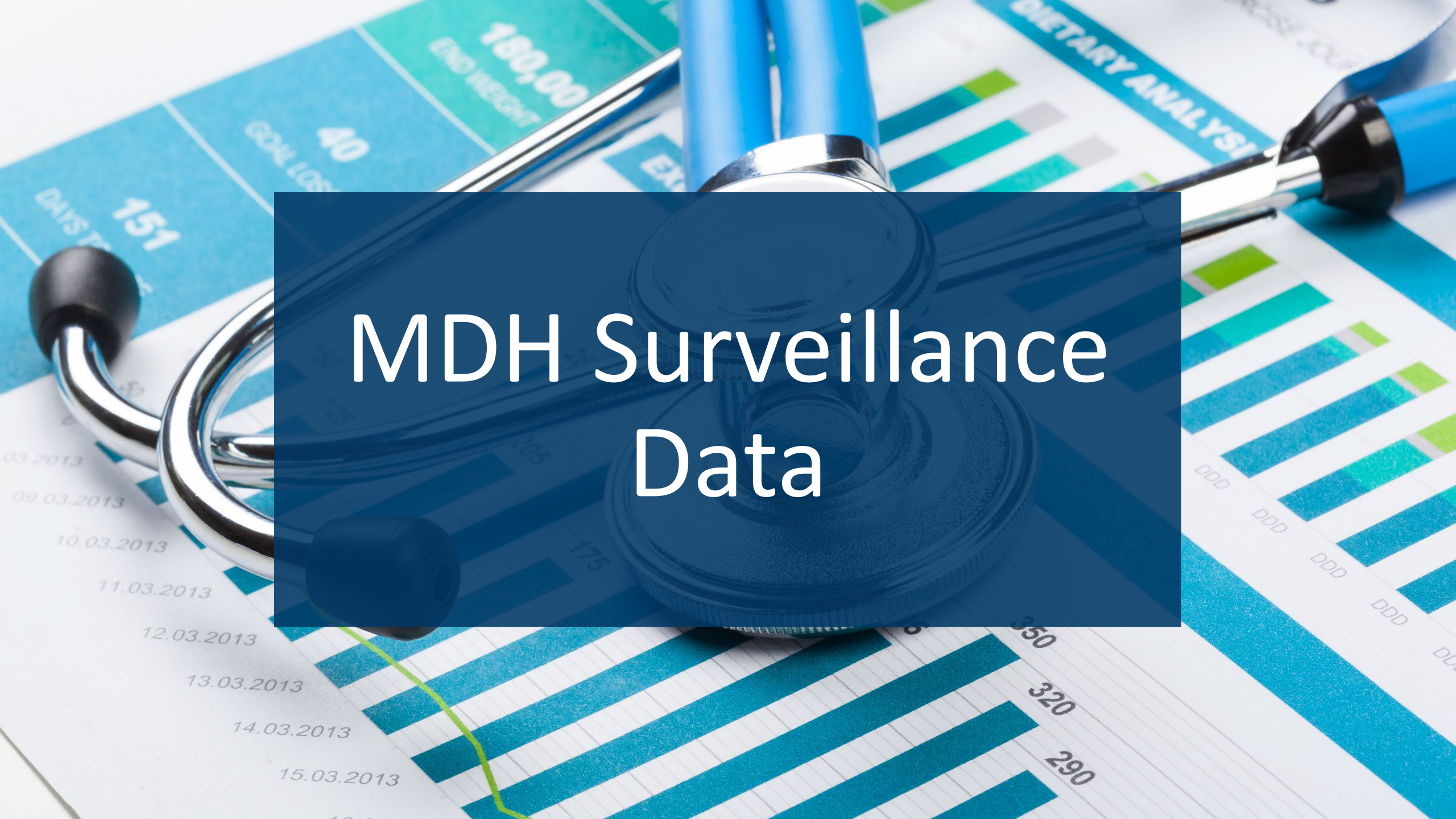
-Lipscomb et al.. A Conceptual Model of Work and Health Disparities in the United States. 2006.

Demographics and Lead Exposure

- Among adults, older adults tend to have higher BLLs than younger adults, reflecting greater lifetime cumulative exposure and lead release from bones
- Men tend to have higher BLLs than women
- People with lower levels of education tend to have higher BLLs
- People with lower income tend to have higher BLLs
- Non-Hispanic Black people tend to have higher BLLs than other groups. Mexican Americans are also sometimes identified as having higher BLLS.

A medical chart with a stethoscope and a blue pen. The chart contains various data points and graphs. A central blue box contains the text "MDH Surveillance Data".

MDH Surveillance Data



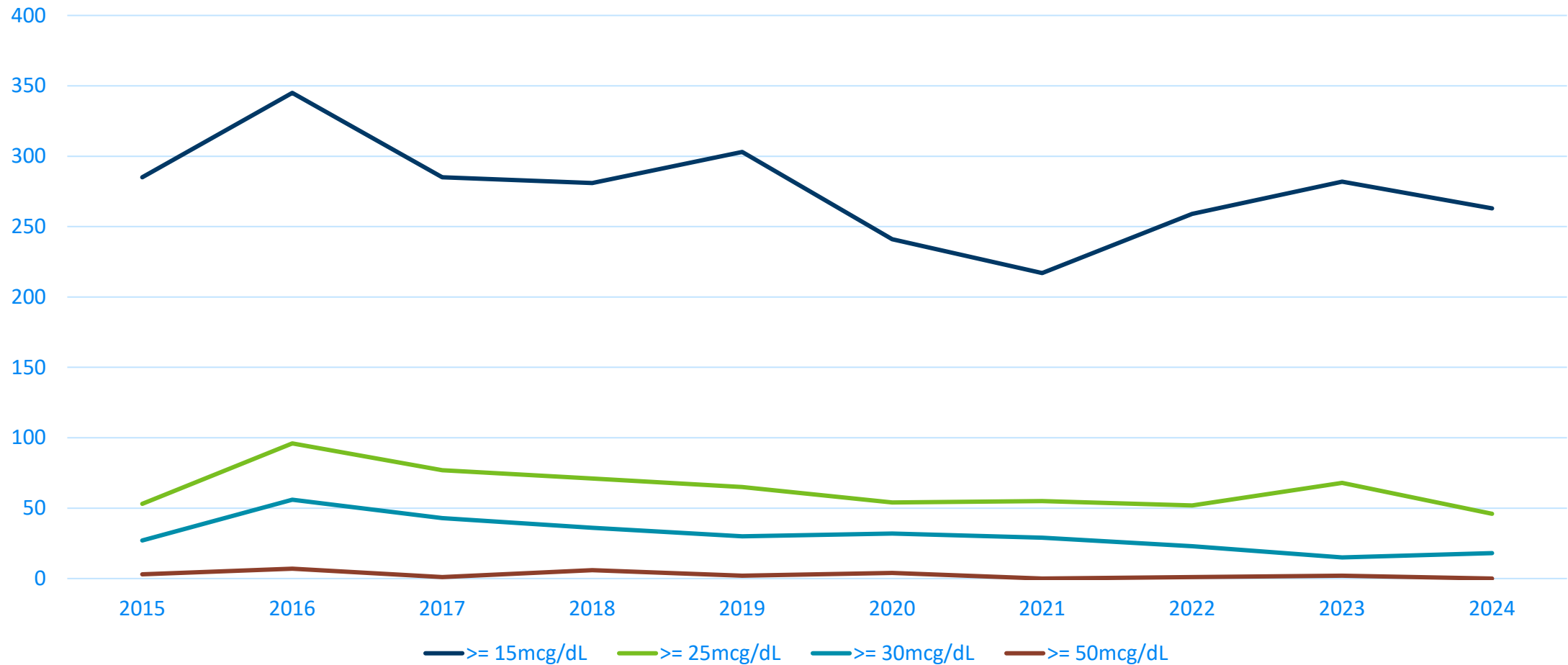
MDH Surveillance System

- Facilities that perform blood lead testing must send all blood lead test results for persons living in Minnesota to MDH
- Reasons adults may receive blood lead tests
 - Occupational surveillance
 - Prenatal screening
 - Symptoms consistent with lead exposure (e.g., neurologic symptoms)
 - Known or suspected lead exposure (e.g., retained bullet fragments or child with non-housing lead exposure)

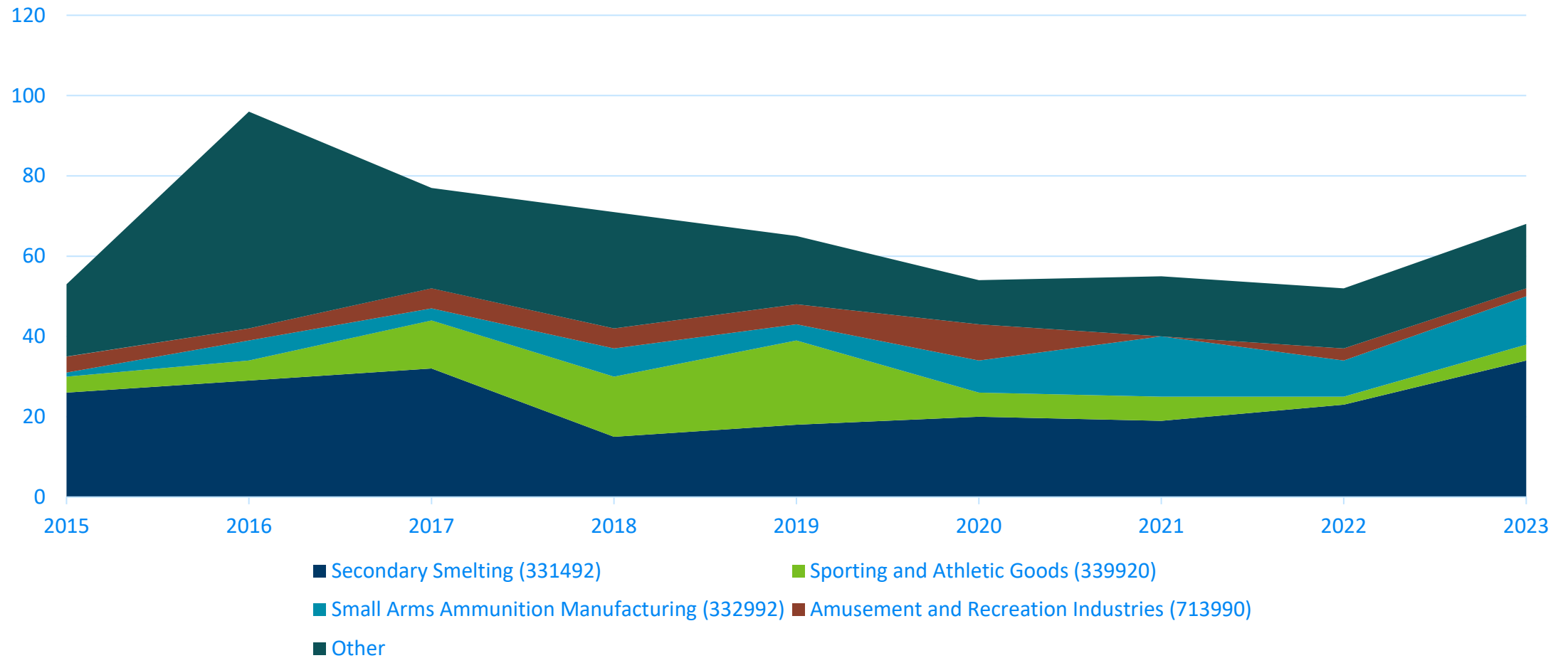
Occupational Data Collection

- Standard laboratory reports do not contain employment information
- Blood lead tests drawn as part of occupational surveillance may have employer listed as ordering provider
- MDH proactively contacts the ordering provider to obtain additional information for:
 - Women of child-bearing age with blood lead levels ≥ 5 mcg/dL
 - Adults with blood lead levels ≥ 25 mcg/dL
 - Adults with blood lead levels 5–25 mcg/dL, as resources allow
- Clinics vary in occupational detail they collect and whether they know patient's pregnancy status

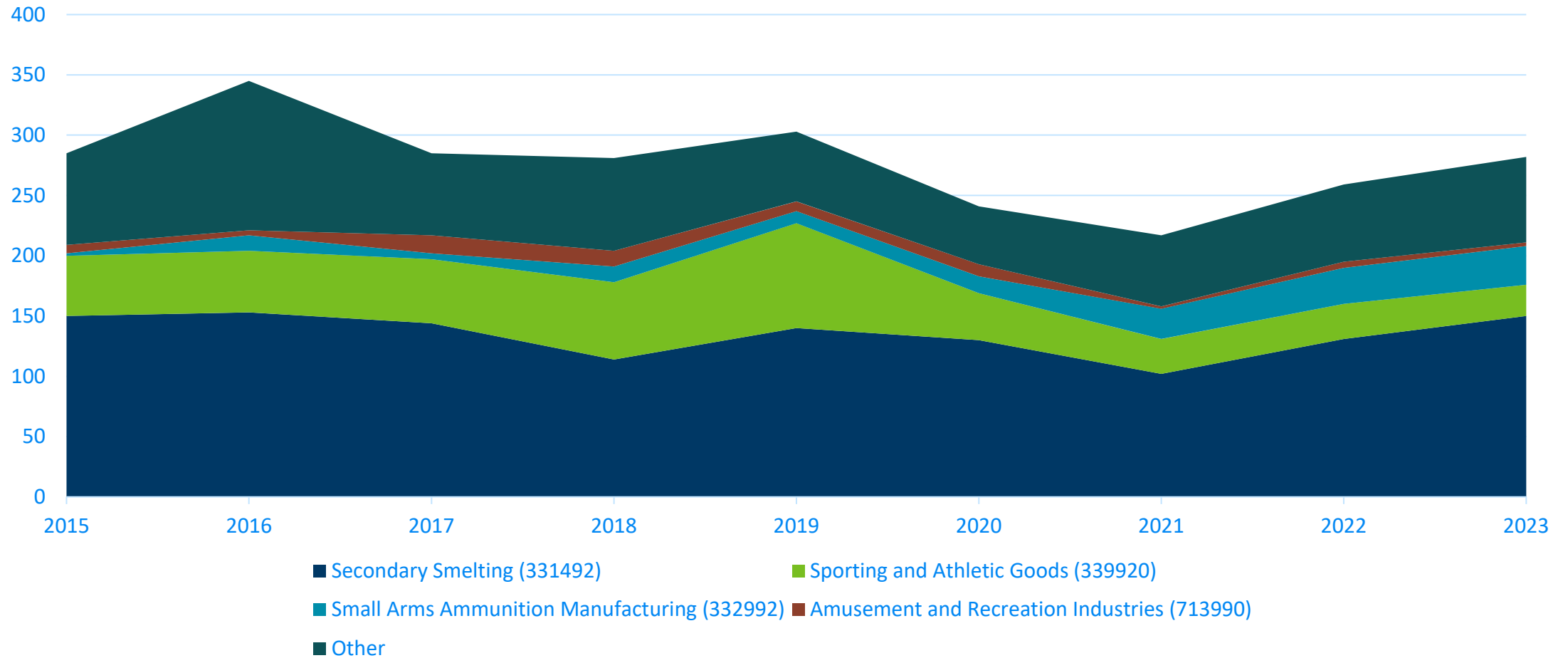
Adult Blood Lead Levels by Year



Adult Blood Lead Levels ≥ 25 mcg/dL by Industry



Adult Blood Lead Levels ≥ 15 mcg/dL by Industry





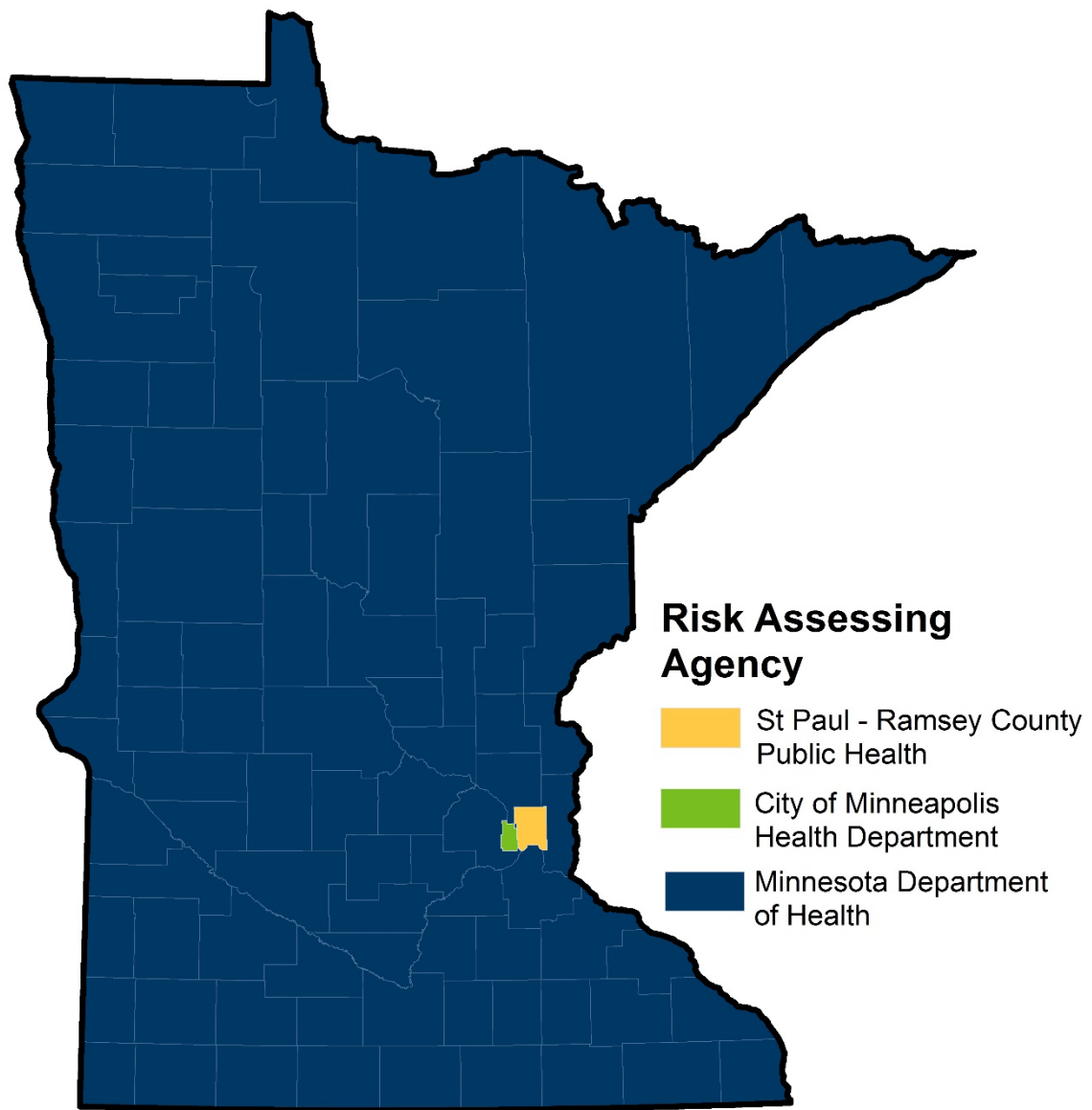
Take-Home Lead Exposure

References: Take-Home Lead Exposure

- Beaucham C, E Page, WA Alarcon, GM Calvert, M Methner, and TM Schoonover. Indoor firing ranges and elevated blood lead levels — United States, 2002–2013. *MMWR*. 2014. 63(16):347–351.
- Boraiko C, EM Wright, and F Ralston. Lead contamination of paint remediation workers' vehicles. *Journal of Environmental Health*. 2013. 75(7):22–27.
- Ceballos DM, Z Dong, JL Peters, RF Herrick, P Gupta, and JD Spengler. Metal dust in workers' homes and potential for take home in the Greater Boston area: Pilot study. *Environmental Research*. 2022. 209:112893.
- Newman N, C Jones, E Page, D Ceballos, and A Oza. Investigation of childhood lead poisoning from parental take-home exposure from an electronic scrap recycling facility — Ohio, 2012. *MMWR*. 2015. 64(27):743–745.
- Oliveri AN, LA Fagerstrom, L Wang, and KD Rosenman. A County-level program for the evaluation of the potential for take-home lead exposures among children in Michigan. *Public Health Reports*. 2022. 137(6):1153–1161.
- Piacitelli GM, EA Whelan, LM Evans, and WK Sieber. Lead contamination in automobiles of lead-exposed bridgeworkers. *Appl Occup Environ Hyg*. 1995. 10(10):849–855.
- Piacitelli GM, EA Whelan, WK Sieber, and B Gerwel. Elevated lead contamination in homes of construction workers. *American Industrial Hygiene Association Journal*. 1997. 58:447–454.
- Porter KA, C Kirk, D Fearey, LJ Castrodale, D Verbrugge, and J McLaughlin. Elevated blood lead levels among fire assay workers and their children in Alaska, 2010–2011. *Public Health Reports*. 2015. 130:440–446.
- Rinsky JL, S Higgins, K Angelon-Gaetz, D Hogan, P Lauffner, M Davies, et al.. Occupational and take-home lead exposure among lead oxide manufacturing employees, North Carolina, 2016. *Public Health Reports*. 2018. 133(6):700–706.
- Roscoe RJ, JL Gittleman, JA Deddens, MR Petersen, and WE Halperin. Blood lead levels among children of lead-exposed workers: A meta-analysis. *American Journal of Industrial Medicine*. 1999. 36:475–481.
- Whelan EA, GM Piacitelli, B Gerwel, TM Schnorr, CA Mueller, Janie Gittleman, et al.. Elevated blood lead levels in children of construction workers. *Am J Public Health*. 1997. 87:1352–1355.
- Yendell SJ, D Janowiak, J Yannarely, Z Rezanian, KMB Haugen, D Yang, et al.. Tackling the lead gremlins: A response to take-home lead exposure in a Minnesota industrial facility, 2019. *AJPH*. 2022. 112(57):S655–S657.

MDH Surveillance System

- Facilities that perform blood lead testing must send all blood lead test results for persons living in Minnesota to MDH
- Reasons kids may receive blood lead tests
 - Routine well-child surveillance
 - Symptoms consistent with lead exposure (e.g., neurologic symptoms)
 - Known or suspected lead exposure (e.g., swallowed object or household member with elevated blood lead level)
- Children <18 years with venous blood lead levels ≥ 5 $\mu\text{g}/\text{dL}$ receive a risk assessment



Risk Assessment Jurisdictions

Lead Risk Assessments



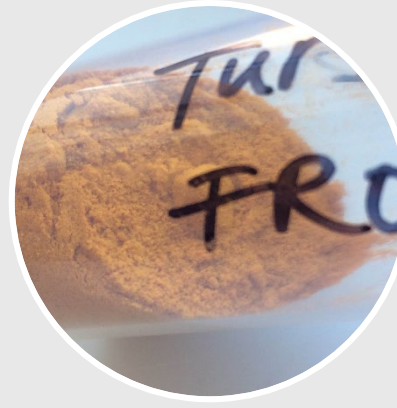
XRF of deteriorated paint



Dust wipe samples



Soil samples



Water and other product samples

Risk Assessment Procedures

- When questionnaire identifies take-home lead as possible factor, risk assessors take additional dust wipe samples:
 - Work shoes
 - Work clothes
 - Driver side floor, driver side seat
 - Child car seat
 - Entry way into home



Example Risk Assessment Findings

- Home built in 1980's
- XRF readings of walls, doors, etc. negative
- Vehicle floor mat 203 mcg/ft²
- Vehicle car seat 84 mcg/ft²
- Worker's shoe sole 24,100 mcg/ft²
- Garage floor 63 mcg/ft²
- Dust wipes for other floors and windows below standards



2021 Changes to Lead Poisoning Prevention Act



Updated Requirements for Lead Risk Assessments

- Lead risk assessments are required within 20 business days when assessing agency is notified of a child or pregnant person as having a venous blood lead level equal to or greater than 5 mcg/dL



Definition of Child

- Anyone under the age of 18 is considered a child.



New Language Added to Lead Risk Assessments

- If another location outside of the home is the original source of lead exposure, the assessing agency may order the responsible person of that location to perform lead hazard reduction and remediate the conditions that allow the lead hazard to migrate from the source location to the home.
- Risk assessments can be done at other locations where lead hazards are suspected in addition to homes, child care facilities, playgrounds, and schools.
- An assessing agency may refer investigations at sites other than the child's or pregnant person's residence to the MDH commissioner for follow up.



Submitting Data

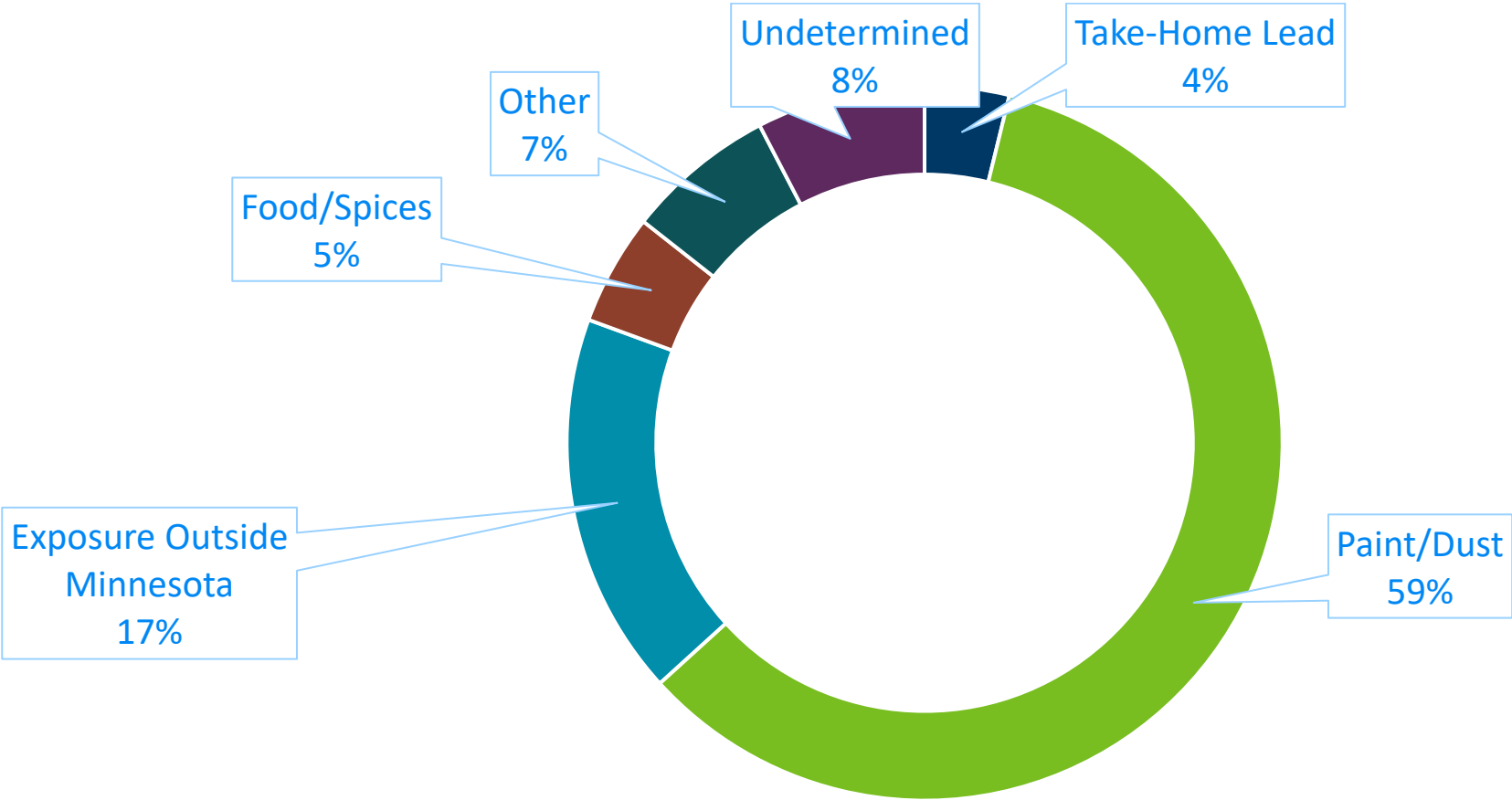
- Data must be submitted by telephone, fax, or electronic transmission "as prescribed by the commissioner".

Enforcement Procedure

Enforced under Minnesota's Health Enforcement Consolidation Act

1. Requests for Information
2. Correction Orders
3. Forgivable or Non-Forgivable Administrative Penalty Orders up to \$10,000

2023–2024 Lead Exposure Sources



2023–2024 Industries Represented

- Ammunition Manufacturing
- Battery Manufacturing
- Commercial and Industrial Machinery and Equipment Repair and Maintenance
- Firearms Training
- Mechanic
- Nonferrous Metal Die-Casting Foundries
- Personal and Household Goods Repair and Maintenance
- Radiator Repair
- Residential Remodelers/Construction
- Roofing Contractors
- Specialized Automotive Repair
- Stained Glass Manufacturing
- Weights and Measures





Recommendations

American College of Occupational and Environmental Medicine (ACOEM) Recommendations

- Medical Removal at a single BLL ≥ 30 $\mu\text{g}/\text{dL}$ or for two successive BLL ≥ 20 $\mu\text{g}/\text{dL}$ measured at a 4-week interval
 - Return-to-work at 15 $\mu\text{g}/\text{dL}$, plus medical approval and addressing conditions that caused exposure
- Physician-ordered medical removal at lower levels based on individual risk
- Workplace management goals to keep workers' BLL less than 10 or 5 $\mu\text{g}/\text{dL}$ (or < 3.5 $\mu\text{g}/\text{dL}$ in the case of women who are or may become pregnant)
- Reduction in the action level (AL) and the permissible exposure level (PEL) for lead in workplace air to 2 and 10 $\mu\text{g}/\text{m}^3$, respectively, as 8-hour time-weighted averages (TWAs)
- Medical surveillance requirements of a revised lead standard should also apply to employees who perform a trigger amount of lead work based on the duration that they are engaged in altering or disturbing materials that contain lead at a concentration $\geq 0.5\%$ by weight

Prevention of Lead Exposure in Adults (PLEA) Workgroup of the Lead Exposure and Prevention Advisory Committee (LEPAC) Recommendations

- OSHA should mirror the changes made by California
- Lower the threshold for medical removal protection to a single BLL > 30 µg/dL or two consecutive BLLs > 20 µg/dL
- Lower the Permissible Exposure Level and the corresponding Action Level for lead in workplace air to 10 µg/m³ and 2 µg/m³ respectively, (as 8-hour time-weighted averages).
- Instead of relying exclusively on air lead monitoring to assess whether the lead standard for general industry may be applicable to a workplace and necessitate medical surveillance, use the concept of “presumed significant lead work.” This includes any work that alters or disturbs material containing lead ≥ 0.5% by weight.
- Increase the frequency of blood lead testing for workers when any BLL exceeds 10 µg/dL.
- Add requirements for direct communication between physicians or other licensed health care professionals and workers regarding BLL test results and follow-up recommendations.
- Expand training, hygiene, and housekeeping requirements for those who work with lead

Basis for Recommendations

- 2024 Session Law Chapter 127. Article 9. Sec. 6. The commissioner of labor and industry, in consultation with the commissioner of health, shall adopt rules to:
 - (1) lower the acceptable blood lead levels above which require mandatory removal of workers from the lead exposure; and
 - (2) lower the blood lead levels required before a worker is allowed to return to work.
- The thresholds established must be based on the most recent public health information on the safety of lead exposure.

AND

- MS 182.655 Subd. 4: The commissioner, in adopting standards dealing with hazardous substances or harmful physical agents under this section, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if the employee has regular exposure to the hazard dealt with by the standard for the period of the employee's working life. Development of standards under this subdivision shall be based upon research, demonstrations, experiments, and other information as may be appropriate. In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws. Whenever practicable, the standard adopted shall be expressed in the terms of objective criteria and of the performance desired.

MDH Recommendations

- While MDH authority can address take-home lead exposure when exposed children are identified, MDH recommends that DLI lower triggers for requiring employer-provided PPE that stays on site and emphasize need for housekeeping to prevent take-home lead.
- MDH recommends removal from work and return to work blood lead levels approximately mirror recommendations from ACOEM and PLEA
- MDH recommends lowering triggers for initiating medical surveillance, by lowering the AL and/or triggering medical surveillance based on presumed significant lead work

Thank You!

Stephanie Yendell

Stephanie.yendell@state.mn.us

651-201-4894