



# Health Impacts of Lead Poisoning

## A preliminary listing of the health effects & symptoms of lead poisoning

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The following list of the symptoms and effects of lead poisoning has been compiled to raise awareness that more blood lead assessments must be done in time for further poisoning to be prevented. After each symptom or effect, the numbers indicate the publications which refer to that effect. So far, only 64 publications have been examined of the thousands published. More will be reviewed and this list updated as time permits.

However, remember that **most** people who are lead poisoned present with no symptoms at all.

### Children

#### Nervous system

- Encephalopathy [brain disease] (1,2,3,4,20,35)
- Acute encephalopathy (11)
- Alters function of developing brain (16)
- Alters electroencephalogram [EEG] (16)
- Convulsions (1, 2, 3, 4)
- Cerebral Palsy (1)
- Neurotransmitter release disrupted (11)

#### Peripheral nervous system

- Peripheral nerve disturbances [reduced touch sensitivity] (2, 3, 4, 5, 6,18)
- Slowed nerve conduction velocity [decreased reaction times] (2,14,18,35,39,58)
- Foot/ hand drop (1,3)
- Proprioceptive pathways involved in balance altered (2)
- Dizziness (1,4,38)

#### Growth & development

- Delayed neurodevelopment [e.g. in sitting up, walking, talking] (2,58)
- Stature and growth rate reduction (1,2,3,18,35,39)
- Impaired pituitary-thyroid endocrine system (18,21)
- Osteoporosis in later years (43)
- Weight loss (58, 60)
- Delayed Puberty (60)
- Reduced postnatal growth (60)

#### Cognitive development

- I.Q. levels decrease (1,2,3,4,5,6,15,24,35,36,39,41,58, 60)



- Cognitive function deficits (2,26,33)
- Verbal function / linguistic deficits (2,14,15)
- Learning difficulties (11,15,35)
- Decreased educational performance (35, 60)
- Decreased reading, maths, non-verbal reasoning ability & short term memory, even at blood lead levels less than 10ug/dL (41)
- Autism (7) in genetically predisposed individuals with metallothionein dysfunction (42)

### **Behaviour**

- Aggression, violence, hostility, anti-social or delinquent behaviour (8,26, 60)
- Attention problems; distractibility, restlessness (8,12,15,21,38,58, 60)
- Externalising and internalising behaviours (8)
- Hyperactive behaviours, difficult to manage (1,2,8)
- Inappropriate / uncontrolled behaviours similar to ADD behaviours, increased frequency (2,11)
- Irritability (1,38)
- Lethargy (1)
- Increased school absenteeism (35)

### **Hearing**

- Hearing impairment; auditory sensitivity decreased (2,3,5,10,14,18,21,26,32,35,39,58, 60)
- Auditory evoked response patterns altered (2)
- Auditory processing altered (2,10)

### **Sight**

- Retinal degeneration (6,10)
- Depressed sensitivity of rod photoreceptors (10)
- Perceptual function deficits (2,21)
- Visio-spatial skills deficit [eg difficulty doing jigsaws] (15)
- Cataract (63)

### **Movement and muscular**

- Visual-motor skills deficits [hand-eye coordination] (2,3,15,26)
- Fine motor dysfunction (1, 2, 3)
- Motor function deficits (2)
- Impaired muscular strength and endurance (26)
- Paralysis (3)
- Somatic complaints [aches and pains] (8,38)

### **Digestive system**

- Impaired Vitamin D metabolism [affecting bone remodelling, mineral absorption and calcium uptake] (2,3,6,18,24,35,38,39,58)
- Colic (3,25,35)
- Loss of appetite (1,2)
- Vomiting (1,4)
- Constipation, diarrhoea, anorexia (38,58)
- Abdominal cramps (39,58)

### **Renal (kidneys), blood and circulation**



- Renal disease – acute nephropathy (14,21,35,38,58)
- Queensland nephritis (14)
- Anaemia (1,2,3,4,5,6,35,38,58)

**Death** (1,2, 3, 4,19,35,46,58)

## **Perinatal Development and Reproductive Health Effects**

### **Foetal**

- Preimplantation loss (3)
- Miscarriage, still birth, neonatal death (2,3,4,5,18,20,24,31,47)
- Reduced gestational age, preterm birth (1,2,3,5,18,24,62)
- Reduced birth weight (1,2,3,4,5,6,18,19, 60,62)
- Minor congenital / chromosomal anomalies (2,3,4,18,31)
- Reproductive abnormalities; disorders (5,13,38)
- Decreased placental functioning (19)
- Lead passed via placenta to foetus from mother (39,58)
- Reduced foetal growth (60,62)

### **Maternal**

- Pre-eclampsia (64)
- Increased risk of maternal death (due to preeclampsia) (64)

### **Adults**

- Altered testicular functioning (24)
- Hypospermia [low sperm count] (3,5,19,47, 60)
- Asthenospermia [sperm weakness] (3,5,20, 60)
- Teratospermia [sperm abnormalities] (3,5,31)
- Erectile dysfunction, impotence (3,40)
- Decreased serum testosterone (3)
- Lead presence in seminal fluid (31)
- Pituitary effects (31)
- Sterility, infertility (5,31,35,39,58)
- Effects on ovaries (19)
- Decreased libido / sex drive (2,21,31)
- Impotence (31)
- Delayed conception time (60)

### **Adults**

#### **Kidneys**

- Renal damage (2,3,5,13,14,21,23,24,28,30,34,39,58)
- Chronic lead nephropathy [kidney disease] (2,3,14,21,22,24,38,58, 60)
- Death from nephritis [kidney inflammation] (29,30)
- Fanconi Syndrome (14)
- Gout (2,3,14)
- Renal hypertension (17)
- Decrease in glomerular filtration rate and Increase in creatinine concentration (23, 60)



### **Nervous system**

- Encephalopathy [brain disease] (2,4,20,24,25,34)
- Cerebrovascular diseases, stroke, cerebral haemorrhage (2,27,28,29,30)
- Psychomotor impairment (13,34)
- Peripheral nervous system (13,24,40,47)
- Peripheral Arterial Disease [PAD](53,54)
- Slowed nerve conduction velocity [slowed reaction time] (2,34,58)
- Tremor (25,26,38,40,55, 60)
- Paresthesia, paralysis (25)

### **Cardiovascular and circulation**

- Hypertension, elevated blood pressure (2,14,17,22,35,38,40,58, 60)
- Increased systolic blood pressure in men (35)
- Cardio-toxic effects (14)
- Increased risk of cardiovascular disease (17, 61)
- Coronary artery disease (2)
- Anaemia; falling haemoglobin levels (2,3,5,13,24,35,38,39,47,58)
- Platelet dysfunction (2)
- Increased erythrocyte [red blood cell] protoporphyrin (35)
- Increased ALA in urine (34)
- Increased protoporphyrin in urine (34)
- Increased risk of early death from heart attack or stroke (46,61)
- Left-ventricular hypertrophy (61)
- Peripheral arterial disease (61)
- Electrocardiographic abnormalities (61)
- Promotes development of atherosclerosis (plaque build-up in arteries) and thrombosis (formation of blood clots) (61)
- Ischaemic heart disease (61)

### **Intellectual and mental**

- Depression (2,13,38)
- Anxiety (38)
- Personality changes (34)
- Death from violence, suicide, accidents (29)
- Impaired concentration (19,25,34,38)
- Deficits in short term memory (2,13,19,34,38)
- Cognitive function deficit (58)
- Oxidative stress (61)

### **Behaviour**

- Fatigue, muscular exhaustion (2,19,25,34,38, 47)
- Sleep disturbance, insomnia (19)
- Irritability, agitation, restlessness, aggression (2,13,24,34,19, 47,58)

### **Sensory**

- Abnormalities in visuomotor coordination (2)
- Abnormalities in fine motor control (2)



- Deficits in visual acuity (2)
- Hearing loss (18,35,39,47,58)
- Somatosensory dysfunction [eg deficits in detection of vibration, changes in temperature] (2,23)

### **Gastrointestinal / Digestive**

- Effects on gastrointestinal tract (24)
- Loss of appetite (19,40)
- Nausea (19)
- Constipation, diarrhoea (25,38)
- Abdominal pain, cramps (25,34,40,47)
- Weight loss, anorexia (25,38)

### **Bone, muscle and joint**

- Bone marrow alterations (21)
- Myalgia [muscle pain] (25,38,40,58)
- Pain in buttocks and cramps in the legs as early stages of peripheral arterial diseases [PAD](53,54)
- Muscular weakness (34,38,39,40,47)
- Arthralgia [joint pain] (25,38,40,47)
- Bone lead mobilisation during menopause leads to decreased neurocognitive performance and increased systolic blood pressure in post-menopausal women (44)
- Wrist drop [the inability to hold the hand extended] (47)
- Long term effect: linked to osteoporosis which has symptoms of decline in bone density and increase risk in fractures, also inhibit normal fracture healing (48,49,50,51,52)

### **Other**

- Headaches (2,19,21,40, 47)
- Decreased longevity (35,39)
- Adrenal dysfunction (38)
- Teeth with blue black-lines near gum base (38,40)
- Pallor (40)
- Cell damage (at blood lead level between 20 to 30 µg/dL for men and between 10 to 20 µg/dL for women) (39)
- Probable human carcinogen (56,57)

### **Death (2,4,19,39,46,61)**

- Increased risk of early death from cancer and all other causes (46)

### **Effects of lead from animal studies**

- Impaired attention, learning and short-term memory in primates (12)
- Behavioural impairment; inflexibility in behavioural change in primates (12)
- Elevated blood pressure at moderate levels (17)
- Impaired immune system in new-borns of rats fed lead [greater susceptibility to asthma] (37,45)
- Increased incidence of tumors (cancer) in rats born to mothers fed lead (45)
- Altered response to stimulant drugs; attenuation of drug induced hyperactivity in rats (2)
- Teratogenic effect causing birth deformities (4)



- Low bone density in lab animals such as mice and fractures due to lead-induced osteoporosis do not heal properly (52)

## References

[LID = Library identification number in Global Lead Advice & Support Service (GLASS) Library]

1. Smith, M. A., Grant, L. D. & Sors, A. (1989). **Lead exposure and child development: an international assessment**. Kleeven Academic Publishers. [LID 5279]
2. Silbergeld, E. K. (1992). **Neurological perspective on lead toxicity**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 756]
3. National Research Council (US). (1993). **Measuring lead exposure in infants children and other sensitive populations**. National Academy Press, Washington DC. [LID 5042]
4. Chemwatch Database. (1996) **Lead Arsenate**. <http://www.chemsw.com/> [LID 73]
5. Alperstein, G., Reznik, R. & Duggin, G. (1991). **Lead: Subtle forms and new modes of poisoning**. The Medical Journal of Australia Vol 155 Sept 16. [LID 208]
6. Berry, M., Garrard, J. & Greene, D. (1994). **Reducing Lead Exposure in Australia**. Commonwealth Department of Human Services and Health, Canberra. [LID 1208]
7. Clark, H. R. (1995). **The cure for all diseases**. Pro Motion Publishing, San Diego California. [http://drclarkia.com/books/The\\_Cure\\_For\\_All\\_Diseases.html](http://drclarkia.com/books/The_Cure_For_All_Diseases.html) . [LID 673]
8. Needleman, H. L., Riess, J. A., Tobin, M., Biesecker, G. & Greenhouse, J.B. (1996). **Bone Lead Levels and Delinquent Behavior**. vol 275 No 5 JAMA. February 7. pp 363-369. <http://jama.jamanetwork.com/article.aspx?articleid=395592> Abstract. [LID 54]
9. F. Gil, A. Facio, E. Villanueva, M.L. Pérez, R. Tojo, A. Gil, **The association of tooth lead content with dental health factors, The science of the total environment**. Volume 192, Issue 2, 2 December 1996, Pages 183–191. <http://www.sciencedirect.com/science/article/pii/S0048969796053132> Abstract.
10. Fox, D. A. (1992). **Visual and Auditory System Alterations following Developmental or Adult Lead Exposure: a critical review**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 4820]
11. Goldstein, G. W. (1992). **Developmental neurobiology of lead toxicity**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 1563]
12. Rice, D. C., (1992). **Behavioural Impairment produced by developmental lead exposure: Evidence from primate research**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 4822]
13. Matte, T. D., Landrigan P. J. & Baker E. L. (1992). **Occupational Lead Exposure**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 4806]
14. Wedeen R. P. (1992). **Lead, the kidneys and hypertension**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press
15. Bellinger, D. & Needleman, H. L. (1992). **Neurodevelopmental effects of low-level lead exposure in children**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 4824]
16. Burchfile, J. L., Duffy, F. H., Bartels P. H., & Needleman, H. L. (1992). **Low-level lead exposure: Effect on quantitative electroencephalography and correlation with neuropsychologic measures**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press
17. Schwartz, J. (1992). **Lead, blood pressure and cardio-vascular disease** In **Human Lead Exposure**, ed H. L. Needleman, CRC Press
18. Schwartz, J. (1992). **Low level health effects of lead: Growth, developmental and neurological disturbances**. In **Human Lead Exposure**, ed H. L. Needleman, CRC Press. [LID 4827]
19. Rutter, M. & Jones, R. (ed) **Lead versus health: Sources and effects of low level lead exposure**. Wiley medical Publications
20. National Academy of Sciences. (1980). **Lead in the Human Environment**. Washington DC.
21. Castellino, N., Castellino, P. & Sannolo, N. (ed). (1995). **Inorganic lead exposure**. Lewis Publishers
22. Hu, H., Pepper, L. & Goldman, R. **Effect of repeated occupational exposure to lead, cessation of exposure, and chelation on levels of lead in bone..** American Journal of Industrial Medicine 1991;20(6):723-35. <http://www.ncbi.nlm.nih.gov/pubmed/1805610> Abstract.
23. Rokho Kim, MD, DrPH; Andrea Rotnitzky, PhD; David Sparrow, DSc; Scott T. Weiss, MD, MSc; Carrie Wager, BSc; Howard Hu, MD, ScD . (1996). **A Longitudinal Study of Low level lead exposure and**



- impairment of renal function.** JAMA Vol 275 No 15 April 1996. p. 1177-1181.  
<http://jama.jamanetwork.com/article.aspx?articleid=400546> Abstract.
24. Fischbein, A. (1992). **Occupational and environmental lead exposure.** In Environmental and Occupational Medicine, 2<sup>nd</sup> edn. Ed W.N. Rom. Little, Brown & Co. [LID 5136]
  25. Rempel, D. MD. **The Lead-Exposed Worker** California occupational health program JAMA. 1989; 262(4): 532-534. <http://jama.jamanetwork.com/article.aspx?articleid=378115> Abstract.
  26. Repko, J. (1976). **Behavioural toxicology of inorganic Lead.** In **Health Effects of Occupational Lead and Arsenic Exposure** - a symposium, ed.B. W. Carnow, US Dept of Health, Education and Welfare Public Health Service Divn of Surveillance Hazard Evaluation and Field Studies, Feb.
  27. Fanning, D. (1988). **A mortality study of lead workers 1926 - 1985.** In Archives of Environmental Health, Vol 43 No 3 May/June. pp. 247-251. <http://www.ncbi.nlm.nih.gov/pubmed/3382250> Abstract.
  28. D Malcolm, H A Barnett. (1982). **A mortality study of lead workers 1925 - 76.** In British Journal of Industrial Medicine 1982; Vol 39. pp. 404-410 <http://oem.bmj.com/content/39/4/404.abstract>
  29. Davies, J. M. (1984). **Long-term mortality study of chromate pigment workers who suffered lead poisoning.** In British Journal of Industrial Medicine, Vol 41. pp. 170-178  
<http://oem.bmj.com/content/41/2/170.abstract?sid=7a6b24e7-2419-4a15-ab25-5d78f48d25f8>
  30. McMichael, A. J. & Johnson, H. M. **Long term mortality profile of heavily exposed lead smelter workers.** In Journal of Occupational Health, Vol 24 No 5 May 1982.  
[http://journals.lww.com/joem/Abstract/1982/24050/Long\\_term\\_Mortality\\_Profile\\_of\\_Heavily\\_Exposed.8.aspx](http://journals.lww.com/joem/Abstract/1982/24050/Long_term_Mortality_Profile_of_Heavily_Exposed.8.aspx)
  31. Winder, C. (1989). **Reproductive and chromosomal effects of occupational exposure to lead in the male.** In Reproductive Toxicology Review. Vol 7. pp. 221-233. [LID 1479]
  32. Schwartz, J. & Otto, D. (1987). **Blood lead, hearing thresholds, and neurobehavioral development in children and youth.** In Archives of Environmental Health Vol 42, No. 21 pp 153-160, 1st May 1987.  
[http://hero.epa.gov/index.cfm?action=reference.details&reference\\_id=57538](http://hero.epa.gov/index.cfm?action=reference.details&reference_id=57538)  
[http://cfpub.epa.gov/si/si\\_public\\_record\\_Report.cfm?dirEntryID=48404](http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryID=48404)
  33. Fergusson, D. M., Hurwood, L. J. & Lynskey, M. T. (1997). **Early dentine lead levels and educational outcomes at 18 years.** In Journal of Child Psychology and Psychiatry, Vol 38 No 4. pp. 471-478.  
<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7610.1997.tb01532.x/abstract;jsessionid=4E242DD9F8439BE0BB0A53981CAEB7B4.d03t02>
  34. NSW Workcover Authority. **Occupational Medicine Handbook** Ch 5 "Lead" p. 58
  35. Royce, S. E. (1992). **Lead toxicity.** US Dept of Health and Human Services Agency for Toxic Substances and Disease Registry. Sept .  
<http://wonder.cdc.gov/wonder/prevguid/p0000017/p0000017.asp>
  36. Gatsonis, C. A.. & Needleman, H. L. (1992). **Recent epidemiological studies of low-level lead exposure and the IQ of children: a meta-analytic review** In Human Lead Exposure, ed H. L. Needleman, CRC Press. [LID 4828]
  37. Day, M. (1998) **Lead in the womb.** New Scientist Magazine. 23 May 1998 p.7
  38. Werbach, M. F. (1997). **Foundations of nutritional medicine.** Third Line press, Tarzana California.
  39. Agency for Toxic Substances Disease Registrar. (1989). **Toxicological profile of lead.** US ATSDR.  
<http://www.atsdr.cdc.gov/ToxProfiles/TP.asp?id=96&tid=22>
  40. Salome, F. & Gulson, B. (1996). **Lead paint management.** Grad School of the Environment, Macquarie University
  41. Lanphear, Bruce P; Dietrich, Kim; Auinger, Peggy; Cox, Christopher. (2000) **Cognitive Deficits Associated with Blood Lead Concentrations <10 µg/dL in US Children and Adolescents**, Public Health Reports Nov 2000, Volume 115, 521-529;  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1308622/pdf/pubhealthrep00019-0027.pdf>
  42. Walsh, William J; Usman, Anju; Tarpey, Jeffrey; and Kelly, Tanika. (2001) **Metallothionein And Autism** Pfeiffer Treatment Center, Health Research Institute, Naperville, Illinois USA. The booklet can be ordered from [info@HRIPTC.org](mailto:info@HRIPTC.org) or via the website [www.hriptic.org](http://www.hriptic.org) for US\$20 + postage but is not web-published. October 2001
  43. Wentzel, Michael, Democrat & Chronicle, 25/2/02, **UR [University of Rochester] links childhood lead to osteoporosis:** <http://www.mindfully.org/Health/Folder%20Settings/2002/Lead-Exposure-Osteoporosis25feb02.htm>



44. Silbergeld, Ellen, **Menopause and Lead: Consequences and Determinants of Bone Lead Mobilization**, Women's Environments & Women's Health Conference, Baltimore, Maryland, October 22, 1999.
45. NBC News, **Lead in Pregnancy Linked to Asthma**, July 29 [1998?] re: study by Dr. Rodney R. Dietert, Cornell University in Ithaca, N.Y published in journal Toxicological Sciences. See [http://www.cyber-nook.com/water/tbl\\_cont.html](http://www.cyber-nook.com/water/tbl_cont.html) [LID 6728]
46. Lustberg, M; Silbergeld, E, **Blood Lead Levels And Mortality**, in Arch Intern Med 2002 Nov 25;162(21):2443-9, <http://archinte.jamanetwork.com/article.aspx?articleid=214370> [LID 6921]
47. Government of Ontario, Canada, Ministry of Labour, Health and Safety, "**Lead on Construction Projects - The Health Effects of Lead**", [http://www.labour.gov.on.ca/english/hs/pdf/gl\\_lead.pdf](http://www.labour.gov.on.ca/english/hs/pdf/gl_lead.pdf)
48. Escribano, A., M. Revilla, E.R. Hernandez, C. Seco, J. Gonzalez-Riola, L.F. Villa, H. Rico. (1997), **Effect of lead on bone development and bone mass: A morphometric, densitometric, and histomorphometric study in growing rats**. Calcified Tissue International. 60(2): 200-203. <http://www.springerlink.com/content/81u4pc2002ecgx54/> <http://www.ncbi.nlm.nih.gov/pubmed/9056171>
49. Gruber, H.E., H.C. Gonick, F. Khalil-Manesh, T.V. Sanchez, S. Motsinger, M. Meyer, C.F. Sharp. (1997). **Osteopenia induced by long-term, low- and high-level exposure of the adult rat to lead**. Mineral & Electrolyte Metabolism. 23(2): 645-73. <http://www.ncbi.nlm.nih.gov/pubmed/9252971>; <http://cat.inist.fr/?aModele=afficheN&cpsidt=2781185>
50. Katrina Smith Korfmacher, PhD, **Long Term Costs of Lead Poisoning. How much can New York save by stopping lead?** Environmental Health Sciences Center, University of Rochester. <http://www.sehn.org/tccpdf/lead%20costs%20NY.pdf>
51. Professor Brian Gulson, Macquarie University News, **Good News for aging Bones**, No longer online.
52. St. Louis Lead Prevention Coalition - **University of Rochester study links osteoporosis to childhood lead exposure**, [http://www.leadprevention.org/web/uploads/childhood\\_lead\\_&\\_osteoporosis.doc](http://www.leadprevention.org/web/uploads/childhood_lead_&_osteoporosis.doc)
53. AHA Journal News report (2004), "**Safe** levels of lead, cadmium may raise risk of peripheral artery disease", 08/06/04. <http://www.charitywire.com/charity8/05787.html> [LID 7385]
54. Ana Navas-Acien, MD, MPH; Elizabeth Selvin, MPH; A. Richey Sharrett, MD, DrPH; Emma Calderon-Aranda, PhD, MD; Ellen Silbergeld, PhD; Eliseo Guallar, MD, DrPH. **Lead, Cadmium, Smoking, and Increased Risk of Peripheral Arterial Disease** (Circulation. 2004;109:3196-3201.) © 2004 American Heart Association, Inc. <http://circ.ahajournals.org/content/109/25/3196.full> [LID 7392]
55. Louis, ED, EC Jurewicz, LK Applegate, P Factor-Litvak, M Parides, L Andrews, V Slavkovich, JH Graziano, S Carroll and A Todd. (2003). "**Association Between Essential Tremor and Blood Lead Concentration** Environmental Health Perspectives", 3 July 2003 <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241711/pdf/ehp0111-001707.pdf> [LID 7330]
56. International Agency for Research on Cancer (IARC), **IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 87 (2006) Inorganic and Organic Lead Compounds** <http://monographs.iarc.fr/ENG/Monographs/vol87/index.php> [LID 7420]
57. National Toxicology Program (of the US department of Health and Human Services) **Report on Carcinogens** Twelfth Edition 2011 <http://ntp-server.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf> [LID 7352]
58. Dr. Ben Balzer, **Lead Poisoning Slide Show**, 6 September 2000 [www.lead.org.au/bblp/bblp.html](http://www.lead.org.au/bblp/bblp.html) [LID 4598]
59. Menke, A, Muntner, P, Batuman, V, Silbergeld, EK, and Guallar, E. 2004. **Blood Lead Below 0.48 µmol/L (10 µg/dL) and Mortality Among US Adults**. Circulation - Journal of the American Heart Association 114:1388. <http://circ.ahajournals.org/cgi/reprint/CIRCULATIONAHA.106.628321v1> [LID 8599]
60. National Toxicology Program (NTP). **NTP Monograph on Health Effects of Low-Level Lead**. U.S Department of Health and Services 2012 [LID 15884]
61. Lanphear B, Rauch S, Auinger P, Allen R, Hornung R, **Low-level lead exposure and mortality in US adults: a population-based cohort study**. Lancet Public Health 2018 [http://www.thelancet.com/journals/lanpub/article/PIIS2468-2667\(18\)30025-2/fulltext](http://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(18)30025-2/fulltext) [LID 18948]
62. Felicia A. Rabito, Mehmet Kocak, Derek W. Werthmann, Frances A. Tylavsky, Christopher D. Palmer, Patrick J. Parsons, **Changes in low levels of lead over the course of**





- pregnancy and the association with birth outcomes.** Reproductive Toxicology Volume 50, December 2014, Pages 138-144, published online 22 Oct 2014, at <https://www.sciencedirect.com/science/article/abs/pii/S0890623814002597?via%3Dihub>
63. Schaumberg DA, Mendes F, Balaram M, Dana MR, Sparrow D, Hu H. **Accumulated lead exposure and risk of age-related cataract in men.** JAMA. 2004;292(22):2750-2754 - JAMA, December 8, 2004 - Vol 292, No. 22. [http://www.rima.org/web/medline\\_pdf/Jama\\_2750.pdf](http://www.rima.org/web/medline_pdf/Jama_2750.pdf)
64. Arthur E. Poropat, Mark A. S. Laidlaw, Bruce Lanphear, Andrew Ball, Howard W. Mielke **Blood lead and preeclampsia: A meta-analysis and review of implications.** Environmental Research Volume 160, January 2018, Pages 12-19, at <https://doi.org/10.1016/j.envres.2017.09.014>
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