Dangers of a blood lead level above 2 µg/dL and below 10 µg/dL to adults

By Robert Taylor for The LEAD Group Inc, Australia, December 2010

NB µg/dL = micrograms per decilitre, and µmol/L = micromoles per litre, are the usual units used for lead in blood results. Also see "Blood lead testing: who to test, when, and how to respond to the result"

1. "Environmental Exposure to Lead and Progression of Chronic Renal Diseases: A Four-Year Prospective Longitudinal Study" by Chun-Chen Yu, Ja-Liang Lin and Dan-Tzu Lin-Tan in J Am Soc Nephrol 15:1016-1022, 2004 at http://jasn.asnjournals.org/cgi/content/full/15/4/1016

"… after long term follow-up for 48 mo, only BLB [body lead burden] and BLL [blood lead level] remained the most important predictors of progressive deterioration of renal function. …it is important to note that no safe limits of lead indices are noted in the current work. The mean BLL of the study participants was only 4.2 µg/dl."

2. "Blood Lead Below 0.48 µmol/L (10 µg/dL) and Mortality Among US Adults" by Andy Menke, Paul Muntner, Vecihi Batuman, Ellen K. Silbergeld and Eliseo Guallar, in Circulation - Journal of the American Heart Association, September 26, 2006 published online Sep 18, 2006; AVAILABLE FOR PURCHASE FROM http://circ.ahajournals.org/cgi/content/short/114/13/1388

"Methods and Results -The geometric mean blood lead level in study participants was 0.12 µmol/L (2.58 µg/dL). After multivariate adjustment, the hazard ratios (95% CI) for comparisons of participants in the highest tertile of blood lead (>0.17 µmol/L [>3.62 µg/dL]) with those in the lowest tertile (<0.09 µmol/L [<1.94 µg/dL]) were 1.25 (1.04 to 1.51; Ptrend across tertiles = 0.002) for all-cause mortality and 1.55 (1.08 to 2.24; Ptrend = 0.003) for cardiovascular mortality. Blood lead level was significantly associated with both myocardial infarction and stroke mortality, and the association was evident at levels >0.10 µmol/L (>2 µg/dL)."

"Mean total cholesterol, the prevalence of hypertension, the prevalence of reduced GFR, and the prevalence of a history of cardiovascular disease were higher at higher lead levels."

"The multivariate adjusted hazard ratio of all-cause mortality for the highest versus the lowest tertile was 1.25 (95% CI 1.04 to 1.51; Ptrend across tertiles = 0.002). When cause-specific deaths were investigated, the increased mortality was concentrated in cardiovascular deaths. The multivariate adjusted hazard ratios for the highest versus the lowest tertile of lead level were 1.55 (1.08 to 2.24), 1.89 (1.04 to 3.43), and 2.51 (1.20 to 5.26), respectively, for cardiovascular, myocardial infarction, and stroke mortality (each Ptrend = 0.05).The results were markedly consistent across subgroups."

"In the present study data, the association of blood lead with cardiovascular mortality was evident at levels as low as 0.10 µmol/L (2 µg/dL). Because 38% of US adults had lead levels 0.10 µmol/L (2 µg/dL) in NHANES 1999 to 2002, the public health implications of these findings are substantial…The results of the present study call for the inclusion of lead exposure at levels <0.48 µmol/L (10 µg/dL) among adult related cardiovascular risk factors."

3. " 'Safe' levels of lead may not be that safe after all" by Melissa Healy, Times Staff Writer, The Los Angeles Times 2/10/06 at http://articles.latimes.com/2006/oct/02/health/he-lead2

A study published in the American Heart Association Journal "Circulation" tracked 13,946 adults for 12 years, comparing lead levels and cause of death. It found that those with a level between 3.6 µg/dL and 10 µg/dL were two and a half times more likely to die of a heart attack than those with very low levels [under 1.9 µg/dL], 89% more likely to die of stroke, and 55% more likely to die of cardiovascular disease.

4. "Lead in Blood: 'Safe' Levels Too High? Average Americans Tested Had Level High Enough for Increased Heart Disease Death Risk" by Miranda Hitti , Medical Writer, WebMD Medical News, Reviewed By Louise Chang, MD Medical Editor, WebMD Medical News, Sept. 18, 2006 at www.webmd.com/news/20060918/lead-in-blood-safe-levels-too-high

"The average blood level of lead found among Americans is high enough to increase the likelihood of heart attack and stroke, according to a new study.

"In fact, people with only a fifth the level of lead in their blood now considered 'high' are more likely to die of heart attack or stroke, the study shows.

"These findings suggest the threshold for 'high' blood levels of lead may not fully take into account lead's heart risks, according to the study.

"The study appears in Circulation's rapid access online edition."

"A 'high' blood level is now defined as more than 10 micrograms of lead per deciliter of blood (10 µg/dL).

"Most Americans -- 99% -- fall below that threshold, write the researchers, who include Andy Menke, MPH, of Tulane University School of Public Health.

"But an increased likelihood of death from heart attack or stroke has started to be seen in people with blood levels greater than 2 µg/dL, according to Menke and colleagues."

5. "Lead, Cadmium, Smoking, and Increased Risk of Peripheral Arterial Disease" by A Navas-Acien, E Selvin, R Sharrett, E Calderon-Aranda, E Silbergeld, E Guallar in Circulation Issue 109, American Heart Association (AHA) Inc. June 7th 2004. Available at http://circ.ahajournals.org/cgi/content/full/109/25/3196

"…the ORs of peripheral arterial disease comparing quartiles 2 to 4 of lead with the lowest quartile were 1.63 (95% CI, 0.51 to 5.15), 1.92 (95% CI, 0.62 to 9.47), and 2.88 (95% CI, 0.87 to 9.47), respectively (P for trend=0.02)."

"Blood lead and cadmium levels were strongly associated with an increased prevalence of PAD in a representative sample of US adults….The observed increase in PAD prevalence occurred at lead and cadmium levels much lower than current safety levels used by environmental and occupational regulatory agencies. For instance, only 1 study participant had lead levels >1.93 µµmol/L (40 µg/dL), the Occupational Safety and Health Administration (OSHA) Safety Standard for lead in whole blood, and only 35 (1.6%) had lead levels >0.48 µmol/L (10 µg/dL), the Centers for Disease Control and Prevention criterion for elevated blood levels in children and pregnant women."

6. "'Safe' levels of lead, cadmium" by Carole Bullock 'Safe' levels of lead, cadmium AHA Journal News report, 8th June 2004, at www.eurekalert.org/pub_releases/2004-06/aha-lo060304.php

"The general public can be exposed to lead and cadmium through cigarette smoke, in ambient air near industrial and combustion sources, in certain foods and sometimes in drinking water. Peripheral artery disease or PAD affects 8 to 12 million Americans, according to the American Heart Association. It is a condition similar to coronary artery disease and carotid artery disease. In PAD, fatty deposits build up in artery walls and reduce blood circulation, mainly in arteries to the legs and feet. In its early stages a common symptom is cramping or fatigue in the legs and buttocks during activity. Such cramping subsides when the person stands still.

"In a study of 2,125 adults, those with the highest blood concentrations of lead or cadmium were almost three times more likely to develop PAD than those with the lowest levels of the two metals. Yet the highest levels were well within what is currently considered safe levels, said senior author Eliseo Guallar, M.D., DrPH, an assistant professor of epidemiology at the Johns Hopkins University Bloomberg School of Public Health in Baltimore. "

7. "Blood Lead Levels and Death from All Causes, Cardiovascular Disease, and Cancer: Results from the NHANES III Mortality Study" by Susan E. Schober, Lisa B. Mirel, Barry I. Graubard, Debra J. Brody, Katherine M. Flegal in Environmental Health Perspectives Online 6th July 2006, The National Institute of Environmental Health Sciences, National Institutes of Health, U.S. Department of Health and Human Services, 1st Oct 2006, at www.ncbi.nlm.nih.gov/pmc/articles/PMC1626441/

"For all ages combined, the relative risks of mortality were 1.24 [95% confidence interval (CI),1.05–1.48 … from cardiovascular disease was 1.20 (95% CI, 0.93–1.55) ... from cancer was 1.44 (95% CI, 1.12–1.86) for those with blood lead levels of 5–9 µg/dL."

"The results of our study showing increased mortality at levels as low as 5–9 µg/dL are consistent with other research that suggests health effects associated with low levels of lead exposure. Recent cross-sectional analyses of the current, ongoing NHANES, with data from 1999–2002, suggest an increased risk of peripheral arterial disease, hypertension, and renal dysfunction in a population with blood lead levels of approximately 2 µg/dL on average (Muntner et al. 2005; Navas-Acien et al. 2004). Other analyses of population-based studies support these results. For example, in the Normative Aging Study, blood lead levels < 10 µg/dL were associated with renal function and cognitive impairment (Kim et al. 1996; Payton et al.1994, 1998; Weisskopf et al. 2004; Wright et al. 2003). Cross-sectional analyses of the NHANES III cohort have shown that blood lead levels are related to increased blood pressure (Nash et al. 2003) and decreased renal function (Muntner et al. 2003)."

8. "Research Indicates that Low Blood Lead Levels Contribute to Early Death from Cardiovascular Disease and Cancer" by Courtney Hinton, Intern at the Alliance for Healthy Housing, & Student, University of Maryland, published in Alliance Alert, August 2006, published by the Alliance for Health Housing (AFHH) at www.afhh.org/res/res_alert_archives_aug06.htm#lowbllearlydeath

This is a summary of item 7, above (The 3rd US National Health and Nutrition Examination Survey, NHANES 3)

"Previous surveys, conducted in 1976-1980, indicated a higher risk of death with blood lead levels higher than 20 µg/dL. Blood lead levels have significantly decreased since 1970, however, and the third survey, conducted from 1988-1994, reflect that even low blood lead levels, between 5-9 µg/dL, carry an increased risk of death.

"The current NHANES, with data from 1999-2002, suggests an elevated risk of peripheral arterial disease, hypertension, and renal dysfunction in a population with blood lead levels averaging approximately 2 µg/dL.

"The analysis of the third NHANES study supports other evidence of adverse health consequences related to blood levels that are lower than current levels of concern."

9. "Association of blood lead concentrations [greater than 8 µg/dL] with mortality in older women: a prospective cohort study" by Naila Khalil , John W Wilson , Evelyn O Talbott , Lisa A Morrow , Marc C Hochberg , Teresa A Hillier , Susan B Muldoon , Steven R Cummings and Jane A Cauley (2009) at www.ehjournal.net/content/8/1/15

"Women with blood lead concentrations ≥ 8 µg/dL (0.384 µmol/L), had 59% increased risk of multivariate adjusted all cause mortality (Hazard Ratio [HR], 1.59; 95% confidence interval [CI], 1.02–2.49) (p = 0.041) especially coronary heart disease (CHD) mortality (HR = 3.08 [CI], (1.23–7.70)(p = 0.016), compared to women with blood lead concentrations < 8 µg/dL(< 0.384 µmol/L). There was no association of blood lead with stroke, cancer, or non cardiovascular deaths."

"Conclusion

Women with blood lead concentrations of ≥ 8 µg/dL (0.384 µmol/L), experienced increased mortality, in particular from CHD as compared to those with lower blood lead concentrations."

10. "Association Between Essential Tremor and Blood Lead Concentration" by ED Louis, EC Jurewicz, LK Applegate, P Factor-Litvak, M Parides, L Andrews, V Slavkovich, JH Graziano, S Carroll, and Todd, at www.ncbi.nlm.nih.gov/pmc/articles/PMC1241711/pdf/ehp0111-001707.pdf

"Essential tremor (ET) is a neurologic disease that is characterized by an action tremor of the hands and/or head. ET is considered to be distinct from age-related enhanced physiologic tremor."

"There was a correlation between the total tremor score and BPb [blood lead] concentration (Spearman's r = 0.14; p = 0.03) in the 243 study subjects."

"BPb concentrations were higher in ET patients than in controls (mean ± SD, 3.3 ± 2.4 and 2.6 ± 1.6 µg/dL, respectively; median, 2.7 and 2.3 µg/dL; p = 0.038)."

"In this case–control study, we found that the BPb concentration was higher in ET patients than in controls. This association between higher BPb concentration and the diagnosis of ET persisted after adjusting for confounding variables. The association was strongest in patients with sporadic ET, that is, those with no family history of tremor, suggesting that lead as a toxicant might be of more relevance in ET patients without a genetic susceptibility for ET."

"Although our data demonstrate an association between ET and higher BPb concentrations, one must be cautious about the interpretation of these data. It is unlikely that a BPb concentration of 3.3 µg/dL alone is sufficient to cause ET."

11. "Maternal Blood Lead Levels and the Risk of Pregnancy Induced Hypertension. The "EDEN" Cohort Study" by Chadi Yazbeck, Olivier Thiebaugeorges, Thierry Moreau, Valérie Goua, Ginette Debotte, Josiane Sahuquillo, Anne Forhan, Bernard Foliguet, Guillaume Magnin, Rémy Slama, Marie-Aline Charles, Guy Huel. Environmental Health Perspectives, online 26 June 2009, *http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ehp.0800488*

"Results: pregnancy-induced hypertension (PIH) was diagnosed in 106 subjects (10.9%). Age, parity, weight gain, alcohol, smoking habits and calcium supplementation were comparable between hypertensive and non hypertensive women. Lead levels were significantly higher in PIH cases (2.2 µg/dl [0.11 µmol/l] SD 1.4 µg/dl) than in normotensive patients (1.9 µg/dl [0.09 µmol/l] SD 1.2 µg/dl); p=0.02."

"Discussion: We found that the adjusted risk of PIH was associated with maternal blood lead levels in mid-pregnancy. This risk was doubled in the highest quartile as compared to the lowest quartile of lead distribution… Our findings that lead may have an etiologic role in PIH, even at low levels of environmental exposure, suggest that it may be appropriate for public health organizations to consider lowering the upper limit of "acceptable" blood lead levels in pregnant women, which is currently at 10 µg/dl"

12. "Blood Lead Levels and Major Depressive Disorder, Panic Disorder, and Generalized Anxiety Disorder in US Young Adults" by Maryse F. Bouchard, David C. Bellinger, Jennifer Weuve, Julia Matthews-Bellinger,; Stephen E. Gilman, Robert O. Wright, Joel Schwartz and Marc G. Weisskopf in Archives Of General Psychiatry/Vol 66 (No. 12), Dec 2009 at http://archpsyc.ama-assn.org/cgi/content/abstract/66/12/1313

"Compared with persons with a blood lead level of less than 0.7 µg/dL (the lowest quintile of blood lead in the study population), those with a level greater than 2.1 µg/dL (the highest quintile) had a 2.3-fold increased risk of meeting DSM-IV criteria for MDD [major depression] and a 4.9-fold increased risk of PD [panic disorder].

After excluding current smokers, the elevation in risk was increased to 2.5-fold for MDD and to 8.2-fold for PD."

"These results support previously reported associations of mood and anxiety disorders with high occupational lead exposure and less well-documented association with lower environmental levels of exposure in older men.

The present findings extend these observations to the general US population of younger adults."

13. "Blood lead at currently acceptable levels may cause preterm labour" by Mohsen Vigeh, Kazuhito Yokoyama, Zahrabigom Seyedaghamiri, Atsuko Shinohara, Takehisa Matsukawa, Momoko Chiba & Masoud Yunesian Occup Environ Med doi:10.1136/oem.2009.050419 online 25/8/10 at http://oem.bmj.com/content/early/2010/08/26/oem.2009.050419.abstract

"This study found that mothers who delivered preterm babies had significantly higher blood lead levels than mothers who delivered full-term babies. Logistic regression analysis showed an increasing risk of preterm birth with increasing blood lead concentration. A negative correlation between blood lead levels and gestational age was also found. Therefore, the current results suggest that raised blood lead concentrations, even at 'acceptable' levels, could be a risk factor for preterm delivery."

"The present results support previous findings of adverse pregnancy outcomes at blood lead levels lower than the currently 'acceptable' levels, although this study may be the first to attribute preterm deliveries to low levels of blood lead (mean <5 µg/dl)."

14. "Recommendations for Medical Management of Adult Lead Exposure" by Michael J. Kosnett; Richard P. Wedeen; Stephen J. Rothenberg; Karen L. Hipkins; Barbara L. Materna; Brian S. Schwartz; Howard Hu; and Alan Woolf, in Environmental Health Perspectives 2007;115(3):463. ©2007 National Institute of Environmental Health Sciences, online 11th April 2007 www.medscape.com/viewarticle/554718

"Removal of individuals from lead exposure should be considered to avoid long-term risk to health if exposure control measures over an extended period do not decrease blood lead concentrations to < 10 µg/dL or if selected medical conditions exist that would increase the risk of continued exposure. Recommended medical surveillance for all lead-exposed workers should include quarterly blood lead measurements for individuals with blood lead concentrations between 10 and 19 µg/dL, and semiannual blood lead measurements when sustained blood lead concentrations are < 10 µg/dL. It is advisable for pregnant women to avoid occupational or avocational lead exposure that would result in blood lead concentrations > 5 µg/dL. Chelation may have an adjunctive role in the medical management of highly exposed adults with symptomatic lead intoxication but is not recommended for asymptomatic individuals with low blood lead concentrations."

15. "The Weight of Lead: Effects Add Up In Adults" by A. Spivey, Environmental Health Perspectives Vol 115, No. 1 January 2007 at http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ehp.115-a30

"Far from being settled, Spivey's article is arguing that lead toxicity is an ongoing problem in the health of U.S. adults. Moves to reduce the sources of lead toxicity such as vehicle fuel have reduced the blood lead levels of the U.S. population. However pockets remain at very high levels, mainly through occupational exposures. Also, while levels are now below OSHA standards, new research indicates that lead poisoning effects occur well below those standards. Tests have improved in the past twenty years; both to provide the evidence of lead as a culprit, but also to measure its negative health impacts, especially to the heart, kidneys and brain. Rising blood pressure has been strongly linked with blood lead levels. Lead is also linked with hypertension, and kidney damage. Angela argues that lead has no natural biological role, and so should be controlled."

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