



The Lead Education and Abatement Design Group
Working to eliminate childhood and foetal lead poisoning
by the year 2012 and to protect the environment from lead
ABN 25 819 463 114

Cigarette Smoking & Lead Toxicity

By Robert Taylor of The LEAD Group Inc.

This is a summary of a longer and fully referenced article that can be found at
[www.lead.org.au/Taylor Tobacco & Lead Toxicity 20101005.pdf](http://www.lead.org.au/Taylor_Tobacco_&_Lead_Toxicity_20101005.pdf)

What has tobacco got to do with lead?

Tobacco leaves trap both radioactive (Pb-210) and non-radioactive (Pb-206) lead from the atmosphere on their surface, due to the presence of trichomes (sticky hairs that trap particles and retain them after washing with water). This is believed to be the main source of lead in tobacco. Pb-210 represents a fraction of the lead trapped, being measured in nanograms while Pb-206 is measured in micrograms.

Around 11% of lead from cigarettes enters the smoke, and roughly half of that is believed to enter the lungs of smokers. The bulk of the remainder is found in the ash, though some contaminates the environment, increasing the lead levels of dust in the households of smokers.

Illegal tobacco tends to have higher levels of heavy metals including lead, while lead has sometimes been added to tobacco or marijuana to increase their weight.

Being insoluble, small quantities of Pb-210 are retained in lungs, releasing radiation as it decays to Polonium-210. The average 1 pack a day smoker is exposed to the equivalent of over ten times the average US background radiation exposure, roughly one third of this from Pb-210. It is unlikely to be predominantly responsible for the increased risk of lung cancer by itself.

Cigarettes contain over 4000 chemicals; over 20 are probably carcinogenic and over 60 mutagenic (affecting genes and their impacts). Cigarette smoke increases the vulnerability of lung tissue to radiation and other carcinogens. There is weak and dated evidence that Pb-210 could play a role in lung cancer.

Lung Cancer Mortality: active and passive smoking

Smokers of European descent have a 22.1% risk of dying of lung cancer before the age of 85 if male, and 11.9% if female, with the comparable rates for non smokers being 1.1% and 0.8%.

Significant exposure to environmental tobacco smoke (ETS or passive smoking) increases the risk of dying of lung cancer by 15-31% (RR 1.15-1.31) for people living with a smoker [RR (Relative risk or Risk Ratio): added risk to exposed individuals frequently translated into a percentage http://en.wikipedia.org/wiki/Relative_risk] or around 24% (RR 1.24) if exposed to ETS through work. However, according to one study, this includes more than doubling the risk for former smokers, while increasing the risk for most non-smokers by very little (OR 1.05, similar to taking over 50 mg a day of vitamin E supplements OR 1.03-1.1). [OR (odds ratio): the probability of the event divided by the probability of an event *not* occurring – not the same as RR and the translation of this figure into percentage increase can be very misleading see http://stats.org/stories/2008/odds_ratios_april4_2008.html] Individuals exposed to large amounts of ETS as children could have their risk doubled (HR 2.00-3.63) [HR (Hazard Ratio) – similar to RR see http://en.wikipedia.org/wiki/Hazard_ratio]

Other Risk Factors and variations

The risk of contracting cancer from ETS (with the above figures adjusted for 84% mortality – roughly 18-38% and 28% respectively) is slightly less than the risk of living beside a major road (OR 1.47) [OR (odds ratio): the probability of the event divided by the probability of an event *not* occurring – not the same as RR and the translation of this figure into percentage increase can be very misleading see http://stats.org/stories/2008/odds_ratios_april4_2008.html], less than the risk of large scale wood dust exposure (OR 1.8), much less than the risk of long term solvent exposure (OR 2.8) and a

fraction of the risk of intensive (4 dishes a day for 25 years) fried food preparation for Chinese women which increases risks by over 300% (OR 1.92-6.15). It is only slightly higher than exposure to wood and coal smoke from cooking and heating in Europe (OR 1.24). The lung cancer risk of ETS is not unique and cannot be considered separately from that of other air toxics.

Japanese male smokers are 66% (RR 0.34) less likely to die of lung cancer as comparable smokers in the USA, but among non-smokers Japanese have 2-3 times the lung cancer mortality of US individuals. This variation is not unique: lung cancer should not be attributed to a single factor and may be influenced by environmental, genetic and nutritional factors.

Cardiovascular impacts

Being a male cigarette smoker more than doubles your risk of cardiovascular mortality, while ETS exposure increases your risk of cardiovascular problems by up to 30%. Lead probably plays a significant role in this, with relatively modest increases in blood lead greatly elevating cardiovascular risk.

What smoking and ETS does to the developing foetus: Why pregnant women shouldn't smoke

Both ETS and lead, whether from ETS or elsewhere, have strong impact on intellectual and behavioural development. Both increase the risk of premature birth, lower IQ, ADD/ADHD and behavioural problems. ETS and lead have synergistic properties, best demonstrated by the fact that the mother being in the top third for US prenatal exposure to tobacco smoke (smoking or ETS) and the child having the a blood lead $\geq 1.3 \mu\text{g/dL}$ (one third of the American teenage population) increases the risk of the child having ADHD by eight times, while either factor in isolation only doubles the risk.

Smoking during pregnancy may have more of an impact on children's blood lead levels than ETS after birth, with every 10 cigarettes per day smoked in 1990 increasing umbilical cord lead by 15%.

Smoking, ETS & blood lead levels

Being a cigarette smoker in the USA in 1998-2002 more than tripled the risk of having a blood lead above $5 \mu\text{g/dL}$.

In 1988-1994, US children with high exposure to ETS were four times more likely to have blood levels above $10 \mu\text{g/dL}$ and had 38% higher blood lead than children with little ETS exposure. In the 1990s, as leaded petrol was phased out, the lead content of cigarettes sold in western countries roughly halved and the ETS exposure of American children of non-smokers declined by two thirds. However, the decline has been much lower for all children 4-11 (37.7%), and does not account for contamination of household dust by cigarette lead. The children of smokers are still at significant risk of increased lead levels, and these risks are likely to be greater for infants who have higher rates of lead absorption and greater home exposure.

The impact of ETS on adults in 1998-1994 was to increase blood lead by around 30%, with much higher impacts among whites and much lower impacts among blacks and Hispanics. Since then the lead content of cigarettes has roughly halved and ETS exposure for non-smokers has fallen by around 75%. The most recent large scale study of American data from urine (1998-2002) found no increased risk for lead levels from high ETS for Mexican Americans, no risk at lower exposure for women or people below the poverty line and higher ETS exposure have no greater risk than lower level exposure for whites.

Limiting smoking in public places: A success story

It is unlikely that ETS is now a major source of lead for non-smoking adults in countries that have limited areas where smoking can occur in public places.

Smoking accelerates the release of lead from bone storage

80-95% of lead is stored in the bones. Smoking increases the rate of resorption (release of minerals, including lead, from the bone), particularly affecting the type of bone that provides the largest long term store of lead, cortical bone. It also reduces oestrogen [US spelling estrogen] levels, increasing the impact of menopause. The impact of smoking on bone is still poorly understood.

Smoking depletes vitamins

Vitamin D, which reduces deposition of lead in the bone, and vitamin C & E, which reduce the damage lead does to body organs, are depleted by cigarette smoking. Smokers are advised to increase their C intake and, more cautiously, their vitamin D but Vitamin E supplementation carries significant risks, including lung cancer.

Recommended Reading

ACS [American Cancer Society] **Cancer Facts and Figures 2009.**

www.cancer.org/acs/groups/content/@epidemiologysurveillance/documents/document/acspc-026238.pdf [basic outline of cancer statistics also see Woloshin reference]

Darren R Brenner, Rayjean J Hung, Ming-Sound Tsao, Frances A Shepherd, Michael R Johnston, Steven Narod, Warren Rubenstein and John R McLaughlin **Lung cancer risk in never-smokers: a population-based case-control study of epidemiologic risk factors** *BMC Cancer* 2010, 10:285 doi:10.1186/1471-2407-10-285 www.biomedcentral.com/1471-2407/10/285 [A recent Canadian study that found a wide range of lung cancer risks from occupational exposure to substance such as wood dust, solvents and smoke.]

Bruno RS, Leonard SW, Atkinson J, Montine TJ, Ramakrishnan R, Bray TM, Traber MG. **Faster plasma vitamin E disappearance in smokers is normalized by vitamin C supplementation** *Free Radical Biology and Medicine* Vol. 40, Iss. 4, 15 February 2006, Pages 689-697 <http://dx.doi.org/10.1016/j.freeradbiomed.2005.10.051> [Given that levels of both Vitamin C & E are reduced in smokers, taking 1000 mg a day of vitamin C reduced the usage of Vitamin E by 25%]

Tim Byers **Nutrition and Lung Cancer** *Am. J. of Respiratory and Critical Care Medicine* Vol 177. pp. 470-471, (2008) <http://ajrccm.atsjournals.org/cgi/content/full/177/5/470> [Ruminates on the fact that while increased fruit and vegetable intake reduces lung cancer risks, taking equivalent quantities of vitamin E or beta-carotene supplements increases lung cancer risks]

Committee on Secondhand Smoke Exposure and Acute Coronary Events; Institute of Medicine (IOM) **Secondhand Smoke Exposure and Cardiovascular Effects: Making Sense of the Evidence** *National Academies Press* 2010 [A significant overview of the role of ETS in cardiovascular problems]

Tanya E. Froehlich, Bruce P. Lanphear, Peggy Auinger, Richard Hornung, Jeffery N. Epstein, Joe Braun, Robert S. Kahn **Association of Tobacco and Lead Exposures With Attention-Deficit/Hyperactivity Disorder** *Pediatrics* Vol. 124 No. 6 Dec. 2009, pp. e1054-e1063 (doi:10.1542/peds.2009-0738)

<http://pediatrics.aappublications.org/cgi/content/abstract/124/6/e1054> [Found that prenatal ETS exposure and higher blood lead levels doubled the risk of ADHD but that both factors together increased the risk eightfold. A previous paper from this group noted little impact from postnatal ETS exposure.]

H Hu, M.M Téllez-Rojo, D Bellinger, D Smith, A S. Ettinger, H L Figueroa, J Schwartz, L Schnaas, A M-García, and M H-Avila **Fetal Lead Exposure at Each Stage of Pregnancy as a Predictor of Infant Mental Development** *Environ Health Perspect.* 2006 November; 114(11): 1730-1735. www.ncbi.nlm.nih.gov/pmc/articles/PMC1665421/ [A study that clearly indicates the impact of prenatal exposure to lead.]

Masayuki Kaji, Mikio Gotoh, Yasuko Takagi and Hiroyuki Masuda **Blood lead levels in Japanese children: Effects of passive smoking** *Env. Health and Prev. Medicine* Vol 2 No 2 July 1997

<http://ukpmc.ac.uk/ptpmcrender.cgi?aid=1838029&blobtype=pdf> [Found markedly different impacts for ETS exposure for younger children and older children.]

Jolanta Lissowska, Alicja Bardin-Mikolajczak, T Fletcher, D Zaridze, N Szeszenia-Dabrowska, P Rudnai, E Fabianova, A Cassidy, D Mate **Lung Cancer and Indoor Pollution from Heating and Cooking with Solid Fuels: The IARC International Multicentre Case-Control Study in Eastern/Central Europe and the United Kingdom** *Am. J. Epidemiol.* (15 August 2005) 162 (4): 326-333. doi: 10.1093/aje/kwi204 <http://aje.oxfordjournals.org/content/162/4/326.full> [Finds that using wood and coal for both cooking and heating increases lung cancer risks by 24%]

David M. Mannino, Rachel Albalak, Scott Grosse & James Repace **Second-hand Smoke Exposure and Blood Lead Levels in U.S. Children** *Epidemiology*, Vol. 14, No. 6, November 2003

http://journals.lww.com/epidem/Abstract/2003/11000/Second_hand_Smoke_Exposure_and_Blood_Lead_Levels.15.aspx [Found that individuals with high levels of ETS exposure had 38% higher blood lead levels than those with minimal ETS exposure]

David M. Mannino, David M. Homa, Thomas Matte and Mauricio Hernandez-Avila **Active and Passive Smoking and Blood Lead Levels in U.S. Adults: Data From the Third National Health and Nutrition Examination Survey** *Nicotine & Tobacco Research* 2005 7(4):557-564 <http://ntr.oxfordjournals.org/cgi/content/abstract/7/4/557> [Found that adults with high levels of ETS exposure had 30% higher blood lead levels than those with minimal ETS exposure. But also found wide ethnic disparities and noted he could not explain the degree of the link as non-smokers absorb a fraction of elements in ETS.]

Tomomi Marugame, Tomotaka Sobue, Hiroshi Satoh, Shoko Komatsu, Yoshikazu Nishino, Haruo Nakatsuka, Tomio Nakayama, Takaichiro Suzuki, Toshiro Takezaki, Kazuo Tajima, Suketami Tominaga **Lung cancer death rates by smoking status: Comparison of the Three-Prefecture Cohort study in Japan to the Cancer Prevention Study II in the USA** *Cancer Science* Vol. 96, Is. 2, pages 120-126, February 2005 <http://onlinelibrary.wiley.com/doi/10.1111/j.1349-7006.2005.00013.x/full> [A major study that found that Japanese smokers were around one third as likely as American smokers to die of lung cancer while for non smokers the figures were almost reversed.]

Nawrot, Tim; Staessen, Jan A Low-Level **Environmental Exposure to Lead Unmasked as Silent Killer** *Circulation* 2006;114:1347-1349 <http://circ.ahajournals.org/cgi/content/full/114/13/1347> [Provides an outline and commentary on an article on the impact of lead on mortality of even low lead levels.]

Brianna Rego **The Polonium Brief** *Isis*, 2009, 100:453-84 www.briannarego.com/Regolsis2009.pdf [A long article on the tobacco industry's reaction to findings of a link between polonium-210, lead-210 and lung cancer. P458-468 summarizes early research into the subject]

Marc Rhoads and Patrick Levallois **Effects Of Maternal Cigarette Smoking And Alcohol Consumption On Blood Lead Levels Of Newborns** *Am J Epidemiol* Vol 145, No. 3, 1997 <http://aje.oxfordjournals.org/cgi/reprint/145/3/250.pdf> [Important study that found that maternal smoking habits during pregnancy can have impacts on a child's lead burden than post natal ETS exposure, increasing umbilical cord lead by 15% per 10 cigarettes smoked per day]

Patricia A. Richter, Ellen E. Bishop, Jiantong Wang, and Monica H. Swahn **Tobacco Smoke Exposure and Levels of Urinary Metals in the U.S. Youth and Adult Population: The National Health and Nutrition Examination Survey (NHANES) 1999-2004** *Int J Environ Res Public Health*. 2009 July; 6(7): 1930-1946. www.ncbi.nlm.nih.gov/pmc/articles/PMC2738890/ [A major study with a questionable method. Measuring lead in urine measures how much lead is being excreted and significant lead is stored in bone rather than excreted. Smoking also increases lead release from the bone. The summary chose to highlight the similar increases in lead from smoking and ETS, downplaying the fact that for many groups in the study increasing levels of ETS had little or no impact on lead excretion. A vital but flawed study]

SE Schober, C Zhang, DJ Brody **Disparities in Secondhand Smoke Exposure - United States, 1988-1994 and 1999-2004** *JAMA* Vol 300 No9 September 3 2008 p1019-1020 <http://jama.ama-assn.org/cgi/content/full/300/9/1019> [An examination of data on ETS from NHANES studies highlighting ethnic, racial, age and sex based variations.]

Kees van der Griendt **Smokers Prevalence vs. Lung Cancer Rates** *Flags and Icons* www.kidon.com/smoke/percentages3.htm#note [Compares national rates of cigarette smoking to deaths from lung cancer. Finds much variability but an obvious limitation is that it only uses current smoking rates rather than including previous smoking rates.]

Mohsen Vigehe, Kazuhito Yokoyama, Zahrabigom Seyedaghamiri, Atsuko Shinohara, Takehisa Matsukawa, Momoko Chiba, Masoud Yunesian **Blood lead at currently acceptable levels may cause preterm labour** *Occup Environ Med* doi:10.1136/oem.2009.050419 <http://oem.bmj.com/content/early/2010/08/26/oem.2009.050419.abstract> [The findings of this paper are important since smoking is associated with preterm labour, and therefore lead may well play a significant role]

P Vineis, L Airoidi, F Veglia, L Olgiati, R Pastorelli, H Autrup, A Dunning, S Garte, E Gormally, P Hainaut, C Malaveille, G Matullo, M Peluso, K Overvad, A Tjonneland, F Clavel-Chapelon, H Boeing, V Krogh, D Palli, S Panico, A Agudo, C Martinez, M Dorransoro, A Barricarte, L Cirera, J Quiros, G B J Manjer, B Forsberg, N E Day, T J Key, R Kaaks, R Saracci and E Riboli. **Environmental tobacco smoke and risk of respiratory cancer and chronic obstructive pulmonary disease in former smokers and never smokers in the EPIC prospective study** *BMJ*, doi:10.1136/bmj.38327.648472.82 www.bmj.com/content/330/7486/277.full.pdf [Discovered that ETS greatly increased lung cancer risks for former smokers but very little for adult non-smokers. A latter paper by this group found that the cancer risk for adults who were exposed to large amounts of ETS as children was doubled]

Marc G. Weisskopf, Nitin Jain, Huiling Nie, David Sparrow, Pantel Vokonas, Joel Schwartz, Howard Hu **A Prospective Study of Bone Lead Concentration and Death From All Causes, Cardiovascular Diseases, and Cancer in the Department of Veterans Affairs Normative Aging Study** *Circulation*. 2009;120:1056-1064. <http://circ.ahajournals.org/cgi/reprint/CIRCULATIONAHA.108.827121v1> [Finds that males in the top third of bone lead levels, a better measure of long term lead exposure than blood lead, were more than twice as likely to die and five times more likely to die of cardiovascular problems.]

Steven Woloshin, Lisa M. Schwartz, H. Gilbert Welch **The Risk of Death by Age, Sex, and Smoking Status in the United States: Putting Health Risks in Context** *J Natl Cancer Inst* 2008;100: 845 – 853 <http://tdi.dartmouth.edu/documents/cmm/Risk%20of%20Death.pdf?phpMyAdmin=ybsa7uLwmT7o192eGez2O3-Lzne> [A much needed reference that accounts for death from cardiovascular and cancer by decade among smokers, former smokers and non-smokers.]