Calculating Value of Avoided Cardiovascular Disease Premature Mortality

From EPA's Economic Analysis for the Final Lead and Copper Rule Improvements, EPA 810-R-24-005

Sections 5.5.7 Concentration-Response Function for Lead and Cardiovascular Disease Premature Mortality &

5.5.8 Valuation of Avoided Cardiovascular Disease Premature Mortality

https://www.epa.gov/system/files/documents/2024-10/508_lcri_final_ea_10-21-2024.pdf

Instructions:

1. Use EPA's All Ages Lead Model to Estimate Pre-Rule and Post-Rule Blood Lead Levels for Typical Child
2. Enter Pre-Rule and Post-Lead Blood Lead Levels in Yellow Highlighted Cell
3. Enter Population Expected to Benefit from Change in Blood Lead Level in Yellow Highlighed Cell
4. Use the Central Estimate for Both Aoki et al 2016 and Lanphear et al. 2018 from Blue Highlighted Box
5. See Low-End and High-End Estimated Changes in Lifetime Earnings in Blue Highlighted Box.

Variable	Value	CVD Mortality Risk Reduction
x_1 =	1.17	Baseline blood lead level
x_2 =	1.053	Post-rule blood lead level
pop	139,712,601	Population for whom the change in blood lead occurs.
y_1	0.00272	Baseline hazard rate of CVD premature mortality for 40-80 year olds in baseline scenario (i.e., without the rule)
β =	See below for each	Beta coefficient, which represents the change in CVD mortality risk per unit change in blood lead
Logz =	10	Log transformation to the base z (e.g., log10)

Aoki et al. 2016 (Low Benefit Estimates)

Central β	0.36	Central beta estimate
Lower β	0.05	Lower beta estimate (based on lower bound of 95% confidence interval for hazard ratio)
Upper β	0.68	Upper beta estimate (based on upper bound of 95% confidence interval for hazard ratio)

	CVD Mortality Risk Reduction	CVD Deaths Avoided	Value
Central	0.00004444	6,209	$ 80,588,260,862
Lower	0.00000622	868	$ 11,272,355,235
Upper	0.00008333	11,642	$ 151,116,277,971

Lanphear et al. 2018 (High Benefit Estimates) (blood lead levels < 5 μg/dL

Central β	0.96	Central beta estimate
Lower β	0.54	Lower beta estimate (based on lower bound of 95% confidence interval for hazard ratio)
Upper β	1.37	Upper beta estimate (based on upper bound of 95% confidence interval for hazard ratio)

	CVD Mortality Risk Reduction	CVD Deaths Avoided	CVD Deaths Avoided
Central	0.00011690	16,332	$ 211,986,817,320
Lower	0.00006639	9,275	$ 120,387,301,577
Upper	0.00016528	23,091	$ 299,723,347,714

5.5.8 Valuation of Avoided Cardiovascular Disease Premature Mortality

VSL	$ 12,980,000	The EPA uses a value of a statistical life (VSL) of $12.98 million in 2022 dollars

$$\Delta CVD\ Premature\ Mortality = y_1\left(1 - e^{\beta \log_z\left(\frac{x_2}{x_1}\right)}\right) \quad \text{(Equation 14)}$$

Thus, the function necessary to estimate the number of cases associated with a change in blood lead levels is:

$$Cases\ Avoided = y_1\left(1 - e^{\beta \log_z\left(\frac{x_2}{x_1}\right)}\right) * pop \quad \text{(Equation 15)}$$

Where:

y_1 = Baseline hazard rate of CVD premature mortality in baseline scenario (i.e., without the rule)

β = Beta coefficient, which represents the change in CVD premature mortality per unit change in blood lead

$\log_z$ = Log transformation to the base z (e.g., $\log_{10}$)

x_2 = Blood lead level associated with the rule

x_1 = Blood lead level without the rule

pop = Population for whom the change in blood lead occurs

Equation 16 can be used to estimate the avoided CVD premature mortality from reductions in blood lead.

The beta coefficient, β, varies based on the study in question and is calculated by:

$$\beta = \frac{\ln(Hazard\ ratio)}{\log_z(Fold\ increase\ in\ blood\ lead\ for\ hazard\ ratio)} \quad \text{(Equation 16)}$$

Exhibit 5-31: Inputs to the Health Impact Function Based on Selected Studies

Variable	Aoki et al. (2016)	Lanphear et al. (2018)
		Blood Pb <5 μg/dL
Log transformation ($\log_z$)	**$\log_{10}$**	**$\log_{10}$**
Central beta (β) estimate	**0.36**	**0.96**
Lower beta (β) estimate (based on lower bound of 95% CI for HR)	0.05	0.54
Upper beta (β) estimate (based on upper bound of 95% CI for HR)	0.68	1.37

Sources: Aoki et al. (2016) and Lanphear et al. (2018).

Note: Bolding identifies the parameters used in the LCRI analysis. For full descriptions of these and the functions not used to quantify CVD premature mortality, see Brown et al. (2020)

Exhibit 22. Age- and Sex-Specific Cardiovascular Disease Mortality Rates in the United States in 2014, Based on CDC's WONDER Database

Age (years)	Sex	Number of Deaths	Total Population	CVD Mortality Rate, Y_1
40-49	M	16,164	20,566,856	7.86E-04
	F	7,886	20,912,669	3.77E-04
50-59	M	47,045	21,521,569	2.19E-03
	F	21,930	22,560,689	9.72E-04
60-69	M	74,155	16,127,000	4.60E-03
	F	39,275	17,764,398	2.21E-03
70-80	M	98,852	9,151,537	1.08E-02
	F	74,989	11,107,883	6.75E-03
Total (40-80 years)	**M**	**236,216**	**67,366,962**	**3.51E-03**
	F	**144,080**	**72,345,639**	**1.99E-03**
	Both	**380,296**	**139,712,601**	**2.72E-03**

Source: CDC - National Center for Health Statistics (2014)