

**Major Epidemiologic Studies of PM<sub>2.5</sub> and Total Mortality in California**

<http://scientificintegrityinstitute.org/Enstrom081512.pdf>

**Relative risk of death from all causes (RR and 95% CI) associated with increase of 10 µg/m<sup>3</sup> in PM<sub>2.5</sub>**

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McDonnell 2000	CA AHSMOG Cohort (N~3,800 [1,347 M + 2,422 F]; Adventists in 9 airsheds, used to estimate PM <sub>2.5</sub> )	RR ~ 1.03 (0.95 – 1.12) during 1976-1992
Krewski 2000 (from Krewski 2010)	CA CPS II Cohort (N=40,408 [18,000 M + 22,408 F]; 4 MSAs; 1979-1983 PM <sub>2.5</sub> ; 44 covariates)	RR = 0.872 (0.805-0.944) during 1982-1989
Enstrom 2005	CA CPS I Cohort (N=35,783 [15,573 M + 20,210 F]; 11 counties; 1979-1983 PM <sub>2.5</sub> ; 25 county internal comparison)	RR = 1.039 (1.010-1.069) during 1973-1982 RR = 0.997 (0.978-1.016) during 1983-2002
Enstrom 2006	CA CPS I Cohort (N=35,783 [15,573 M + 20,210 F]; 11 counties; 1979-1983 & 1999-2001 PM <sub>2.5</sub> )	RR = 1.061 (1.017-1.106) during 1973-1982 RR = 0.995 (0.968-1.024) during 1983-2002
Zeger 2008	“West” portion of MCAPS Cohort (3.1 M [1.5 M M + 1.6 M F]; Medicare enrollees in CA+OR+WA; 2000-2005 PM <sub>2.5</sub> )	RR = 0.989 (0.970-1.008) during 2000-2005
Jerrett 2010	CA CPS II Cohort (N=77,767 [34,367 M + 43,400 F]; 54 counties; 2000 PM <sub>2.5</sub> ; KRG ZIP; 20 Ind Cov+7 Eco Var; Slide 12)	RR ~ 0.994 (0.965-1.025) during 1982-2000
Krewski 2010	CA CPS II Cohort (N=40,408; 4 MSAs; 1979-1983 PM <sub>2.5</sub> ) 44 covariates (N=50,930; 7 MSAs; 1999-2000 PM <sub>2.5</sub> )	RR = 0.960 (0.920-1.002) during 1982-2000 RR = 0.968 (0.916-1.022) during 1982-2000
Jerrett 2011	CA CPS II Cohort (N=73,609 [32,509 M + 41,100 F]; 54 counties; 2000 PM <sub>2.5</sub> ; KRG ZIP Model; 20 Ind Cov+7 Eco Var; Table 28)	RR = 0.994 (0.965-1.024) during 1982-2000
Jerrett 2011	CA CPS II Cohort (N=73,609 [32,509 M + 41,100 F]; 54 counties; 2000 PM <sub>2.5</sub> ; Nine Model Ave; 20 IC+7 EV; Fig 22 & Tab 27-32)	RR = 1.002 (0.992-1.012) during 1982-2000

Lipsett 2011	CA Teachers Cohort (N=73,489 [73,489 F]; 2000-2005 PM <sub>2.5</sub> )	RR = 1.01 (0.95 – 1.09) during 2000-2005
Ostro 2011 replaced Ostro 2010	CA Teachers Cohort (N=43,220 [43,220 F]; 2002-2007 PM <sub>2.5</sub> )  Incorrect 2010 Result:	RR = 1.06 (0.96 – 1.16) during 2002-2007  RR = 1.84 (1.66 – 2.05) during 2002-2007

**Epidemiologic Study of PM<sub>2.5</sub> and Total Mortality in Los Angeles Basin**  
**Relative risk of death from all causes (RR and 95% CI) associated with increase of 10 µg/m<sup>3</sup> in PM<sub>2.5</sub>**

Jerrett 2005	CPS II Cohort in Los Angeles Basin (N=22,905; 267 zip code areas; 1999-2000 PM <sub>2.5</sub> ; 44 covariates + maximal confounders)	RR = 1.11 (0.99 - 1.25) during 1982-2000
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**Epidemiologic Study of PM<sub>2.5</sub> and Total Mortality in United States Relied Upon by CARB and US EPA as of 2010**  
**Relative risk of death from all causes (RR and 95% CI) associated with increase of 10 µg/m<sup>3</sup> in PM<sub>2.5</sub>**

Krewski 2009	CPS II Cohort (N=342,521; 58 MSAs; 1979-1983 PM <sub>2.5</sub> ) 44 covariates (N=488,370; 116 MSAs; 1999-2000 PM <sub>2.5</sub> )	RR = 1.028 (1.014-1.043) during 1982-2000 RR = 1.036 (1.017-1.054) during 1982-2000
FJC	Requirement to establish causal epidemiologic relationship	RR >= 2.0

Federal Judiciary Center and National Academy of Sciences “Reference Manual on Scientific Evidence, Third Edition” 2011  
[http://www.fjc.gov/public/home.nsf/autoframe?openform&url\\_l=/public/home.nsf/inavgeneral?openpage&url\\_r=/public/home.nsf/pages/1448](http://www.fjc.gov/public/home.nsf/autoframe?openform&url_l=/public/home.nsf/inavgeneral?openpage&url_r=/public/home.nsf/pages/1448)  
 Reference Guide on Epidemiology by MICHAEL D. GREEN, D. MICHAL FREEDMAN, AND LEON GORDIS  
[http://www.fjc.gov/public/pdf.nsf/lookup/SciMan3D12.pdf/\\$file/SciMan3D12.pdf](http://www.fjc.gov/public/pdf.nsf/lookup/SciMan3D12.pdf/$file/SciMan3D12.pdf)

## References for Epidemiologic Studies of PM<sub>2.5</sub> and Total Mortality

<u>Author &amp; Year</u>	<u>Home Institution</u>	<u>Underlying Study Cohort</u>	<u>Primary Funding</u>
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### California-wide Studies

McDonnell 2000      Loma Linda U, CA      California Adventist Health Study of Smog (AHSMOG)      CARB and US EPA  
1) McDonnell WF; Nishino-Ishikawa N; Petersen FF; Chen LH; Abbey DE (2000). Relationships of mortality with the fine and coarse fractions of long-term ambient PM<sub>10</sub> concentrations in nonsmokers. *J Expo Anal Environ Epidemiol* 2000;10:427-436. EPA ISA No 010319 Peer-Reviewed Journal (<http://scientificintegrityinstitute.org/JEAAA090100.pdf>)

Krewski 2000      U Ottawa, CN      1982 ACS Cancer Prevention Study (CPS II)      Assume HEI  
1) Unpublished August 31, 2010 letter from Krewski to HEI with California-specific results from Table 33 in Krewski 2009 ([http://www.arb.ca.gov/research/health/pm-mort/HEI\\_Correspondence.pdf](http://www.arb.ca.gov/research/health/pm-mort/HEI_Correspondence.pdf))  
2) "Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality: HEI Special Report. July 2000" (<http://pubs.healtheffects.org/view.php?id=6>). Figure 5 and Figure 21 of Part II: Sensitivity Analyses (<http://pubs.healtheffects.org/getfile.php?u=275>) and (<http://scientificintegrityinstitute.org/HEIFigure5093010.pdf>)  
3) Enstrom JE (2006). Response to "A Critique of 'Fine Particulate Air Pollution and Total Mortality Among Elderly Californians, 1973-2002'" by Bert Brunekreef, PhD, and Gerard Hoek, PhD, *Inhal Toxicol* 2006;18:509-514 (<http://scientificintegrityinstitute.org/IT060106.pdf>)

Enstrom 2005      UCLA, CA      1959 California Cancer Prevention Study (CA CPS I)      EPRI  
Enstrom JE (2005). Fine particulate air pollution and total mortality among elderly Californians, 1973-2002. *Inhal Toxicol* 2005;17:803-816. EPA ISA No. 087356 Peer Reviewed Journal ([http://www.arb.ca.gov/planning/gmerp/dec1plan/gmerp\\_comments/enstrom.pdf](http://www.arb.ca.gov/planning/gmerp/dec1plan/gmerp_comments/enstrom.pdf)) and (<http://scientificintegrityinstitute.org/IT121505.pdf>)

Enstrom 2006      UCLA, CA      1959 California Cancer Prevention Study (CA CPS I)      EPRI  
Enstrom JE (2006). Response to "A Critique of 'Fine Particulate Air Pollution and Total Mortality Among Elderly Californians, 1973-2002'" by Bert Brunekreef, PhD, and Gerard Hoek, PhD', *Inhal Toxicol* 2006;18:509-514 (<http://scientificintegrityinstitute.org/IT060106.pdf>) and (<http://scientificintegrityinstitute.org/ITBH060106.pdf>)

Zeger 2008      Johns Hopkins U, MD      2000 US Medicare Cohort (MCAPS)      EPA and NIEHS  
Zeger SL, Dominici F, McDermott A, Samet JM (2008). Mortality in the Medicare Population and Chronic Exposure to Fine Particulate Air Pollution in Urban Centers (2000-2005). *Environ Health Perspect* 2008;116:1614-1619 (<http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.11449>)

Jerrett 2010 UC Berkeley, CA 1982 ACS Cancer Prevention Study (CPS II) CARB  
Principal Investigator, Michael Jerrett, UC Berkeley/CARB Proposal No. 2624-254 "Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort"  
Co-Investigators: Burnett RT, Krewski D, Pope CA III, Thurston G, Christakos G, Hughes E, Calle E, Thun M.  
Unpublished February 26, 2010 CARB presentation (<http://scientificintegrityinstitute.org/carbjerrett022610.pdf>)

Krewski 2010 U Ottawa, CN 1982 ACS Cancer Prevention Study (CPS II) Assume HEI  
1) Unpublished August 31, 2010 letter from Krewski to HEI with California-specific results from Krewski 2009  
([http://www.arb.ca.gov/research/health/pm-mort/HEI\\_Correspondence.pdf](http://www.arb.ca.gov/research/health/pm-mort/HEI_Correspondence.pdf))

Ostro 2010 & 2011 Cal EPA OEHHA 1995 California Teachers Cohort CARB and NCI  
Ostro B, Lipsett M, Reynolds P, Goldberg D, Hertz A, Garcia C, Henderson KD, Bernstein L (2010). Long-Term Exposure to Constituents of Fine Particulate Air Pollution and Mortality: Results from the California Teachers Study. *Environ Health Perspect* 2010;118:363-369 with June 2011 Erratum (<http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.0901181>)

Jerrett 2011 UC Berkeley, CA 1982 ACS Cancer Prevention Study (CPS II) CARB  
Principal Investigator Michael Jerrett, October 28, 2011 Revised Final Report for Contract No. 06-332 to CARB Research Screening Committee, "Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort"  
Co-Investigators: Burnett RT, Pope CA III, Krewski D, Thurston G, Christakos G, Hughes E, Ross Z, Shi Y, Thun M  
(<http://www.arb.ca.gov/research/rsc/10-28-11/item1dfr06-332.pdf>) and (<http://www.scientificintegrityinstitute.org/jerrett012510.pdf>)  
and (<http://www.scientificintegrityinstitute.org/JerrettCriticism102811.pdf>)

Lipsett 2011  
Lipsett MJ, Ostro BD, Reynolds P, Goldberg D, Hertz A, Jerrett M, Smith DF, Garcia C, Chang ET, Bernstein L (2011). Long-term Exposure to Air Pollution and Cardiorespiratory Disease in the California Teachers Study Cohort. *AJRCCM* 2011;184:828–835  
(<http://ajrccm.atsjournals.org/content/184/7/828.full.pdf>) and (<http://scientificintegrityinstitute.org/Lipsett062311.pdf>)

#### Los Angeles Basin and US Studies

Jerrett 2005 USC, CA 1982 ACS Cancer Prevention Study (CPS II) HEI, NIEHS, U Ottawa  
Jerrett M, Burnett RT, Ma R, Pope CA III, Krewski D, Newbold KB, Thurston G, Shi Y, Finkelstein N, Calle EE, Thun MJ (2005). Spatial Analysis of Air Pollution and Mortality in Los Angeles. *Epidemiology* 2005;16:727–736.  
(<http://www.ncbi.nlm.nih.gov/pubmed/16222161>) and (<http://scientificintegrityinstitute.org/Jerrett110105.pdf>)

Krewski 2009 U Ottawa, CN 1982 ACS Cancer Prevention Study (CPS II) HEI,NIEHS,CARB,US EPA  
Krewski D, Jerrett M, Burnett RT, Ma R, Hughes E, Shi Y, Turner MC, Pope CA III, Thurston G, Calle EE, Thun MJ. Extended  
Analysis of the American Cancer Society Study of Particulate Air Pollution and Mortality. HEI Research Report 140. May 2009  
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## **References Examining and Criticizing Epidemiologic Studies of PM<sub>2.5</sub> and Total Mortality in California**

February 26, 2010 CARB Symposium “Estimating Premature Deaths from Long-term Exposure to PM<sub>2.5</sub>”  
([http://www.arb.ca.gov/research/health/pm-mort/pm-mort-ws\\_02-26-10.htm](http://www.arb.ca.gov/research/health/pm-mort/pm-mort-ws_02-26-10.htm))

August 31, 2010 CARB Report “Estimate of Premature Deaths Associated with Fine Particle Pollution in California Using the United  
States Environmental Protection Agency Methodology”  
([http://www.arb.ca.gov/research/health/pm-mort/pm-report\\_2010.pdf](http://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf))

October 10, 2010 Bakersfield Californian article by Lois Henry "Air board must be held accountable"  
(<http://www.bakersfield.com/news/local/x618251275/Air-board-must-be-held-accountable>)

November 14, 2010 Bakersfield Californian article by Lois Henry "Air pollution 'deaths' all over the map"  
(<http://www.bakersfield.com/news/local/x1613299841/LOIS-HENRY-Air-pollution-deaths-all-over-the-map>)

October 28, 2011 Enstrom Compilation of Critiques of Jerrett 2011, Draft & Revised Final Report for CARB Contract No. 06-332  
(<http://www.scientificintegrityinstitute.org/JerrettCriticism102811.pdf>)

November 28, 2011 UCLA Institute of the Environment Enstrom Seminar "Does Fine Particulate Matter Kill Californians?"  
(<http://www.environment.ucla.edu/calendar/showevent.asp?eventid=667>)  
([http://www.arb.ca.gov/lists/gmbond2011/3-ioes\\_seminar\\_does\\_particulate\\_matter\\_kill\\_californians\\_enstrom\\_112811.pdf](http://www.arb.ca.gov/lists/gmbond2011/3-ioes_seminar_does_particulate_matter_kill_californians_enstrom_112811.pdf))

April 24, 2012 Dose-Response 2012 Enstrom Lecture "Pseudoscientific Aspects of Particulate Matter Epidemiology, 1993-2012"  
([http://www.dose-response.org/conference/2012/pdf/Enstrom\\_Dose\\_Response\\_Fine\\_Part particulate.pdf](http://www.dose-response.org/conference/2012/pdf/Enstrom_Dose_Response_Fine_Part particulate.pdf))

August 1, 2012 American Statistical Association Joint Statistical Meeting Seminar “Are Fine Particulates Killing Californians?”  
(<http://www.amstat.org/meetings/jsm/2012/onlineprogram/ActivityDetails.cfm?SessionID=207510>)  
(<http://www.scientificintegrityinstitute.org/ASA080112.pdf>)

## **CARB Diesel Regulatory Documents Based in Part on Epidemiologic Studies of PM<sub>2.5</sub> and Total Mortality**

Proposed Amendments to the Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use On-Road Diesel-Fueled Vehicles, the Heavy-Duty Vehicle Greenhouse Gas Emission Reduction Measure, and the Regulation to Control Emissions from In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Intermodal Rail Yard Facilities

<http://www.arb.ca.gov/regact/2010/truckbus10/truckbus10.htm>

Appendix J Methodology for Estimating Ambient Concentrations of Particulate Matter from Diesel-Fueled Engine Emissions And Health Benefits Associated with Reductions in Diesel PM Emissions from In-Use On-Road Heavy-Duty Diesel-Fueled Vehicles  
<http://www.arb.ca.gov/regact/2010/truckbus10/truckbusappj.pdf>

Page J-17: Table 1: Estimate of Premature Deaths Avoided Associated with Emission Reductions from Implementation of the On-Road Truck Regulation (2010-2025)

Total premature deaths avoided (from PM & NO<sub>x</sub>) = 3,500 (2,700 - 4,400) in 15 years ---> 233 / year  
(based on US EPA methodology using national results (Krewski 2009))

Proposed Amendments to the Regulations for In-Use Off-Road Diesel-Fueled Fleets and Off-Road Large Spark Ignition Engine Fleet Requirements

<http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadlsi10.htm>

### **APPENDIX G: HEALTH BENEFITS AND METHODOLOGY**

**APPENDIX G1: HEALTH BENEFITS ASSOCIATED WITH REDUCTIONS IN DIESEL PM EMISSIONS FROM OFF-ROAD DIESEL VEHICLES**

**APPENDIX G2: METHODOLOGY FOR ESTIMATING AMBIENT CONCENTRATIONS OF PARTICULATE MATTER FROM DIESEL-FUELED ENGINE EMISSIONS**

<http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadappg.pdf>

Page G1-1: Table 1: Estimate of Premature Deaths Avoided Associated with Emission Reductions from Implementation of the Off-Road Vehicle Regulation (2010-2029)

Total premature deaths avoided (from PM & NO<sub>x</sub>) = 470 (360-570) in 19 years ---> 25 / year  
(based on US EPA methodology using national results (Krewski 2009))

Total premature deaths avoided = 233 (on-road) + 25 (off-road) = 258 per year (based on US EPA methodology using national results)

Total premature deaths avoided ~ 0 (on-road) + 0 (off-road) = 0 per year (based on US EPA methodology using CA-specific results)

December 17, 2010 CARB News Release #10-64 “Changes to diesel rules protect public health, provide relief and flexibility to California businesses” (<http://www.arb.ca.gov/newsrel/newsrelease.php?id=171>) “The diesel rules for vehicles cover almost everything that moves on or off the road, from trucks and buses to off-road construction equipment, and over the next 12 years they will prevent 3,900 premature deaths by removing thousands of tons of diesel soot from the air we breathe . . . .”

Total premature deaths avoided =  $3900 / 12 = 325$  per year (based on CARB News Release)

Total deaths in CA ~ 235,000 per year