Supplemental Material

Particulate Matter Induced Health Effects: Who's Susceptible?

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Supplemental Material, Table 1. Studies evaluated to identify characteristics of populations susceptible to PM.

Study	Location[a]	Population / Animal Model[b]	Exposure Duration[c]	Pollutant[d]	Health Endpoint[e]
Lifestage					
Children					
Host et al. 2007	6 French cities	0-14 vs. ≥65 yrs	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	Cardiorespiratory HA
Mar et al. 2004	Spokane, WA	9 asthmatic children (16 asthmatic adults)	Short-term	$PM_{2.5}$ $PM_{10-2.5}$ PM_{10}	Respiratory symptoms
Peel et al. 2005	Atlanta, GA	0-1, 2-18 vs. ≥19, ≥65 yrs	Short-term	$PM_{2.5}$ PM_{10}	Respiratory ED visits
Mauad et al. 2008	São Paulo, Brazil (open-top chamber)	120 M, 120 F and offspring BALB/c mice	Short-term	$PM_{2.5}$ PM_{10}	Alterations in pulmonary development
Pinkerton et al. 2004	Model Particles	9 pregnant Sprague-Dawley rats and offspring	Short-term	UFP	Pulmonary development
Pinkerton et al. 2008	Model Particles	4-8 young adult male and 26-day neonatal Sprague-Dawley rats for each assay	Short-term	UFP	Inflammation and oxidative stress in the airways
Older Adults					
Barnett et al. 2006	2 New Zealand cities, 5 Australian cities	15-64 vs. ≥65 yrs	Short-term	$PM_{2.5}$ PM_{10}	Cardiovascular HA
Franklin et al. 2007	27 U.S. communities	<75 vs. ≥75 yrs	Short-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Fung et al. 2005a	Windsor, Ontario, CAN	<65 vs. ≥65 yrs	Short-term	PM_{10}	Cardiovascular HA
Fung et al. 2005b	London, Ontario, CAN	<65 vs. ≥65 yrs	Short-term	PM_{10}	Cardiovascular, respiratory HA
Host et al. 2007	6 French cities	All ages vs. ≥65 yrs	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	Cardiorespiratory HA
Larrieu et al. 2007	8 French cities	All ages vs. ≥65 yrs	Short-term	PM_{10}	Cardiovascular HA
Le Tertre et al. 2002	8 European cities	<65 vs. ≥65 yrs	Short-term	PM_{10}	Cardiovascular HA
Metzger et al. 2004	Atlanta, GA	All ages vs. 19-64 vs. ≥65 yrs	Short-term	$PM_{2.5}$ PM_{10}	Cardiovascular ED visits
Naess et al. 2007	Oslo, Norway	51-70 vs. 71-90 yrs	Long-term	$PM_{2.5}$ PM_{10}	All-cause (non-accidental) mortality
Ostro et al. 2006	9 California counties	All ages vs. ≥65 yrs	Short-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Pope et al. 2008	Utah's Wasatch Front	<65 vs. ≥65 yrs	Short-term	$PM_{2.5}$	Heart failure HA

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Samoli et al. 2008	APHENA	<75 vs. ≥75 yrs	Short-term	PM_{10}	All-cause (non-accidental) mortality
Villeneuve et al. 2002	6 U.S. cities	<60 vs. ≥60 yrs	Long-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Zanobetti and Schwartz 2005	21 U.S. cities	<75 vs. ≥75 yrs	Short-term	PM_{10}	MI HA
Zeka et al. 2006b	20 U.S. cities	< 65, 65-75, 75+ yrs	Short-term	PM_{10}	All-cause (non-accidental) mortality
Devlin et al. 2003	Chapel Hill, NC CAPs	10 healthy older adults (60-80yrs)	Short-term	$PM_{2.5}$	HRV
Gong et al. 2004a	Los Angeles, CA CAPs	13 older adults with COPD (6 healthy controls)	Short-term	$PM_{2.5}$	HRV
Nadziejko et al. 2004	Tuxedo, NY CAPs	12 Fischer 344 rats	Short-term	$PM_{2.5}$	HRV
Tankersley et al. 2004	Model particles	3 terminally senescent and 5 age-matched healthy AKR/J mice	Short-term	CB	HRV
Tankersley et al. 2008	Model particles	18- and 28-month old C57BL/6, C3H/HeJ, B6C3F1 mice (15 mice/age group)	Short-term	CB	HRV
Sex					
Boezen et al. 2005	Netherlands	327 older adults (160 M, 167 F)	Long-term	PM_{10}	Lung function, respiratory symptoms, airway hyperresponsiveness
Chen et al. 2005	3 California metro areas	Stratified by gender	Long-term	$PM_{2.5}$	CHF mortality
Franklin et al. 2007	27 U.S. communities	Stratified by gender	Short-term	$PM_{2.5}$	All-cause (non-accidental), CV, respiratory mortality
Luginaah et al. 2005	Windsor, Ontario, CAN	Stratified by gender	Short-term	PM_{10}	Respiratory HA
Malig and Ostro 2009	15 California counties	Stratified by gender	Short-term	$PM_{10-2.5}$	All-cause (non-accidental), CV mortality
Middleton et al. 2008	Nicosia, Cyprus	Stratified by gender	Short- term	PM_{10}	CV, respiratory HA
Naess et al. 2007	Oslo, Norway	Stratified by gender	Short-term	$PM_{2.5}$	Lung cancer, COPD mortality
Ostro et al. 2006	9 California counties	Stratified by gender	Short-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Wellenius et al. 2006b	7 U.S. cities	Stratified by gender	Short-term	PM_{10}	CHF HA
Zanobetti and Schwartz 2005	21 U.S. cities	Stratified by gender	Short-term	PM_{10}	MI ED visits
Zeka et al. 2006b	20 U.S. cities	Stratified by gender	Short-term	PM_{10}	Respiratory mortality
Frampton et al. 2006	Model particles	56 adults (20 healthy, 16 asthmatics) (18 M, 28 F)	Short-term	UF EC	Vascular effects, blood parameters
Race / Ethnicity					

Study	Location[a]	Population / Animal Model[b]	Exposure Duration[c]	Pollutant[d]	Health Endpoint[e]
Malig and Ostro et al. 2009	15 California counties	Stratified by race and ethnicity (Hispanic, white)	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	All-cause (non-accidental), CV mortality
Ostro et al. 2006	9 California counties	Stratified by race and ethnicity (white non-Hispanic, black non-Hispanic, Hispanic)	Short-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Ostro et al. 2008	6 California counties	Stratified by race and ethnicity (white, black, Hispanic)	Short-term	$PM_{2.5}$	CV mortality
Wellenius et al. 2006b	7 U.S. cities	Stratified by race	Short-term	PM_{10}	CHF HA
Zanobetti et al. 2008	34 U.S. cities	COPD cohort; Stratified by race (white and non-white)	Long-term	PM_{10}	All-cause (non-accidental) mortality
Zeka et al. 2006b	20 U.S. cities	Stratified by race (white and black)	Short-term	PM_{10}	All-cause (non-accidental), respiratory, heart disease, stroke, MI mortality
Genetic Factors					
Baccarelli et al. 2008	Boston, MA	549 subjects from Normative Aging Study; MTHFR and cSHMT polymorphisms	Short-term	$PM_{2.5}$	HRV
Chahine et al. 2007	Boston, MA	539 subjects from the Normative Aging Study; null and wild-type GSTM1; HO-1 promoter polymorphism	Short-term	$PM_{2.5}$	HRV
Park et al. 2006	Boston, MA	518 subjects from the Normative Aging Study; hemochromatosis (HFE) polymorphisms	Short-term	$PM_{2.5}$	HRV
Peters et al. 2009	5 European cities	854 MI survivors; fibrinogen gene single nucleotide polymorphisms	Short-term	PM_{10}	Inflammation, fibrinogen levels
Schneider et al. 2008	Chapel Hill, NC	22 people with type 2 diabetes mellitus; 10 diabetics with null GSTM1 alleles	Short-term	$PM_{2.5}$	Flow-mediated dilation, inflammation
Schwartz et al. 2005	Boston, MA	497 subjects from the Normative Aging Study with null GSTM1 alleles	Short-term	$PM_{2.5}$	HRV, oxidative stress
Suh et al. 2008	Seoul, Korea	117 women with pre-term and 118 with term deliveries; null GSTM1	Long-term	PM_{10}	Preterm birth

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Gilliland et al. 2004	Los Angeles, CA	19 non-smoking volunteers with positive skin test to short ragweed or history of allergic rhinitis; null GSTM1 or GSTP1, GSTP1 105 variants	Short-term	DE	Allergic inflammation
Obesity					
Diez Roux et al. 2008	6 U.S. cities	5,172 participants in MESA	Long-term	PM_{10} $PM_{2.5}$	Common carotid intimal-medial thickness (CIMT), ankle-brachial index (ABI), coronary artery calcification (CAC)
Dubowsky et al. 2006	St. Louis, MO	44 older adults, 14 obese with BMI $\geq$ 30 kg/m^2	Short-term	$PM_{2.5}$	Inflammation
Miller et al. 2007	36 U.S. cities	65,893 postmenopausal women without previous cardiovascular disease	Long-term	$PM_{2.5}$	CV-related events
Schneider et al. 2008	Chapel Hill, NC	22 people with type 2 diabetes mellitus; 12 people with BMIs $\geq$ 30 kg/m^2	Short-term	$PM_{2.5}$	Flow-mediated dilation, inflammation
Zeka et al. 2006a	Boston, MA	710 participants from VA Normative Aging Study	Long-term	$PM_{2.5}$ UFP CB	Thrombotic and inflammatory markers
Schwartz et al. 2005	Boston, MA	497 participants from the Normative Aging Study; BMI $\geq$ 30 kg/m^2	Short-term	$PM_{2.5}$	HRV
Bennet and Zeman 2004	Model particles	36 overweight children	Short-term	FP	Fractional deposition, lung function
Pre-Existing Disease					
Cardiovascular Disease					
Bateson et al. 2004	Cook County, IL	Secondary diagnosis: CHF	Short-term	PM_{10}	All-cause (non-accidental) mortality
Lee et al. 2008	Taipei, Taiwan	Secondary diagnosis: hypertension	Short-term	PM_{10}	CHF HA
Park et al. 2005	Boston, MA	497 men from the Normative Aging Study; Secondary diagnosis: IHD	Short-term	$PM_{2.5}$	HRV
Peel et al. 2007	Atlanta, GA	Secondary diagnosis: hypertension, dysrhythmia	Short-term	PM_{10}	Arrhythmias, CHF, IHD ED visits
Pope et al. 2006	Wasatch Front, Utah	Secondary diagnosis: CHF, hypertension	Short-term	$PM_{2.5}$	Acute coronary events (MI)

Study	Location[a]	Population / Animal Model[b]	Exposure Duration[c]	Pollutant[d]	Health Endpoint[e]
Wellenius et al. 2006b	7 U.S. cities	Secondary diagnosis: hypertension, dysrhythmia, MI	Short-term	PM_{10}	CHF HA
Zanobetti and Schwartz 2005	21 U.S. cities	Secondary diagnosis: CHF	Short-term	PM_{10}	MI HA
Zeka et al. 2006b	20 U.S. cities	Secondary diagnosis: Stroke	Short-term	PM_{10}	All-cause (non-accidental) mortality
Mills et al. 2007	Model particles	20 men with CAD and prior MI	Short-term	DE	HRV
Mills et al. 2008	Edinburgh, Scotland CAPs	12 non-smoking men with CAD and prior MI or stable angina (12 non-smoking healthy controls)	Short-term	UFP $PM_{2.5}$	HRV
Routledge et al. 2006 088674	Model particles	20 subjects with stable angina and CAD	Short-term	UF CP	HRV
Anselme et al. 2007	Model particles	Healthy and CHF Wistar rats	Short-term	UFP $PM_{2.5}$	HRV
Araujo et al. 2008	Los Angeles, CA CAPs	51 (17/group) $ApoE^{-/-}$mice	Short-term	UFP $PM_{2.5}$	HRV
Bartoli et al. 2009	Boston, MA CAPs	5 female mixed-breed canines in induced myocardial ischemia model	Short-term	$PM_{2.5}$	HRV
Campen et al. 2006	Reno, NV (diesel exhaust and paved road dust)	30 $ApoE^{-/-}$ mice	Short-term	DE GE	HRV
Chen and Hwang et al. 2005	Northeastern regional background CAPs	9 C57 and 19 $ApoE^{-/-}$mice	Long-term	UFP $PM_{2.5}$	HRV
Chen and Nadziejko 2005	Tuxedo, NY CAPs	9 C57, 15 $ApoE^{-/-}$, 23 $ApoE^{-/-}$ and $LdLr^{-/-}$ DK mice	Long-term	UFP $PM_{2.5}$	HRV
Sun et al. 2005	Tuxedo, NY CAPs	28 $ApoE^{-/-}$mice	Long-term	UFP $PM_{2.5}$	HRV
Sun et al. 2008	Tuxedo, NY CAPs	28 $ApoE^{-/-}$mice	Long-term	UFP $PM_{2.5}$	HRV
Wellenius et al. 2003	Boston, MA CAPs	6 retired mongrel breeder dogs in canine model of induced myocardial ischemia	Short-term	$PM_{2.5}$	HRV
Wellenius et al. 2006a	CAPs	85 Sprague-Dawley rats with acute MI	Short-term	$PM_{2.5}$	HRV
Respiratory Diseases					
Delfino et al. 2002	Alpine, CA	22 asthmatic children	Short-term	$PM_{2.5}$	Asthma symptoms
Delfino et al. 2003	Los Angeles, CA	22 Hispanic asthmatic children	Short-term	PM_{10}	Respiratory symptoms
Desqueyroux et al. 2002	Paris, France	60 asthmatic adults	Short-term	PM_{10}	Asthma symptoms

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Gent et al. 2003	CT and Springfield, MA	271 asthmatic children	Short-term	$PM_{2.5}$	Asthma symptoms
Lagorio et al. 2006	Rome, Italy	11 COPD, 11 non-smoking asthmatic adults	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	Lung function
Mortimer et al. 2002	8 urban U.S. areas	846 asthmatic children (NCICAS cohort)	Short-term	PM_{10}	Respiratory symptoms
Nordenhall et al. 2001	Model particles	14 non-smoking asthmatic adults	Short-term	DEP	Airway inflammation, airway hyperresponsiveness
Rabinovitch et al. 2006	Denver, CO	73 asthmatic children	Short-term	$PM_{2.5}$	Asthma symptoms
Silkoff et al. 2005	Denver, CO	34 COPD subjects	Short-term	$PM_{2.5}$ PM_{10}	Lung function
Trenga et al. 2006	Seattle, WA	57 COPD subjects, 17 asthmatic children	Short-term	$PM_{2.5}$	Lung function
Zeka et al. 2006b	20 U.S. cities	Secondary diagnosis: pneumonia	Short-term	PM_{10}	All-cause (non-accidental) mortality
Bastain et al. 2003	Model particles	18 non-smoking rhinitic volunteers	Short-term	DEP	Allergic inflammation
Diaz-Sanchez et al. 1997	Los Angeles, CA	13 non-smoking adults with allergic rhinitis	Short-term	DEP plus ragweed allergen	Allergic inflammation
Gong et al. 2003	Southern California CAPs	12 non-smoking asthmatic adults (12 non-smoking healthy controls)	Short-term	$PM_{2.5}$ CAPs	Inflammation, lung function, hematology
Gong et al. 2004a	Los Angeles, CA Suburb CAPs	13 COPD subjects (6 healthy controls)	Short-term	$PM_{2.5}$	Lung function, respiratory symptoms
Gong et al. 2004b	Los Angeles, CA Suburb CAPs	12 asthmatic adults (4 healthy controls)	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	Respiratory symptoms, lung function, airway inflammation
Gong et al. 2008	Los Angeles, CA Suburb CAPs	14 non-smoking asthmatic adults (17 non-smoking healthy controls)	Short-term	UFP	Lung function, respiratory symptoms, hematology
Bennett et al. 1997	Model particles	13 COPD subjects (11 non-smoking healthy age-matched subjects)	Short-term	UFP	Deposition fraction, lung function
Brown et al. 2002	Model particles	10 COPD subjects (9 non-smoking healthy subjects)	Short-term	UFP (Carbon Aerosol)	Deposition fraction, lung function
Heidenfelder et al. 2009	Grand Rapids, MI CAPs	32 Brown Norway Rats with allergic airway disease	Short-term	$PM_{2.5}$	Expression of genes associated with inflammation, airway remodeling

Study	Location[a]	Population / Animal Model[b]	Exposure Duration[c]	Pollutant[d]	Health Endpoint[e]
Li et al. 2009	Los Angeles, CA	6- to 8-week old ovalbumin sensitized female BALB/C mice	Short-term	UFP	Adjuvant effect of PM
Lopes et al. 2009	São Paulo, Brazil (open-top chamber)	6- to 8-weel old male BALB/C mice in an emphysema model	Long-term	PM_{10}	Pulmonary remodeling
Morishita et al. 2004	Detroit, MI CAPs	32 Brown Norway rats with allergic airway disease	Short-term	$PM_{2.5}$	Airways inflammation
Respiratory Conditions to Cardiovascular Effects					
De Leon et al. 2003	New York City, NY	Secondary diagnosis: pneumonia, COPD, and contributing respiratory disease	Short-term	PM_{10}	Circulatory mortality
Peel et al. 2007	Atlanta, GA	Secondary diagnosis: COPD	Short-term	PM_{10}	CV ED visits
Wellenius et al. 2005	Allegheny County, PA	Secondary diagnosis: COPD	Short-term	PM_{10}	CHF ED visits
Wellenius et al. 2006b	7 U.S. cities	Secondary diagnosis: respiratory infection	Short-term	PM_{10}	CHF ED visits
Zanobetti and Schwartz 2005	21 U.S. cities	Secondary diagnosis: pneumonia	Short-term	PM_{10}	MI ED visits
Fakhri et al. 2009	Toronto, Ontario, CAN CAPs	50 non-smoking subjects (10 with asthma)	Short-term	$PM_{2.5}$	HRV
Gong et al. 2003	Los Angeles, CA CAPs	12 non-smoking asthmatic adults (12 non-smoking healthy controls)	Short-term	$PM_{2.5}$	CV, circulatory responses
Gong et al. 2004b	Los Angeles, CA CAPs	12 non-smoking asthmatic adults (4 non-smoking healthy controls)	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	CV response
Gong et al. 2008	Los Angeles, CA CAPs	14 non-smoking asthmatic adults (17 non-smoking healthy adults)	Short-term	UFP	CV response, Holter ECG
Batalha et al. 2002	Model particles	28 Sprague-Dawley rats in a chronic bronchitis model (28 normal rats)	Short-term	$PM_{2.5}$	Pulmonary artery lumen-to-wall ratio
Diabetes					
Dubowsky et al. 2006	St. Louis, MO	44 older adults, 8 with diabetes	Short-term	$PM_{2.5}$	Inflammation
Goldberg et al. 2006	Montreal, Quebec, CAN	Secondary diagnosis: diabetes	Short-term	$PM_{2.5}$	All-cause (non-accidental) mortality
Liao et al. 2005	4 U.S. study centers	10,208 middle-age people in ARIC cohort	Short-term	PM_{10}	Homeostasis, inflammation
Liu et al. 2007	Windsor, Ontario, CAN	25 diabetic adults	Short-term	PM_{10}	Flow-mediated dilation

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Peel et al. 2007	Atlanta, GA	Secondary diagnosis: diabetes	Short-term	PM_{10}	IHD, arrhythmias, CHF ED visits
Pope et al. 2006	Wasatch Front, Utah	Secondary diagnosis: diabetes	Short-term	$PM_{2.5}$ PM_{10}	Acute coronary events (MI)
Schneider et al. 2008	Chapel Hill, NC	22 people with type 2 diabetes mellitus	Short-term	$PM_{2.5}$	Flow-mediated dilation, inflammation
Wellenius et al. 2006b	7 U.S. cities	Secondary diagnosis: diabetes	Short-term	PM_{10}	CHF ED visits
Zanobetti and Schwartz 2002	4 U.S. cities	Secondary diagnosis: diabetes	Short-term	PM_{10}	CVD HA
Zanobetti and Schwartz 2005	21 U.S. cities	Secondary diagnosis: diabetes	Short-term	PM_{10}	MI ED visits
Zeka et al. 2006b	20 U.S. cities	Secondary diagnosis: diabetes	Short-term	PM_{10}	All-cause (non-accidental) mortality
Carlsten et al. 2008	Model particles	16 subjects with metabolic syndrome	Short-term	DE	Thrombosis
Socioeconomic Status					
Baccarelli et al. 2008	Boston, MA	Normative Aging Study; stratified by education level; nutrient intake	Short-term	$PM_{2.5}$	HRV
Franklin et al. 2008	25 U.S. cities	SES examined by income, % below poverty line, % high school graduates	Short-term	$PM_{2.5}$	All-cause (non-accidental), respiratory, CVD, stroke mortality
Jerrett et al. 2004	Hamilton, CAN	Educational attainment	Short-term	PM_{10}	All-cause (non-accidental) mortality
Krewski et al. 2009	U.S.	ACS cohort; Educational attainment	Long-term	$PM_{2.5}$	Lung cancer, IHD mortality
Malig and Ostro 2009	15 California counties	Educational attainment	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	All-cause (non-accidental), CV mortality
Ostro et al. 2006	9 California counties	Educational attainment	Short-term	$PM_{2.5}$	All-cause (non-accidental), respiratory, CV, IHD, diabetes mortality
Ostro et al. 2008	6 California counties	Education level	Short-term	$PM_{2.5}$	CV mortality
Wilson et al. 2007	Phoenix, AZ	Educational attainment, income	Short-term	$PM_{2.5}$ $PM_{10-2.5}$	All-cause (non-accidental) mortality
Zeka et al. 2006b	20 U.S. cities	Educational attainment	Short-term	PM_{10}	All-cause (non-accidental), respiratory, heart disease, stroke, MI mortality

Study	Location[a]	Population / Animal Model[b]	Exposure Duration[c]	Pollutant[d]	Health Endpoint[e]

[a] Model particles include particles generated in a laboratory setting (e.g., UFP from particle generation system; PM generated from a diesel engine), but excluding concentrated ambient particles (CAPs).
[b] For epidemiologic studies, if the size of the population considered is not specified a time-series or cohort study design was used, which consists of a large sample size.
[c] Short-term is defined as days to weeks. Long-term is defined as months to years.
[d] GE = gasoline emissions; CB = carbon black ; UFP = ultrafine particles ; UF CP = ultrafine carbon particles; EPM = Emission particulate matter ; DE = diesel exhaust ; TSP = total suspended particles
[e] HA = hospital admissions; ED = emergency department; HRV = heart rate variability; CAD = coronary artery disease; CV = cardiovascular; CHF = congestive heart failure; IHD = ischemic heart disease; MI = myocardial infarction
[f] Studies not shaded = epidemiologic studies; Dark gray shading = controlled human exposure studies; Medium gray shading = dosimetric studies; Light gray shading = toxicological studies

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