

**Testimony of Gregory Wellenius, ScD**

**Assistant Professor of Epidemiology at Brown University**

**Hearing on**

**H.R. 1633, the “Farm Dust Regulation Prevention Act of 2011”**

**Subcommittee on Energy and Power  
Committee on Energy and Commerce**

**U.S. House of Representatives**

**October 25, 2011**

Mr. Chairman, Members of the Committee, thank you for the opportunity to testify today. I am Dr. Gregory Wellenius, Assistant Professor of Epidemiology at Brown University. I earned my doctorate in Environmental Health and Epidemiology from the Harvard School of Public Health and served on the faculty at Harvard Medical School from 2007 to 2009. I have been conducting research on the health effects of air pollution for more than 10 years and have authored or coauthored more than a dozen original studies in this area. I contributed as an author for the EPA’s December 2009 Integrated Science Assessment for particulate matter. Currently, my research focuses on the effect of ambient air pollution on cardiovascular disease and brain health.

There is a broad consensus in the scientific community that particulate matter air pollution is harmful to human health. Based on the available evidence, the American Heart Association recently concluded that exposure to ambient fine particulate matter air pollution (PM<sub>2.5</sub>) is a “modifiable factor that contributes to cardiovascular morbidity and mortality”.<sup>1</sup> The World Health Organization

attributes 28,000 premature deaths in North America and 800,000 worldwide to ambient particulate matter each year,<sup>2-3</sup> although more recent studies suggest that the true public health burden might be even greater.<sup>4</sup>

In the scientific review of the 2009 Integrated Science Assessment for Particulate Matter, the external panel of independent scientists that make up the Clean Air Scientific Advisory Committee and the EPA scientists concluded that a “causal relationship” exists between ambient fine particulate matter and both mortality and cardiovascular effects and that “a likely causal” relationship exists between ambient fine particulate matter and respiratory effects.<sup>5-6</sup>

The conclusion that ambient fine particulate matter is an important and preventable cause of death and hospitalization has been endorsed by a number of scientific organizations including the World Health Organization, the National Research Council, the American Medical Association, the American Lung Association, the American Heart Association, the American Thoracic Association, the American Academy of Pediatrics, the American College of Cardiology, and the American Association of Cardiovascular and Pulmonary Rehabilitation, among others. Clean Air Scientific Advisory Committee.

I now draw your attention to some key scientific findings of these health effects.

### **Long-term health effects**

A number of large studies have looked at the long-term health effects of ambient particles. The first of these studies was the Harvard Six Cities study which followed 8111 men and women living in 6 U.S. cities for 14-16 years. The researchers found that over a 16 year period, adults who lived in the most polluted of the 6 cities had a 26% higher rate of death as compared to those in the least polluted city.<sup>7</sup> Several other studies have found similar results including the American Cancer Society Cancer Prevention Study II,<sup>8-10</sup> the California Seventh-day Adventists cohort study,<sup>11</sup> and a recent national study of 66,000

participants from the Women's Health Initiative (WHI) Observational Study.<sup>12</sup> These studies provide evidence linking long-term exposure to ambient particulate matter and all-cause mortality, cardiovascular mortality, and non-fatal cardiovascular events.

We now know that the increased risk of cardiovascular events linked to ambient particulate matter is at least partly due to increases in atherosclerosis from particulate matter. Specifically, several studies have shown that people that live in areas with more air pollution have more atherosclerosis.<sup>13-15</sup> These findings are supported by laboratory experiments showing that animals exposed to particulate matter develop more atherosclerosis than those animals exposure to clean air.<sup>16-18</sup>

The impact of particulate air pollution on life expectancy is substantial. Scientists recently looked at changes in life expectancy in 200 counties in the U.S. and calculated that reductions in fine particle air pollution between 1980 and 2000 increased the average lifespan in these counties by approximately 5 months.<sup>19</sup> Importantly, the greatest increase in life expectancy was seen in those counties showing the greatest reduction in fine particle air pollution during this time.

### **Short-term health effects**

Hundreds of studies in the U.S. and around the world have confirmed that elevations in particulate matter are associated with an increased risk of premature death, cardiovascular death, hospitalization for respiratory and cardiovascular diseases, and respiratory symptoms within days.<sup>5</sup> These associations have been found for PM<sub>2.5</sub> (fine particles smaller than 2.5 micrometers in diameter), PM<sub>10</sub> (particles smaller than 10 micrometers in diameter), and PM<sub>10-2.5</sub> (coarse particles ranging in diameter from 2.5 to 10 micrometers).

These scientific studies have linked particulate matter exposure to a variety of problems, including:

- aggravated asthma in children;<sup>20</sup>
- increased emergency department visits and hospital admissions;<sup>21-22</sup>
- higher risk of hospitalization for congestive heart failure,<sup>23</sup> stroke,<sup>24</sup> and myocardial infarction (heart attacks);<sup>25</sup>
- increased risk of premature death;<sup>26</sup>
- greater risk of discharge of implantable cardioverter-defibrillator (ICD).<sup>27</sup>

Not only does particulate matter trigger serious health threats, higher exposure can also increase the risk of subsequent cardiovascular events. In a large study of nearly two hundred thousand heart attack survivors showed that these people faced increased risk for harm from subsequent exposure to PM10, risks that include death, subsequent myocardial infarction (MI), or admission to a hospital for congestive heart failure.<sup>28</sup>

Particulate pollution can cause health problems for anyone, but certain people are especially susceptible. Children and teenagers, the elderly, and people who already have cardiovascular disease, chronic lung disease or diabetes and individuals with low socioeconomic status or lower educational levels are among the groups most at risk. Even healthy adults who work or exercise outdoors may face higher risk.<sup>5</sup>

Many of these studies have been done in cities that are in compliance of the U.S. National Ambient Air Quality Standards. Thus, the harmful effects of particulate matter can be seen even at pollution levels below the current regulatory standards.

Other studies have taken advantage of natural experiments to show that reducing PM levels leads to improved health. An 8-month national copper smelter strike in the 1960's led to a large reduction in ambient particulate matter

and a 2.5% reduction in death rates in the southwestern U.S.<sup>29</sup> Similarly, respiratory deaths fell by 15% and cardiovascular deaths fell by 10% following a ban on the sale of coal in Dublin, Ireland in 1990.<sup>30</sup>

### **Health Effects of Coarse Particles**

The coarse and fine fractions of particulate matter differ in their size, sources, and composition. While fewer studies have looked specifically at the health effects of coarse particles, the existing evidence suggests that these particles are also harmful to people. In the 2009 Integrated Science Assessment for Particulate Matter, EPA staff concluded that the available evidence is “suggestive for a causal relationship” between coarse particles and mortality, cardiovascular effects, and respiratory effects.<sup>5</sup>

A systematic review of more than 30 studies that investigated the effects of both fine and coarse particles found that for some health endpoints, the effects are even stronger for coarse particles than for fine particles.<sup>31</sup> For example, in studies of chronic obstructive pulmonary disease, asthma and respiratory admissions, coarse particles have a stronger or as strong an effect as fine particles. The review also found support for an association between coarse particles and cardiovascular hospital admissions. The review also cited toxicology studies showing that coarse PM exerts toxic effects.

The following studies serve as examples:

- A study in Spokane, Washington found that even low concentrations of coarse particle air pollution may cause symptoms of respiratory distress in children with asthma. Stronger associations with cough were reported for coarse particles than for fine particles. Increased phlegm and runny nose were associated with PM<sub>10</sub> and PM<sub>10-2.5</sub>.<sup>32</sup>
- A study of daily deaths and hospital admissions among the elderly in the Detroit metropolitan area found that for ischemic heart disease and stroke,

the relative risks were higher for PM<sub>10-2.5</sub> than for PM<sub>2.5</sub>.<sup>33</sup> A study in Toronto, Canada reported a stronger effect of PM<sub>10-2.5</sub> on asthma hospitalization among children compared with both PM<sub>2.5</sub> and PM<sub>10</sub>.<sup>34</sup> PM<sub>10-2.5</sub> was significantly associated with hospital admissions for respiratory disease in Vancouver.<sup>35</sup>

- A multi-decade study reported that women living in areas with greater coarse particle concentrations had a higher risk of developing and dying from coronary heart disease. Coarse particles were associated with increased risk of fatal heart disease in women, especially older women, but not in men, though the effect was stronger for fine particles.<sup>36</sup>
- An analysis of 112 U.S. cities found that coarse PM was linked with higher risk of premature death from all causes, stroke and respiratory causes, even after controlling for levels of fine particles.<sup>37</sup>
- A study of 15 counties in California found that coarse particles were associated with all-cause and cardiovascular deaths, even after adjusting for PM<sub>2.5</sub> levels.<sup>38</sup>

Taken together, the existing evidence suggests that exposure to higher levels of coarse particulate matter can increase the risk of death, cardiovascular hospitalizations, and respiratory effects.

Most existing epidemiologic studies on coarse particles have been conducted in urban settings. However, we have known for a long time that agricultural dust can also be harmful. Two large reviews completed over a decade ago found serious respiratory health hazards in agricultural dust sources from exposure to infectious and non-infectious bioaerosols, other organic dusts, and mineral dusts.<sup>39-40</sup> Field workers exposed to mineral dusts from agricultural sources experience more acute and chronic bronchitis, chronic obstructive airways

disease and interstitial lung disease.<sup>41</sup> Agricultural workers exposed to organic dusts have been found to have higher risk of allergic reactions, asthma, hypersensitivity pneumonitis and organic dust toxic syndrome.<sup>42</sup> Research that included examining the lungs of California farm workers found that their bronchioles had accumulation of dust particles, and thickening and inflammation in the respiratory tissues.<sup>43</sup>

Sandstorms and other dust events typically increase the concentration of coarse particulate matter much more than fine particulate matter. Therefore, studying these events provides information on the potential health effects of coarse particles of non-urban origin. For example, one study looked at the effect of Asian dust storms on hospital admissions in Taipei, Taiwan over an eight year period and found that dust storms were associated with increased rates of hospital visits for ischemic heart diseases (including heart attacks).<sup>44</sup> Other studies have linked dust events in Spain and Cypress with increased risk of hospitalization or death.<sup>45-46</sup> These studies add to the evidence of health effects of coarse particles and highlight that even coarse particles from non-urban environments can have important health effects.

Congress built into the Clean Air Act an orderly process for the regular review of the scientific evidence related to the health effects of air pollution. This review includes multiple rounds of peer review, including by the congressionally mandated panel of independent scientists – the Clean Air Scientific Advisory Committee (CASAC). I strongly urge you to preserve the authority of the EPA to periodically review and update the air quality standards as mandated by the Clean Air Act, including for PM<sub>10</sub> and coarse particle pollution. The evidence of the harm from particulate matter pollution underscores how important it is for the EPA to update the nation's key pollution control tools on an ongoing basis — and for Congress to continue to allow them to do so.

## References:

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3. Cohen AJ, Ross Anderson H, Ostro B, et al. The global burden of disease due to outdoor air pollution. *J Toxicol Environ Health A*. 2005;68(13-14):1301-1307.
4. Anenberg SC, Horowitz LW, Tong DQ, West JJ. An estimate of the global burden of anthropogenic ozone and fine particulate matter on premature human mortality using atmospheric modeling. *Environ Health Perspect*. 2010;118(9):1189-1195.
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6. Samet J. *CASAC Review of integrated science assessment for particulate matter (second external review draft, July 2009)*. Washington, D. C.: U.S. Environmental Protection Agency;2009. EPA-CASAC-10-001.
7. Dockery DW, Pope CA, 3rd, Xu X, et al. An association between air pollution and mortality in six U.S. cities. *N Engl J Med*. 1993;329(24):1753-1759.
8. Pope CA, 3rd, Thun MJ, Namboodiri MM, et al. Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults. *Am J Respir Crit Care Med*. 1995;151(3 Pt 1):669-674.
9. Pope CA, 3rd, Burnett RT, Thun MJ, et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *Jama*. 2002;287(9):1132-1141.

10. Pope CA, 3rd, Burnett RT, Thurston GD, et al. Cardiovascular mortality and long-term exposure to particulate air pollution: epidemiological evidence of general pathophysiological pathways of disease. *Circulation*. 2004;109(1):71-77.
11. Abbey DE, Nishino N, McDonnell WF, et al. Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. *Am J Respir Crit Care Med*. 1999;159(2):373-382.
12. Miller KA, Siscovick DS, Sheppard L, et al. Long-term exposure to air pollution and incidence of cardiovascular events in women. *N Engl J Med*. 2007;356(5):447-458.
13. Kunzli N, Jerrett M, Mack WJ, et al. Ambient air pollution and atherosclerosis in Los Angeles. *Environ Health Perspect*. 2005;113(2):201-206.
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20. Slaughter JC, Lumley T, Sheppard L, Koenig JQ, Shapiro GG. Effects of ambient air pollution on symptom severity and medication use in children with asthma. *Ann Allergy Asthma Immunol.* 2003;91(4):346-353.
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22. Dominici F, Peng RD, Bell ML, et al. Fine particulate air pollution and hospital admission for cardiovascular and respiratory diseases. *JAMA.* 2006;295(10):1127-1134.
23. Wellenius GA, Bateson TF, Mittleman MA, Schwartz J. Particulate air pollution and the rate of hospitalization for congestive heart failure among medicare beneficiaries in Pittsburgh, Pennsylvania. *Am J Epidemiol.* 2005;161(11):1030-1036.
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27. Peters A, Liu E, Verrier RL, et al. Air pollution and incidence of cardiac arrhythmia. *Epidemiology.* 2000;11(1):11-17.
28. Zanobetti A, Schwartz J. Particulate air pollution, progression, and survival after myocardial infarction. *Environ Health Perspect.* 2007;115(5):769-775.
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35. Yang Q, Chen Y, Krewski D, Shi Y, Burnett RT, McGrail KM. Association between particulate air pollution and first hospital admission for childhood respiratory illness in Vancouver, Canada. *Arch Environ Health*. 2004;59(1):14-21.
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**CURRICULUM VITAE**  
**Gregory A. Wellenius**

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**EDUCATION**

Undergraduate McGill University, Physiology, B.Sc. (Distinction), 1996

Graduate School McGill University, Physiology, M.Sc., 1999

Harvard School of Public Health, Environmental Health and  
Epidemiology, Sc.D., 2004

**POSTGRADUATE TRAINING**

Fellowship Research Fellow in Medicine, Cardiovascular Division, Beth Israel  
Deaconess Medical Center, 2004-2007

**HONORS AND AWARDS**

1994, 1995 Intramural Research and Training Fellowship Award, NIH

1997 Student Travel Award, McGill University Alumni Association

2003 Student Travel Award, International Society of Environmental  
Epidemiology

2004 Edgar Haber Award in Biological Sciences, Harvard School of Public  
Health, Doctoral Thesis

2007 Annual Meeting Poster Award, Society for Epidemiologic Research

2009 Merck Sharp & Dohme Award for best work in cardiovascular disease  
prevention, Chilean Society of Cardiology and Cardiac Surgery.

2010 Professor Dr. Armando Ilanes Lacalle Foundation Award for best work in  
clinical research, Chilean Society of Cardiology and Cardiac Surgery.

**ACADEMIC APPOINTMENTS**

2007-2009	Instructor of Medicine, Harvard Medical School
2009-2011	Assistant Professor of Community Health, Department of Community Health (Epidemiology Section), Brown University
2011-Present	Assistant Professor of Epidemiology, Department of Epidemiology, Brown University

**HOSPITAL APPOINTMENTS**

2007-2009	Instructor of Medicine, Beth Israel Deaconess Medical Center, Department of Medicine, Cardiovascular Division
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**OTHER APPOINTMENTS**

1994-1996	Intramural Research Fellow, National Institutes of Health
1996-1999	Research Assistant, McGill University
1999-2009	Research Specialist, Bioengineering, Harvard School of Public Health
2008-2009	Consultant, US Environmental Protection Agency
2011-Present	Associate Director, Center for Environmental Health and Technology, Brown University

**MEMBERSHIP IN SOCIETIES**

2006-Present	Member, International Society of Environmental Epidemiology
2008-Present	Member, American Heart Association
2009-Present	Member, Society for Epidemiologic Research
2010-Present	Fellow, International Society for Holter and Noninvasive Electrocardiology

**GRANT REVIEW ACTIVITIES**

2009-Present	Ad hoc reviewer, Health Effects Institute, Boston, MA
2010-Present	Ad hoc reviewer, NIEHS Center, Harvard School of Public Health

**EDITORIAL ACTIVITIES**

Ad hoc reviewer for:

- American Journal of Cardiology
- American Journal of Epidemiology
- American Journal of Industrial Medicine
- American Journal of Kidney Diseases
- American Journal of Physiology: Heart and Circulatory Physiology
- Arteriosclerosis, Thrombosis and Vascular Biology

BMC Health Services Research  
 Brazilian Journal of Medical and Biological Research  
 Chronobiology International  
 Environment International  
 Environmental Health  
 Environmental Health Perspectives  
 Environmental Science & Technology  
 European Journal of Clinical Investigation  
 Epidemiology  
 Inhalation Toxicology  
 International Journal of Biometeorology  
 International Journal of Cardiology  
 International Journal of Environmental Research and Public Health  
 Journal of Industrial Medicine  
 Journal of Toxicology and Environmental Health  
 Lancet  
 Occupational and Environmental Medicine  
 Science of the Total Environment  
 Stroke, Journal of the American Heart Association

### **UNIVERSITY COMMITTEES**

2009-Present	Chair, Epidemiology Curriculum Committee, Department of Epidemiology, Brown University
2009-2010	Member, Epidemiology Admissions Committee, Department of Community Health, Brown University
2010-2012	Member, Environmental Epidemiology Faculty Search Committee, Department of Epidemiology, Brown University
2011-2012	Member, Molecular Epidemiology Faculty Search Committee, Department of Epidemiology, Brown University
2011-2012	Member, Ad-hoc Committee to Review Epidemiology Curriculum, Department of Epidemiology, Brown University
2011-Present	Member, Public Health Curriculum Committee, Program in Public Health, Brown University

### **TEACHING**

#### **Classroom Teaching – Primary Instructor**

2010	PHP2200: Intermediate Epidemiology Brown University Graduate Students, 3 hr/week for 15 weeks
2010	PHP2240: Methods in Environmental Epidemiology Brown University Graduate Students, 3 hr/week for 15 weeks

**Other Teaching Experience**

2001, 2006           Section Leader  
B23: The Human Organism  
Harvard College  
Undergraduate Students, Six 2-hr sessions

2001-2008           Laboratory Demonstrator  
EH205: Human Physiology  
Harvard School of Public Health  
Graduate Students, One 2-hr session

2002                 Teaching Assistant  
EH205: Human Physiology  
Harvard School of Public Health  
Graduate Students, One 1-hr session per week for 16 weeks

2003, 2005           Teaching Assistant  
EPI202: Elements of Epidemiologic Research  
Harvard School of Public Health  
Graduate Students, One 2-hr session per week for 8 weeks

2007-2011           Workshop Leader  
EPI208: Introduction to Clinical Epidemiology  
Harvard School of Public Health  
MPH Students, Two 2-hr group sessions and 1-on-1 meetings

2008, 2011           Guest Lecture  
ID215: Environmental/Occupational Epidemiology  
Harvard School of Public Health  
Graduate Students, One 2-hr guest lecture

2009                 Guest Lecture  
Cardiology Fellows Research Course  
Beth Israel Deaconess Medical Center  
Two 1-hr guest lectures

2010                 Guest Lecture  
PHP1070: The Burden of Disease in Developing Countries  
Brown University  
Undergraduate Students, One 2-hr guest lecture

2010, 2011           Guest Lecture  
PHP2180: Critical Epidemiology  
Brown University  
Graduate Students, One 3-hr guest lecture

2011                 Guest Lecture  
PHP0320: Introduction to Public Health  
Brown University  
Undergraduate Students, One 1-hr guest lecture

**RESEARCH TRAINEES SUPERVISED****Post-Doctoral Fellows**

- 2011 – Present      Dr. Yi Wang, Post-Doctoral Research Associate  
 2011 – Present      Dr. Deborah Watkins, Post-Doctoral Research Associate

**PhD Students (PhD Dissertation Chair)**

- 2010 – Present      Regina Grebla, PhD Candidate, Department of Epidemiology, Brown University. Degree expected 2012.  
 2011 – Present      Nina Joyce, PhD Candidate, Department of Epidemiology, Brown University. Degree expected 2015.

**PhD Students (Thesis Committee Member)**

- 2010 – 2011      Anthony Nunes, PhD Candidate, Department of Epidemiology, Brown University. Graduated 2011.

**MPH Students (Primary Advisor)**

- 2010 – Present      Dr. Atika Faiz, MPH Candidate, Program in Public Health. Brown University. Degree expected 2012.  
 2010 – Present      Mengna Huang, MPH Candidate, Program in Public Health. Brown University. Degree expected 2012.  
 2011 – Present      Larry Warner, MPH Candidate, Program in Public Health. Brown University. Degree expected 2013.  
 2011 – Present      Samantha Kingsley, MPH Candidate, Program in Public Health. Brown University. Degree expected 2013.

**ScM Students (Thesis Reader)**

- 2011- Present      Dr. Lori A. Daiello, ScM Candidate, Department of Epidemiology, Brown University. Degree expected 2012.

**Medical Students**

- Summer 2010      Luke Boyle, BM BCh BAO and MPH Candidate, Queen's University Belfast. Degrees expected 2012.

**INVITED PRESENTATIONS****Regional**

1. 2002 Cardiovascular Effects of Particulate Air Pollution / Oral Presentation  
Comision Nacional del Medio Ambiente, Government of Chile, Santiago, Chile  
(sponsored by the Harvard School of Public Health)
2. 2003 Cardiovascular Effects of Inhaled Ambient Particles / Seminar  
Physiology Program, Harvard School of Public Health
3. 2004 Cardiovascular Effects of Inhaled Ambient Particles / Seminar  
Pathology Department, Brigham and Women's Hospital
4. 2005 Effects of Air Pollution in Patients with Congestive Heart Failure / Seminar  
Physiology Program, Harvard School of Public Health
5. 2005 Effects of Air Pollution in Subjects with Heart Failure / Seminar  
Cardiovascular Division, Beth Israel Deaconess Medical Center
6. 2006 Effects of Ambient Air Pollution in Patients with Heart Failure: A Pilot Study /  
Departmental Symposium  
Department of Environmental Health, Harvard School of Public Health
7. 2007 Ambient Air Pollution and the Risk of Acute Ischemic Stroke / Seminar  
Department of Environmental Health, Harvard School of Public Health
8. 2008 Environmental Determinants of Cerebrovascular Disease / Seminar  
Department of Environmental Health, Harvard School of Public Health
9. 2010 Air Pollution: A Novel Risk Factor for Acute Ischemic Stroke? / Research Grand  
Rounds  
Center for Primary Care and Prevention, Memorial Hospital
10. 2010 Health Risks from Ambient Air Pollution: How Much Do We Really Know?  
Science Seminar for Journalists, Brown University Superfund Research Program

**National**

1. 2005 Case-crossover Methods for Studying the Effects of Environmental Exposures /  
Seminar  
Department of Epidemiology and Preventive Medicine, University of Maryland
2. 2006 Particulate Air Pollution and Hospital Admissions for Congestive Heart Failure in  
Eight US Cities / Oral Abstract  
US Environmental Protection Agency
3. 2006 Air Pollution as a Trigger of Acute Cardiovascular Events: Heart Failure and  
Stroke / Seminar  
Southern California Environmental Health Sciences Center, University of  
Southern California

4. 2007 Ambient Air Pollution and the Risk of Acute Ischemic Stroke / Seminar  
Department of Environmental and Community Medicine, University of Medicine and Dentistry of New Jersey
5. 2008 Onset Time Misclassification Leads to Underestimation of Acute Health Effects / Oral Abstract  
International Society for Environmental Epidemiology Annual Mtg, Pasadena, CA
6. 2008 How Weather Influenced West Nile Virus in the United States (2001-2005) / Oral Abstract  
International Society for Environmental Epidemiology Annual Mtg, Pasadena, CA
7. 2008 Issues of Spatial Analysis / Session Chair  
International Society for Environmental Epidemiology Annual Mtg, Pasadena, CA
8. 2009 Air Pollution and Stroke / Symposium  
Experimental Biology meeting, New Orleans, LA
9. 2010 Particulate Air Pollution is Associated with Increased Risk of Acute Ischemic Stroke in Patients with Diabetes: Results from the Registry of the Canadian Stroke Network / Oral Abstract  
American Heart Association Cardiovascular Disease Epidemiology and Prevention Conference, San Francisco, CA.
10. 2010 Mechanistic Evidence Linking Pollutant Exposure to Vascular Phenomena. / Invited Speaker  
2010 NIEHS-EPA Symposium on Air Pollution and Cardiovascular Disease  
University of Washington
11. 2011 Air Pollution: A Novel Risk Factor for Acute Ischemic Stroke? / Seminar  
Department of Epidemiology, University of Alabama, Birmingham

### **International**

1. 2007 Pollution and Heart Disease: The Emerging Science of Environmental Cardiology / Seminar  
Population Health Research Institute, McMaster University, Hamilton, Canada
2. 2008 Air Pollution and Cardiovascular Health / Research Rounds  
Institute for Clinical and Evaluative Sciences, University of Toronto, Canada
3. 2009 Ambient Air Pollution and the Risk of Acute Ischemic Stroke / Grand Rounds  
Population Health Research Institute, McMaster University, Hamilton, Canada
4. 2009 Environmental Determinants of Cerebrovascular Disease / Cardiovascular Rounds  
Institute for Clinical and Evaluative Sciences, University of Toronto, Canada
5. 2009 Temperature and the Risk of Acute Ischemic Stroke: Results from the Registry of the Canadian Stroke Network / Oral Abstract  
Int. Society for Environmental Epidemiology Annual Meeting, Dublin, Ireland

6. 2009 Diabetes Mellitus Modifies the Association between Particulate Air Pollution and Acute Ischemic Stroke: Results from the RCSN / Oral Abstract  
Int. Society for Environmental Epidemiology Annual Meeting, Dublin, Ireland
7. 2011 Chronic Exposure to Traffic Pollution Is Associated with Reduced Glomerular Filtration Rate / Oral Abstract  
Int. Society for Environmental Epidemiology Annual Meeting, Barcelona, Spain
8. 2011 Exposure to Ambient Fine Particulate Matter Alters Cerebral Blood Flow in the Elderly: The MOBILIZE Boston Study / Oral Abstract  
Int. Society for Environmental Epidemiology Annual Meeting, Barcelona, Spain
9. 2011 Traffic Pollution and Cognitive Function in Community-Dwelling Seniors: The MOBILIZE Boston Study / Oral Abstract  
Int. Society for Environmental Epidemiology Annual Meeting, Barcelona, Spain
10. 2011 Air Pollution and Cardiovascular Disease I / Session Chair  
Int. Society for Environmental Epidemiology Annual Meeting, Barcelona, Spain
11. 2011 Air Pollution and Cardiovascular Biomarkers / Poster Discussion Session Chair  
Int. Society for Environmental Epidemiology Annual Meeting, Barcelona, Spain

## **RESEARCH GRANTS**

### **Completed**

1. 2001-2004 Lung biology and respiratory disease (PI: Joseph Brain)  
NHLBI T32 HL007118  
Role: Trainee
2. 2004-2005 Cardiovascular research training program (PI: James Morgan)  
NHLBI T32 HL007374  
Role: Trainee
3. 2005-2007 Particulate air pollution and acute ischemic stroke  
NIEHS F32 ES001380  
Role: PI (\$99,564)  
  
The goal of this individual post-doctoral fellowship was to evaluate the association between acute exposure to ambient air pollution and the risk of hospitalization for acute ischemic stroke among Boston-area residents.
4. 2007-2008 Air Pollution health effects in heart failure pilot study  
Harvard-Thorndike General Clinical Research Center C-111  
Role: PI (\$13,179)  
  
This award was made under the Clinical Research Feasibility Funds (CRFF) Program of the GCRC at the Beth Israel Deaconess Medical Center. The goal of this award was to carry out a pilot study evaluating the effects of acute exposure to ambient air pollution on physiologic endpoints in patients with congestive heart failure.

5. 2007-2009 Mechanisms of Air Pollution Health Effects in Subjects with Heart Failure  
NIEHS K99 ES015774  
Role: PI (\$163,000)  
  
The goal of this career development award is to evaluate the effects of acute exposure to ambient air pollution on physiologic endpoints in patients with congestive heart failure.
6. 2005-2010 Project 3: Effect of Ambient Particles on Acute Stroke Onset (PI: Mittleman)  
NIEHS P01 ES009825  
Role: Co-I  
  
The goal of this project is to evaluate the effect of ambient air pollution on the risk of acute ischemic stroke among Boston-area residents. The emphasis of this project is on identifying sources of pollution responsible for the observed associations.
7. 2009-2011 Ambient Particles and Ischemic and Hemorrhagic Stroke (PI: Mittleman)  
NIEHS R03 ES017125  
Role: Co-I  
  
This study investigates whether short-term changes in ambient particles can precipitate the onset of acute ischemic and hemorrhagic stroke, to evaluate the latency of this effect, and to assess whether patients with cardiovascular comorbid conditions are at increased risk.

### **Current**

1. 2009-2013 Mechanisms of Air Pollution Health Effects in Subjects with Heart Failure  
NIEHS R00 ES015774  
Role: PI (\$462,539)  
  
The goal of this study is to evaluate the role of autonomic function, inflammation, and vascular endothelial function in air pollution health effects.

### **PUBLICATIONS**

#### **Original Publications in Peer-Reviewed Journals**

1. **Wellenius GA**, Cullen KE. A comparison of head-unrestrained and head-restrained pursuit: influence of eye position and target velocity on latency. *Exp Brain Res.* 2000;133(2):139-55.
2. **Wellenius GA**, Saldiva PH, Batalha JR, Krishna Murthy GG, Coull BA, Verrier RL, Godleski JJ. Electrocardiographic changes during exposure to residual oil fly ash (ROFA) particles in a rat model of myocardial infarction. *Toxicol Sci.* 2002;66(2):327-35.

3. **Wellenius GA**, Coull BA, Godleski JJ, Koutrakis P, Okabe K, Savage ST, Lawrence JE, Murthy GG, Verrier RL. Inhalation of concentrated ambient air particles exacerbates myocardial ischemia in conscious dogs. *Environ Health Perspect.* 2003;111(4):402-8.
4. Kumar K, Nguyen K, Waxman S, Nearing BD, **Wellenius GA**, Zhao SX, Verrier RL. Potent antifibrillatory effects of intrapericardial nitroglycerin in the ischemic porcine heart. *J Am Coll Cardiol.* 2003;41(10):1831-7.
5. **Wellenius GA**, Batalha JR, Diaz EA, Lawrence J, Coull BA, Katz T, Verrier RL, Godleski JJ. Cardiac effects of carbon monoxide and ambient particles in a rat model of myocardial infarction. *Toxicol Sci.* 2004;80(2):367-76.
6. **Wellenius GA**, Bateson TF, Mittleman MA, Schwartz J. Particulate air pollution and the rate of hospitalization for congestive heart failure among Medicare beneficiaries in Pittsburgh, Pennsylvania. *Am J Epidemiol.* 2005;161(11):1030-6.
7. Rhoden CR, **Wellenius GA**, Ghelfi E, Lawrence J, González-Flecha B. PM-induced cardiac oxidative stress and dysfunction are mediated by autonomic stimulation. *Biochim Biophys Acta.* 2005;1725(3):305-13.
8. **Wellenius GA**, Schwartz J, Mittleman MA. Air pollution and hospital admissions for ischemic and hemorrhagic stroke among Medicare beneficiaries. *Stroke.* 2005;36(12):2549-53.
9. Fisman DN, Lim S, **Wellenius GA**, Johnson C, Britz P, Gaskins M, Maher J, Mittleman MA, Spain CV, Haas CN, Newbern C. It's not the heat, it's the humidity: wet weather increases legionellosis risk in the greater Philadelphia metropolitan area. *J Infect Dis.* 2005;192(12):2066-73.
10. **Wellenius GA**, Schwartz J, Mittleman MA. Particulate air pollution and hospital admissions for congestive heart failure in seven United States cities. *Am J Cardiol.* 2006;97(3):404-8.
11. **Wellenius GA**, Coull BA, Batalha JR, Diaz EA, Lawrence J, Godleski JJ. Effects of ambient particles and carbon monoxide on supraventricular arrhythmias in a rat model of myocardial infarction. *Inhal Toxicol.* 2006;18(14):1077-82.
12. Mukamal KJ, **Wellenius GA**, Mittleman MA. Holiday review. Early to bed and early to rise: does it matter? *CMAJ.* 2006;175(12):1560-2.
13. **Wellenius GA**, Mukamal KJ, Winkelmayr WC, Mittleman MA. Renal dysfunction increases the risk of saphenous vein graft occlusion: Results from the Post-CABG trial. *Atherosclerosis.* 2007;193(2):414-20.
14. Mbanu I, **Wellenius GA**, Mittleman MA, Peeples L, Stallings LA, Kales SN. Seasonality and coronary heart disease deaths in United States firefighters. *Chronobiol Int.* 2007;24(4):715-26.

15. **Wellenius GA**, Yeh GY, Coull BA, Suh HH, Phillips RS, Mittleman MA. Effects of ambient air pollution on functional status in patients with chronic congestive heart failure: a repeated-measures study. *Environ Health*. 2007;6(1):26.
16. Ghelfi E, Rhoden CR, **Wellenius GA**, Lawrence J, Gonzalez-Flecha B. Cardiac oxidative stress and electrophysiological changes in rats exposed to concentrated ambient particles are mediated by TRP-dependent pulmonary reflexes. *Toxicol Sci*. 2008;102(2):328-36.
17. **Wellenius GA**, Mukamal KJ, Kulshreshtha A, Asonganyi S, Mittleman MA. Depressive symptoms and the risk of atherosclerotic progression among patients with coronary artery bypass grafts. *Circulation*. 2008;117(18):2313-9.
18. **Wellenius GA**, Mittleman MA. Disparities in myocardial infarction case fatality rates among the elderly: The 20-year Medicare experience. *Am Heart J*. 2008;156(3):483-90.
19. Lokken RP, **Wellenius GA**, Coull BA, Burger MR, Schlaug G, Suh HH, Mittleman MA. Misclassification of onset time of acute cardiovascular events leads to underestimation of air pollution health effects. *Epidemiology*. 2009; 20(1): 137-42.
20. Mukamal KJ, **Wellenius GA**, Mittleman MA. Hematologic parameters, atherosclerotic progression, and prognosis in patients with previous coronary artery bypass grafting (from the Post CABG Trial). *Am J Cardiol*. 2009;103(3):328-32.
21. Bartoli CR, **Wellenius GA**, Coull BA, Akiyama I, Diaz EA, Lawrence J, Okabe K, Verrier RL, Godleski JJ. Concentrated Ambient Particles Alters Myocardial Blood Flow during Acute Ischemia in Conscious Canines. *Environ Health Perspect*. 2009;117:333-7.
22. Bartoli CR, **Wellenius GA**, Diaz EA, Lawrence J, Coull BA, Akiyama I, Lee LM, Okabe K, Verrier RL, Godleski JJ. Mechanisms of Inhaled Fine Particulate Air Pollution-Induced Arterial Blood Pressure Changes. *Environ Health Perspect*. 2009; 117:361-6.
23. Mukamal KJ, **Wellenius GA**, Suh HH, Mittleman MA. Weather and Air Pollution as Triggers of Severe Headaches. *Neurology*. 2009;72(10):922-7.
24. Stuart-Shor EM, **Wellenius GA**, Dello Iacono D, Mittleman MA. Gender differences in presenting and prodromal stroke symptoms. *Stroke*. 2009;40(4): 1121-6.
25. Mostofsky E, **Wellenius GA**, Noheria A, Levitan EB, Burger MR, Schlaug G, Mittleman MA. Renal Function Predicts Survival in Patients with Acute Ischemic Stroke. *Cerebrovasc Dis*. 2009;28:88-94.
26. Soverow JE, **Wellenius GA**, Fisman DN, Mittleman MA. Infectious Disease in a Warming World: How Weather Influenced West Nile Virus in the United States (2001-2005). *Environ Health Perspect*. 2009;117:1049-52.
27. Brook RD, Urch B, Dvorchak JT, Bard RL, Speck M, Keeler G, Morishita M, Marsik FJ, Kamal AS, Kaciroti N, Harkema J, Corey P, Silverman F, Gold DR, **Wellenius G**, Mittleman MA, Rajagopalan S, Brook JR. Insights into the mechanisms and mediators of the effects of air pollution exposure on blood pressure and vascular function in healthy humans. *Hypertension*. 2009;54(3):659-67.

28. Fakhri AA, Ilic LM, **Wellenius GA**, Urch B, Silverman F, Gold DR, Mittleman MA. Autonomic Effects of Controlled Fine Particulate Exposure in Young Healthy Adults: Effect Modification by Ozone. *Environ Health Perspect.* 2009;117(8):1287-92.
29. Rosenbloom JI, **Wellenius GA**, Mukamal KJ, Mittleman MA. Self-reported anxiety and the risk of clinical events and atherosclerotic progression among patients with Coronary Artery Bypass Grafts (CABG). *Am Heart J.* 2009;158(5):867-73.
30. Baja ES, Schwartz JD, **Wellenius GA**, Coull BA, Zanobetti A, Vokonas PS, Suh HH. Traffic-Related Air Pollution and QT Interval: Modification by Diabetes, Obesity, and Oxidative Stress Gene Polymorphisms in the Normative Aging Study (NAS). *Environ Health Perspect.* 2010;118(6):840-846.
31. Ghelfi E, **Wellenius GA**, Lawrence J, Millet E, Gonzalez-Flecha B. Cardiac oxidative stress and dysfunction by fine concentrated ambient particles (CAPs) are mediated by angiotensin-II. *Inhal Toxicol.* 2010;22(11):963-972.
32. O'Donnell MJ, Fang J, Mittleman MA, Kapral MK, **Wellenius GA**. Fine Particulate Air Pollution (PM<sub>2.5</sub>) and the Risk of Acute Ischemic Stroke: Results from the Registry of the Canadian Stroke Network. *Epidemiology.* 2011;22(3):422-431.
33. **Wellenius GA**, Diaz EA, Gupta T, Ruiz PA, Long M, Kang C-M, Coull BA, Godleski JJ. Electrocardiographic and Respiratory Responses to Coal-Fired Power Plant Emissions in a Rat Model of Acute Myocardial Infarction: Results from the Toxicological Evaluation of Realistic Emissions of Source Aerosols Study. *Inhal Toxicol.* 2011;Suppl 2:84-94.
34. Coull BA, **Wellenius GA**, Gonzalez-Flecha B, Diaz EA, Koutrakis P, Godleski JJ. The Toxicological Evaluation of Realistic Emissions of Source Aerosols Study: Statistical Methods. *Inhal Toxicol.* 2011;Suppl 2:31-41.
35. Wang SV, Coull BA, Schwartz J, Mittleman MA, **Wellenius GA**. Potential for bias in case-crossover studies with shared exposures analyzed using SAS. *Am J Epidemiol.* 2011;174(1):118-24.
36. Wang S, Linkletter C, Maclure M, Dore D, Mor V, Buka S, **Wellenius GA**. Future Cases as Present Controls to Adjust for Exposure Trend Bias in Case-only Studies. *Epidemiology.* 2011;22(4):568-574.
37. **Wellenius GA**, Burger MR, Coull BA, Schwartz J, Suh HH, Koutrakis P, Schlaug G, Gold DR, Mittleman MA. Ambient Air Pollution and the Risk of Acute Ischemic Stroke. *Arch Intern Med.* In Press.

### Reviews, chapters, monographs and editorials

1. Coull BA, **Wellenius GA**. Cardiac Toxicology. In: A. H. El-Shaarawi and W. W. Piegorsch, editors. *Encyclopedia of Environmetrics*. New York: Wiley;2002. p. 271-272.
2. Verrier RL, Kumar K, **Wellenius GA**. Predicting cardiac resynchronization therapy response based on endothelial dysfunction: Causal link or fellow traveler? *Heart Rhythm.*

2008;5(9):1236-7.

3. U.S. EPA. Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009.
4. **Wellenius GA**, Gold DR, Mittleman MA. Ambient Particulate Matter and the Risk of Stroke. In: A Bhatnagar, editor. Environmental Cardiology. Cambridge (UK): Royal Society of Chemistry; 2010.

### Thesis

1. **Wellenius GA**. A comparison of head-restrained and head-unrestrained gaze pursuit. Montreal, Canada: McGill University;1999.
2. **Wellenius GA**. Air pollution-induced cardiac arrhythmias, ischemia, and heart failure. Boston, MA: Harvard University;2004.

### Abstracts of Unpublished Works

1. Mehdiratta M, Schlaug G, **Wellenius G**, Burger M, Ajani Z, Savitz SI, Kumar S, Caplan L, Menet M, Mittleman MA. The incidence and risk factor profiles of patients waking up with stroke symptoms among patients discharged with stroke diagnoses. *American Academy of Neurology*, 2007.
2. O'Neill M, Zanobetti A, **Wellenius G**, Schwartz J. Heat and hospital admissions in 43 U.S. cities. *International Society for Environmental Epidemiology*, 2007.
3. Mehdiratta M, **Wellenius GA**, Selim M, Kumar S, Caplan LR, Mittleman MA, Schlaug G. Acute stroke patients with unknown onset times: significant epidemiological and mortality differences between patients waking up with a stroke and those found down with stroke symptoms. *International Stroke Conference*, 2008.
4. O'Donnell M, Fang J, Mittleman M, Kapral M, **Wellenius G**. Diabetes Mellitus Modifies the Association between Particulate Air Pollution and Acute Ischemic Stroke: Results from the Registry of the Canadian Stroke Network. *International Society of Environmental Epidemiology*, 2009.
5. **Wellenius G**, O'Donnell M, Fang J, Kapral M, Mittleman M. Temperature and the Risk of Acute Ischemic Stroke: Results from the Registry of the Canadian Stroke Network. *International Society of Environmental Epidemiology*, 2009.
6. **Wellenius GA**, O'Donnell MJ, Fang J, Kapral MK, Mittleman MA. Particulate Air Pollution is Associated with Increased Risk of Acute Ischemic Stroke in Patients with Diabetes: Results from the Registry of the Canadian Stroke Network. *American Heart Association Cardiovascular Disease Epidemiology and Prevention Conference*, 2010.
7. Fakhri AA, **Wellenius GA**, Aroesty JM, Ho KK, Mittleman MA. Living Near Major Roadways is Associated with Coronary Atherosclerosis. *American Heart Association Cardiovascular Disease Epidemiology and Prevention Conference*, 2010.
8. McNeely E, McCracken J, Germany R, **Wellenius G**, Mittleman M. Increased Rate of

- Ectopic Beats in Passengers During a Simulated Commercial Flight. *American Heart Association Cardiovascular Disease Epidemiology and Prevention Conference*, 2010.
9. Castro P, Verdejo H, Vera J, Rossel V, Sepulveda L, Vukasovic JL, Concepcion R, **Wellenius G**, Cifuentes L. Polución Ambiental por Material Particulado Fino se Asocia a Riesgo de Hospitalización por Insuficiencia Cardíaca Descompensada en Pacientes con Fracción de Eyección Ventricular Izquierda Disminuida. *XLVII Congreso Chileno de Cardiología y Cirugía Cardiovascular*, 2010.
  10. **Wellenius GA**, Wilhelm-Benartzi CS, Jones RN, Suh HH, Lipsitz LA. Exposure to Ambient Ozone and Traffic Pollution Impairs Blood Pressure Regulation in the Elderly: The MOBILIZE Boston Study. *American Heart Association Cardiovascular Disease Epidemiology and Prevention Conference*, 2011.
  11. Lue S-H, **Wellenius GA**, Wilker EH, Mittleman MA. Chronic Exposure to Traffic Pollution is Associated with Reduced Glomerular Filtration Rate. *International Society of Environmental Epidemiology*, 2011.
  12. Baja ES, Schwartz J, Coull BA, **Wellenius GA**, Vokonas PS, Suh HH. Bayesian Structural Equation Modeling of Inflammation Response to Short-Term Local Traffic Pollution Exposure. *International Society of Environmental Epidemiology*, 2011.
  13. Gronlund CJ, O'Neill MS, Zanobetti A, **Wellenius GA**, Schwartz J. The Added Health Wave Effect in the Association Between Temperature and Hospital Admissions Among the Elderly in 129 US Cities. *International Society of Environmental Epidemiology*, 2011.
  14. **Wellenius GA**, Boyle LD, Wilker EH, Coull BA, Koutrakis P, Lipsitz LA. Exposure to Ambient Fine Particulate Matter Alters Cerebral Blood Flow in the Elderly: The MOBILIZE Boston Study. *International Society of Environmental Epidemiology*, 2011.
  15. **Wellenius GA**, Boyle LD, Coull BA, Milberg W, Gryparis A, Schwartz J, Lipsitz LA. Traffic Pollution and Cognitive Function in Community-Dwelling Seniors: The MOBILIZE Boston Study. *International Society of Environmental Epidemiology*, 2011.
  16. Wilker E, Yeh G, **Wellenius G**, Davis R, Phillips R, Mittleman M. Ambient Temperature and Biomarkers Of Heart Failure: A Repeated Measures Analysis. *International Society of Environmental Epidemiology*, 2011.