

CAVIN KEITH WARD-CAVINESS

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EDUCATION

Duke University Durham, NC 2009 – 2014
PhD, Computational Biology and Bioinformatics
Dissertation title: Gene-Environment Interactions in Cardiovascular Disease

Tulane University New Orleans, LA 2005 – 2009
BS, Biological Chemistry and Mathematics

RESEARCH EXPERIENCE

Clinical Research Branch, US EPA Chapel Hill, NC Jan, 2017 – present
Principal Investigator (Computational Biology)

- Project Lead for PEP 4 – Translate Research into Actions that Protect Public Health and Wellbeing
- Task lead for PEP 4.2 – Integrating environmental public health principles into the health care system to increase environmental health literacy and promote health and wellbeing
- As a PI I lead a multi-disciplinary research lab whose members have backgrounds in epidemiology, computational biology, mathematics, and database administration. The overarching goals of my group are: 1) Use of electronic health records for understanding the impact of chemical and non-chemical environmental stressors on health 2) Evaluation of the impacts of air pollutants on the epigenome and metabolome; 3) Identification of individuals with increased sensitivity to air pollutants (due to underlying disease or genetic factors) and the potentially modifiable factors (e.g. socioeconomic factors and ‘omics-based biomarkers) associated with sensitivity to air pollution; and 4) Integration of genomic, epigenomic, and metabolomic data to understand the mechanisms of wellness and disease and factors that link environmental exposures and health outcomes

Helmholtz Institute Munich, Germany June, 2014 – Dec, 2016
Postdoctoral Researcher, Institute of Epidemiology II

- Integrated genomic, epigenomic, metabolomic, and transcriptomic data to understand the mechanisms underlying myocardial infarction and aging. Advisor: Dr. Annette Peters
- Studied the molecular mechanisms of accelerated aging as well as the clinical and environmental factors associated with accelerated aging
- Associated epigenomic and metabolomics biomarkers and signatures with short and long-term exposure to air pollution
- Performed Mendelian randomization analyses to evaluate the causality of biomarkers for myocardial infarction and coronary heart disease

Duke University Durham, NC Aug, 2009 – May, 2014
Computational Biology and Bioinformatics Program

- Dissertation explored interactions between genetic variants and environmental exposures at a genome wide-scale to better understand the pathogenic links between air pollution and cardiovascular disease. Integrated gene-environment interaction associations with metabolomics and gene expression studies to better contextualize associations within a more systems biology framework. Advisor: Dr. Elizabeth Hauser
- Designed and performed data analyses to examine the interaction between coronary artery disease, chronic kidney disease, and genetic variation using exome sequencing and array-based data from a clinical trial. Mentors: Drs. Elizabeth Hauser & Michelle Winn

GRANTS & AWARDS

Duke University Durham, NC

- US EPA Scientific and Technological Achievement Award (STAA) Level 1 (highest level) – 2018
- Department of Energy, Office of Research and Development - Research Participation Fellowship, 2012 – 2014
- Key researcher on 3-year Health Effects Institute grant to study gene-environment interactions, 2013
- Duke University Graduate School Travel Award: 2011, 2012, 2013
- American Heart Association Functional Genetics and Translational Biology Travel Award, 2012
- International Society of Environmental Epidemiology Travel Award, 2012
- Chancellor's Scholarship, 2009
- Deans Graduate Fellowship, 2009

Tulane University New Orleans, LA

- Distinguished Scholar Award, 2005

PUBLICATIONS

Accepted (in reverse chronological order)

Methylome-wide association study provides evidence of particulate matter air pollution-associated DNA methylation (2019) Rahul Gondalia, Antoine Baldassari, ..., **Cavin K Ward-Caviness**, ..., Andrea A Baccarelli, Eric A Whitsel. *Environment International* <https://doi.org/10.1016/j.envint.2019.03.071>

Mendelian Randomization evaluation of causal effects of fibrinogen on incident coronary heart disease (2019) **Cavin K Ward-Caviness**, Paul S. de Vries, ..., Annette Peters, Alanna C Morrison. *PLoS One* <https://doi.org/10.1371/journal.pone.0216222>

Evaluating DNA methylation age on the Illumina methylationEPIC BeadChip (2019) Radhika Dhingra, Lydia Coulter Kwee, ..., Kenneth Olden, **Cavin K. Ward-Caviness** *PLoS One* <https://doi.org/10.1371/journal.pone.0207834>

A review of gene-by-air pollution interactions for cardiovascular disease, risk factors, and biomarkers (2019) **Cavin K. Ward-Caviness**. *Human Genetics* <https://doi.org/10.1007/s00439-019-02004-w>

Neighborhood Sociodemographic Effects on the Associations Between Long-term PM2.5 Exposure and Cardiovascular Outcomes and Diabetes Mellitus (2019) Weaver, Anne M.; McGuinn, Laura; ..., **Ward-Caviness, Cavin**; ..., Schwartz, Joel; Diaz-Sanchez, David. *Environmental Epidemiology* 3(1):p e038 doi: 10.1097/EE9.0000000000000038

A genome-wide association study identifies new loci for Factor VII and implicates Factor VII in ischemic stroke etiology (2019). Paul S. de Vries, Maria Sabater-Lleal, ..., **Cavin K. Ward-Caviness**, ..., Christopher J. O'Donnell, and Nicholas L. Smith. *Blood* 133:967-977

Genome-wide association trans-ethnic meta-analysis identifies novel associations regulating coagulation Factor VIII and von Willebrand Factor plasma levels (2019). Maria Sabater-Lleal, Jennifer E. Huffman, Paul S. de Vries, ..., **Cavin Ward-Caviness**, ..., Charles J. Lowenstein, Nicholas L. Smith. *Circulation* 139:620-635

FDTTool: a Python application to mine for functional dependencies and candidate keys in tabular data (2019). Matt Buranosky, Elmar Stellnberger, Emily Pfaff, David Diaz-Sanchez, **Cavin Ward-Caviness**. *F1000 Research* [version 2; peer review: 2 approved]

Analysis of repeated leukocyte DNA methylation assessments reveals persistent epigenetic alterations after an incident myocardial infarction (2018). **Cavin K. Ward-Caviness***, Golareh Agha*, Brian H. Chen*, ..., Melanie Waldenberger, Annette Peters. *Clinical Epigenetics* 10:161 <https://doi.org/10.1186/s13148-018-0588-7>

Association of long-term PM2.5 exposure with traditional and novel lipid measures related to cardiovascular disease risk (2018). Laura A. McGuinn, Alexandra Schneider, Robert W. McGarrah, **Cavin Ward-Caviness**, ..., Robert B. Devlin *Environment International* 122:193-200 <https://doi.org/10.1016/j.envint.2018.11.001>

Autosomal genetic variation is associated with DNA methylation in regions variably escaping X-chromosome inactivation (2018). by René Luijk, Haoyu Wu, **Cavin Ward-Caviness**, ..., Erik. W van Zwet, and Bastiaan Heijmans. *Nat Comm* 9: 3738

DNA methylation age is associated with an altered hemostatic profile in a multi-ethnic meta-analysis (2018). **Cavin K Ward-Caviness**, Jennifer E Huffman, ..., Nicholas L Smith, Annette Peters. *Blood* 132:1842-1850

DNA methylation age – environmental influences, health impacts, and its role in environmental epidemiology (2018). Radhika Dhingra, Jamaji C. Nwanji-Enwerem, Madeline Samet, **Cavin K. Ward-Caviness**. *Curr Envir Health Rpt* <https://doi.org/10.1007/s40572-018-0203-2>

WanYun Cheng, Kelly E. Duncan, Andrew Ghio, **Cavin K Ward-Caviness**, Edward D. Karoly, Rory B. Conolly, Robert B. Devlin (2018). Changes in Metabolites Present in Lung-Lining Fluid Following Exposure of Humans to Ozone. *Toxicological Sciences* 163(2): 430-439

Cavin K. Ward-Caviness, William E. Kraus, ..., Lucas M. Neas, Elizabeth R. Hauser (2018). Associations Between Residential Proximity to Traffic and Vascular Disease in a Cardiac Catheterization Cohort. *Arteriosclerosis, Thrombosis, and Vascular Biology* 38: 275-282

Long-term air pollution exposure, genome-wide DNA methylation and lung function in the LifeLines cohort study (2018). Ana Julia de F.C. Lichtenfels, Diana A. van der Plaats, ... **Cavin K. Ward-Caviness**, ..., H. Marike Boezen, Judith M. Vonk. *Environ Health Perspect*. doi: 10.1289/EHP2045

Rory Wilson, Simone Wahl, Liliane Pfeiffer, **Cavin K. Ward-Caviness**, ..., Christian Gieger, Melanie Waldenberger (2017). The dynamics of smoking-related disturbed methylation: a two time-point study of methylation change in smokers, non-smokers, and former smokers. *BMC Genomics* 18:805 doi:10.1186/s12864-017-4198-0

Laura A. McGuinn, **Cavin Ward-Caviness**, ..., David Diaz-Sanchez, Robert B. Devlin (2017). Fine particulate matter and cardiovascular disease: Comparison of assessment methods for long-term exposure. *Environmental Research* 159: 16-23

Cavin K. Ward-Caviness, Lucas M. Neas, ..., William E. Kraus, Elizabeth R. Hauser (2017). Novel Coronary Atherosclerosis Genes Revealed via Interactions Between Genetic Variants and Residential Exposure to Traffic: Results from a Trans-ethnic Genome-wide Interaction Study. *PLoS One* doi:10.1371/journal.pone.0173880

Cavin K. Ward-Caviness*, Tao Xu*, Thor Aspelund*, ..., Rui Wang-Sattler, Annette Peters (2017). Improvement of myocardial infarction risk prediction via inflammation-associated metabolite biomarkers. *Heart* <http://dx.doi.org/10.1136/heartjnl-2016-310789>

Symen Ligthart, Carola Marzi, ..., **Cavin K. Ward-Caviness**, ..., Emelia J. Benjamin, Abbas Dehghan (2016). DNA methylation signatures of chronic low-grade inflammation are associated with complex diseases. *Genome Biology* 17(1), 255

Cavin K. Ward-Caviness, Jamaji C. Nwanaji-Enwerem, ..., Alexandra Schneider, Annette Peters (2016). Long-term exposure to air pollution is associated with biological aging. *Oncotarget* 7(46): 74510-74525

Susanne Breitner, Alexandra Schneider, Robert B Devlin, **Cavin K. Ward-Caviness**, ..., Svati H Shah, William E Kraus (2016). Associations between plasma metabolite levels and short-term exposure to PM_{2.5} and ozone in a cohort of cardiac catheterization patients. *Environment International* 97: 76-84

Chen BH, Marioni RE, Colicino E, Peters MJ, **Ward-Caviness CK**, ..., Ferrucci L, Horvath S (2016). Blood-based epigenetic measures of age that predict all-cause mortality: a meta-analysis. *Aging* 8(9):1844–1865. doi:10.18632/aging.101020

Cavin K Ward-Caviness, Suanne Breitner, ..., Alexandra Schneider, Annette Peters (2016). Short-term NO₂ exposure is associated with long-chain fatty acids in prospective cohorts from Augsburg, Germany: results from an analysis of 138 metabolites and three exposures. *International Journal of Epidemiology* 45(5): 1528-1538 doi: 10.1093/ije/dyw247

Regina Hampel, Susanne Breitner, ..., **Cavin K Ward-Caviness**, ..., Annette Peters, Alexandra Schneider (2016). Short-term effects of air temperature on plasma metabolites in patients undergoing cardiac catheterization. *Environmental Research* 151:224–232 doi: 10.1016/j.envres.2016.07.010

Cavin K. Ward-Caviness, Lucas M. Neas, ..., William E. Kraus, Elizabeth R. Hauser (2016). Genetic variants in the Bone Morphogenic Protein gene family modify the association between residential exposure to traffic and peripheral arterial disease. *PLoS One* 11(4):e0152670

Laura A. McGuinn, **Cavin K. Ward-Caviness**, ..., Petros Koutrakis, Robert B. Devlin (2016). Association Between Satellite-based Estimates of Long-term PM_{2.5} Exposure and Coronary Artery Disease. *Environ Res.* 145:9-17. DOI: 10.1016/j.envres.2015.10.026

Andrew J Simpkin, Gibran Hemani, ..., **Cavin Ward-Caviness**, ..., Caroline L Relton, George Davey Smith (2015). Prenatal and early life influences on epigenetic age in children: A study of mother-offspring pairs from two cohort studies. *Hum. Mol. Genet.* 25(1):191–201 doi: 10.1093/hmg/ddv456

Majorlein J. Peters, Roby Joehanes, ... **Cavin K. Ward-Caviness** ... Joyce B.J. van Meurs, Andrew D. Johnson (2015). The transcriptional landscape of age in human peripheral blood. *Nature communications.* 6:8570 doi: 10.1038/ncomms9570

Cavin Ward-Caviness, William E. Kraus, ..., Elizabeth R. Hauser, Lucas Neas (2015). Association of Traffic-Related Air Pollution with Fasting Plasma Glucose and Metabolic Risk Factors for Cardiovascular Disease. *Environmental Health Perspectives.* 123(10): doi:10.1289/ehp.1306980

Cavin Ward-Caviness, Carol Haynes, ..., William E. Kraus, Elizabeth R. Hauser (2013). Gene-smoking interactions in multiple Rho-GTPase pathway genes in an early onset coronary artery disease cohort. *Human Genetics.* 132(12):1371-1382

Saunders KO, **Ward-Caviness C**, ..., Kepler TB, Tomaras GD (2011). Secretion of MIP-1 β and MIP-1 α by CD8(+) T-lymphocytes correlates with HIV-1 inhibition independent of coreceptor usage. *Cellular Immunology.* 266(2):154-164

SOFTWARE

Epigenome-wide Analysis Study of Chron's Disease using the Illumina 850K array

https://github.com/CavinWard/methyl_course

In this short course students learn the basics of performing an epigenome-wide association study as well as subsequent analyses (pathway enrichments and Mendelian Randomization) using publicly available samples (GSE99788) from Chron's disease patients and controls.

Mendelian Randomization with Biomarker Associations for Causality with Outcomes (MR BACOn)

https://github.com/NCBI-Hackathons/MR_BACOn

MR BACOn is an available web tool developed as part of a 2-day National Center for Biotechnology Information hosted hackathon at the University of North Carolina Chapel Hill. MR BACOn allows users to visualize the causal effect of metabolites on coronary heart disease using Mendelian Randomization. Is currently being migrated to an Amazon Web Services hosted platform and being extended to visualize pathway effects.

FDTTool

<https://github.com/USEPA/FDTTool>

FDTTool is a python-based application which automates many necessary processes for understanding datasets and designing databases. Specifically, FDTTool automates finding candidate keys for tables and functional dependencies within tables. A minimal set of keys and functional dependencies are provided to the user in an easy to interpret format. FDTTool works across a wide set of table dimensions and is optimized for use with large tables containing millions of rows – such as those found in electronic health record databases

CONFERENCE PUBLICATIONS

Selected Oral Presentations

Cavin K Ward-Caviness, Wayne E Cascio, Robert B Devlin, Lucas M Neas, David Diaz-Sanchez (2017). Use of large electronic health record databases for environmental epidemiology studies. International Society of Environmental Epidemiology 2017 Annual Meeting – Sydney, Australia

Cavin Ward-Caviness on behalf of the CHARGE Hemostasis Working Group (2017). Associations between hemostatic factors and epigenetic biomarkers of aging. CHARGE Meeting – New York City, New York

Cavin Ward-Caviness, Kathrin Wolf, Simone Wahl, Josef Cyrus, Christian Gieger, Annette Peters (2016). Long-term air pollution exposure is associated with molecular markers of accelerated molecular ageing. 2016. International Society of Environmental Epidemiology (ISEE) – Rome, Italy

Cavin Ward-Caviness, Alexandra Schneider, ... Rui Wang-Sattler, Annette Peters (2015). Short-term air pollution exposure is associated with metabolite levels in two cohorts from Augsburg, Germany. In: Abstracts of the 2015 Conference of the International Society of Environmental Epidemiology (ISEE). Abstract 2289. Research Triangle Park, NC: *Environmental Health Perspectives*; <http://dx.doi.org/10.1289/ehp.isee2015>

Cavin Ward-Caviness, Lucas Neas, ..., Marie Lynn Miranda, Elizabeth R. Hauser (2012). Genetic Variants in the Bone Morphogenic Protein (BMP) Family of Genes Interact with Mobile Source Air Pollution to Increase Risk of Peripheral Arterial Disease. American Heart Association 2012 Scientific Sessions – Los Angeles, CA.

Selected Poster Presentations

Anne M Weaver, Wayne E Cascio, Robert B Devlin, Lucas M Neas, David Diaz-Sanchez, **Cavin K Ward-**

Caviness (2018). Application of a large electronic health record database to study effects of air quality on mortality in a heart failure population. NC BREATHE Annual Meeting – Wake Forest, North Carolina

Cavin K Ward-Caviness, Alanna C Morrison on behalf of the CHARGE Hemostasis Working Group (2017). Mendelian randomization provides evidence for a causal association between fibrinogen and incident coronary heart disease. CHARGE Meeting – New York City, New York

Cavin Ward-Caviness, Lilianne Pfeiffer, ..., Melanie Waldenberger, Annette Peters (2016). A multi-omic approach to understanding associations from an epigenome-wide association study for MI in the KORA cohorts. Munich Heart Alliance Summer Meeting – Starnberg, Germany

ACADEMIA & TEACHING

- Adjunct Faculty: Duke University Department of Biostatistics and Bioinformatics (2017 - present)
- Adjunct Faculty: University of North Carolina Curriculum in Toxicology & Environmental Medicine; Curriculum in Biostatistics and Computational Biology (2017 - present)
- Lecturer for Columbia University Epigenetics Boot Camp (June, 2017)
- Lecturer for Cardiovascular Disease Epidemiology at the Helmholtz Zentrum München (2015, 2016)
- Guest Lecturer for Bio 89S “Pathways to Biomedical Research” at Duke University (2012 & 2013)
- Teaching Assistant for Duke University Beaufort Ethics Retreat (2011 & 2012)

LEADERSHIP

Project Lead, Task Lead, Clinical Research Branch, Environmental Public Health Division, US EPA

Project Lead for PEP 4 – Translate Research into Actions that Protect Public Health and Well-being, and Task Lead for PEP4.2 – Integrating environmental public health principles into the health care system to increase environmental health literacy and promote health and wellbeing. This is a multi-year project primarily concerned with performing and translating environmental public health research in such a way that it can be effectively used by clinicians and the general public.

Lead role in multiple international consortia

Have brought expertise in statistics and analysis of genomic data to multiple international consortia including CHARGE and e:AtheroSysMed

Integral and founding member of ongoing partnership between the Duke Molecular Physiology Institute, EPA, and Helmholtz Institute of Munich

Led initial contact team for the ongoing and productive partnership between the Center for Human Genetics (CHG) at Duke University (now the Duke Molecular Physiology Institute), Helmholtz Institute of Munich, Germany, and the US Environmental Protection Agency (EPA).