



The Exposome: Introducing a New Lens on Cardiovascular Health

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ISSUE INTRODUCTION



In recent years, the concept of the exposome has emerged as a revolutionary framework for understanding the myriad environmental factors that influence human health throughout the lifespan.^{1,2} This issue of the *Methodist DeBakey Cardiovascular Journal* delves into the intricate relationship between the exposome and cardiovascular disease (CVD), a connection that is reshaping our approach to both cardiovascular care and public health policy.

Traditionally, the focus on CVD prevention has been on genetic predisposition and lifestyle choices, critical yet incomplete pieces of the puzzle. Today, we recognize that our cardiovascular health is profoundly shaped by a complex web of external influences, ranging from the air we breathe to the communities we live in. Emerging research highlights how factors such as air pollution, urban design, socioeconomic status, and climate change play a significant role in shaping cardiovascular health. As global challenges such as urbanization and climate-related stressors intensify, these exposures are becoming more pronounced and demand a comprehensive approach. Understanding and addressing these exposures enables us to shift from a narrow focus on individual risk factors to more holistic CVD prevention and treatment strategies. This is especially important for tackling health disparities because marginalized populations are often disproportionately impacted by these environmental and social factors.

As guest editors, we are pleased to present a collection of 11 review articles that not only advance the latest research in this burgeoning field but also challenge us to rethink our approach to cardiovascular care with a deeper understanding of environmental and social determinants. By focusing on exposures, we can tackle current inequities and pave the way for a future where cardiovascular care is more equitable, holistic, and proactive.

Our first review, “Zip Code Health Disparities: Mapping Cardiovascular Inequities at the Neighborhood Level,” sets the stage for the very real impact of residential location on health. Dr. Safi Khan presents a powerful case of how one’s postal code can be an effective predictor of cardiovascular health outcomes. This piece underscores the profound role that systemic inequalities in healthcare access and community resources play in shaping cardiovascular health.

In “A Costly Cure: Understanding and Addressing Financial Toxicity in CV Disease Healthcare,” Drs. Hyeon-Ju Ryoo Ali, Vijay Aaroha Kandula, and colleagues bring to light the financial burden that often accompanies cardiovascular care, highlighting how economic stress can exacerbate health disparities and impact treatment adherence.

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Moving on to “Food for Thought: Nourishing Cardiovascular Health Amidst the Exposome,” Dr. Bassel Daher delves into the intricate relationships between our food environment, dietary choices, and cardiovascular health, making a compelling case for systemic changes to promote heart-healthy eating habits.

In “Green Streets, Healthy Hearts: Exploring Urban Planning Nature Scores and Walkability in CV Health,” Drs. Khurram Nasir, Nwabunie Nwana, and colleagues investigate the impact of urban design on cardiovascular health, revealing how access to green spaces and walkable neighborhoods can significantly influence heart disease risk.

Next, Drs. Haitham Khraishah and Sanjay Rajagopalan discuss the cardiovascular impact of air pollution, the leading environmental cause of global morbidity and mortality. The authors highlight air pollution’s insidious effects on cardiovascular health and stress the urgent need for environmental policies that safeguard heart health in both urban and industrial settings.

In “Harnessing Digital Technologies to Decode the Cardiovascular Exposome,” Drs. Seth Martin, Geyner A. Gaona, and coauthors explore the potential of digital health technologies for measuring and understanding the complex interactions between environmental exposures and cardiovascular outcomes.

From there, Dr. Barrak Alahmad, Jacob Berry, and coauthors explore the multifaceted exposures in the workplace that contribute to cardiovascular diseases. In “A Review of the Links Between Work And Heart Disease in the 21st Century,” they examine how exposure to physical, ergonomic, chemical, biological, psychosocial, and emerging occupational hazards present significant concerns for worker health and safety, and they highlight the often-overlooked occupational hazard of extreme heat exposure, particularly relevant in the context of climate change, and its impact on cardiovascular health.

Next is a review by Drs. Fatima Rodriguez, Sara King, and colleagues titled “Leveraging Social Determinants of Health to Enhance Recruitment of Underrepresented Populations in Clinical Trials.” Addressing the critical issue of diversity in cardiovascular research, the authors propose strategies for ensuring that clinical trials better represent the populations most affected by heart disease.

In “Integrating the Poly Social Risk Score: Enhancing Comprehensive Healthcare Delivery,” Drs. Zulqarnain Javed, Aayush Shah, and team introduce an innovative approach to quantifying and addressing multiple social risk factors in cardiovascular care, potentially revolutionizing how we assess and mitigate social determinants of health.

Following is a review titled “Intersectionality and Social Drivers of Health in Cardiovascular Care” by Drs. Garima

Sharma, Jared Spitz, and coauthors, who delve into the complex interplay of social identities and how they collectively influence cardiovascular health outcomes and care experiences.

Concluding the issue with “Big Data, Big Insights: Leveraging Data Analytics to Unravel CV Exposome Complexities,” Drs. Sadeer Al-Kindi, Ramzi Ibrahim, and colleagues explore the potential of big data analytics for clarifying the complexities of the cardiovascular exposome, pointing towards a future of more personalized and precise cardiovascular care.

THE EXPOSOME: A PARADIGM SHIFT IN CARDIOVASCULAR HEALTH

The concept of the exposome represents a paradigm shift in our understanding of CVD etiology and prevention. By considering the totality of environmental exposures from conception onwards, we gain a more holistic view of the factors that shape heart health throughout life.^{3,4} This special issue illuminates the multifaceted nature of these exposures, from the macro-level influences of urban planning and air quality to the micro-level impacts of personal financial stress and dietary choices.

A recurring theme throughout this collection is the profound influence of social and environmental factors in perpetuating cardiovascular health disparities. The articles by Drs. Khan, Ryoo Ali, and Rodriguez highlight how socioeconomic status, social environment, and geography intersect to create significant inequities in cardiovascular disease risk and outcomes. These pieces collectively call for a more nuanced approach to cardiovascular care that addresses not just individual risk factors but also the broader social determinants of health.

On the environmental front, the reviews by Drs. Rajagopalan, Nwana, and Alahmad highlight the critical need for a comprehensive approach to understanding and mitigating environmental exposures that significantly contribute to cardiovascular disease. Emerging literature underscores the urgent need for policies that promote cleaner air, greener cities, and safer working conditions as integral components of public health strategy.⁵ As climate change continues to exacerbate environmental stressors, understanding and mitigating these exposures becomes increasingly critical for cardiovascular health on a global scale.⁶

In addition, technological innovation emerges as a powerful tool in this new paradigm. Dr. Martin’s exploration of digital health technologies and the big data analytics discussed by Dr. Al-Kindi point towards a future where we can more precisely measure, analyze, and intervene in the

complex web of environmental exposures affecting heart health. These innovations are paving the way for a new era in cardiovascular care, one that harnesses data and technology to offer more tailored and effective preventive strategies.

The contributions of Dr. Javed and Dr. Sharma, focusing on the Poly Social Risk Scores and intersectionality of social determinants and CVD care, respectively, highlight the importance of developing more comprehensive and nuanced approaches to assessing and addressing social determinants of health. These frameworks offer exciting possibilities for tailoring interventions to the complex realities of patients' lives, potentially improving both the equity and efficacy of cardiovascular care.

LOOKING TO THE FUTURE: WHAT DOES IT MEAN FOR THE CARDIOVASCULAR COMMUNITY

As we reflect on the insights gathered in this special issue, several key themes emerge that promise to shape the future of cardiovascular medicine and public health: The implications of focusing on the exposome for the cardiovascular community are profound, extending across stakeholders (eg, clinicians, health systems, policymakers, and industry stakeholders). As clinicians, these findings necessitate a shift in how we approach patient care—embracing broader social and environmental realities beyond traditional risk factors, allowing us to incorporate these factors into our care plans and provide more targeted and meaningful interventions, particularly for those most susceptible and vulnerable to social and environmental stressors. It is about recognizing deeper impacts on health and taking action to solve them.

For health systems, this equates to bringing new frameworks, such as the Poly Social Risk Score and neighborhood factors, into clinical settings to do a better job of capturing those complex risks. It's not about just implementing a tool; it's partnering with community groups, environmental specialists, and public health bodies to take on those root causes of disparities in cardiovascular outcomes.

In the end, the sector—from pharmaceuticals to technology—stands to seize a unique opportunity to drive innovation in digital health, widespread data analytics, and personalized interventions. As cardiovascular care moves increasingly toward prevention and precision medicine, the exposome provides a strategic roadmap for large-scale partnerships, prioritized innovations, and impactful interventions with substantial benefits for both individual patients and society as a whole.

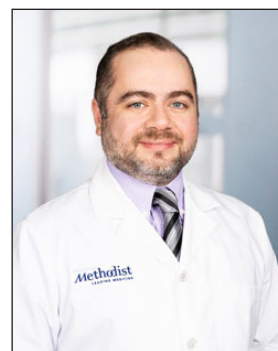
CONCLUSION: A CALL TO ACTION FOR INTEGRATING EXPOSOME INTO THE FUTURE OF CARDIOVASCULAR CARE

The cardiovascular exposome framework in this issue represents an important call to action at the interface between cardiovascular medicine and public health. Given the complexities of cardiovascular disease, a transition away from traditional models and towards more integrated, patient-oriented strategies should be entertained considering the strong influence of environmental and social determinants. Through integration of clinical innovation, modification in policy, and collaborative efforts across disciplines, we can realize our obligation to deliver more personalized and more effective care for all patients but particularly the most vulnerable to health disparities. The findings presented in this issue contribute beyond mere knowledge; they lay a foundation for a future in which cardiovascular health is not determined based on one's place of residence or quality of air inhaled. We believe it is our shared responsibility—clinicians, researchers, policymakers, and industry leaders—to rise to the challenge of making sure such advances in our time translate into meaningful, lasting change for future generations.

GUEST EDITOR BIOGRAPHIES

The editorial team of the *Methodist DeBakey Cardiovascular Journal* expresses our thanks to Dr. Sadeer Al-Kindi and Dr. Khurram Nasir for their thoughtful planning, continual guidance, and heartfelt commitment to curating this pioneering issue on the exposome and cardiovascular health.

SADEER G. AL-KINDI, MD, FACC



Dr. Al-Kindi received his medical degree from Weill Cornell Medical College in Qatar. He went on to complete his residency in internal medicine and fellowships in cardiovascular medicine and cardiovascular imaging at

University Hospitals-Case Western Reserve University in Cleveland, Ohio. He then served as the codirector for the cardiometabolic center and a staff cardiologist at University Hospitals. In 2023, Dr Al-Kindi moved to Houston Methodist DeBakey Heart & Vascular Center.

Clinically, Dr. Al-Kindi serves as a preventive and imaging cardiologist at the Houston Methodist DeBakey Heart & Vascular Center, where he is the Jerold B. Katz Translational Investigator, the associate director for the division of cardiovascular prevention and wellness, and associate director for the Center for Cardiovascular Computational & Precision Health (C3PH) at Houston Methodist DeBakey Heart & Vascular Center. He is also the medical director for the Center for Health and Nature in Houston, Texas.

Dr. Al-Kindi is an active clinical and translational researcher with over 300 peer-reviewed publications in top journals such as *Journal of the American College of Cardiology*, *Circulation*, *European Heart Journal*, and *JAMA Cardiology*. He is an associate editor at *JACC Advances* and serves on editorial boards of several journals.

Dr. Al-Kindi's research has focused on understanding the exposomic underpinnings of cardiovascular disease and novel methods to identify risk and precision cardiovascular prevention. He focuses on environmental and social determinants of cardiometabolic disease and their interaction with novel imaging phenotypes to determine risk. His research has been funded by several sources, including the National Institutes of Health. He has won several national awards for his research, including the American College of Cardiology's Young Investigator Award.

KHURRAM NASIR, MD, MSC, MPH



Dr. Nasir is the William A. Zoghbi Centennial Chair in Cardiovascular Health and holds the position of chief of cardiovascular disease prevention and wellness at Houston Methodist. He is also the founding director of the newly established Center for Cardiovascular Computational Health & Precision Medicine. Additionally, he holds academic appointments as a professor of medicine at Weill Cornell Medical College and as a professor of cardiology at the Houston Methodist Academic Institute. Recently, he was honored as a visiting professor at the London School of

Economics. Prior to his current roles, Dr. Nasir served as the director of Population Health & Health System Research at Yale University School of Medicine from 2018 to 2019 and as the director of the Center for Health Advancement & Outcomes at Baptist Health South Florida from 2015 to 2018.

Dr. Khurram Nasir received his medical degree from Pakistan followed by a Masters in Public Health at Johns Hopkins University. He completed his internship at UPMC, his internal medicine residency at Boston Medical Center, and a cardiology fellowship at Yale University. He received postdoctoral research training at the division of cardiology at Johns Hopkins Hospital and was a recipient of the NIH T-32 fellowship at Massachusetts General Hospital. In 2017, he also earned a master's degree in Health Economics and Policy Management from the London School of Economics & Political Science.

Throughout his career, Dr. Nasir has demonstrated an exceptional commitment to advancing cardiovascular research and practice. To date, he has published more than 950 peer-reviewed manuscripts in high-impact journals, including *NEJM*, *JAMA*, *BMJ*, *Lancet*, *Nature Reviews*, *Circulation*, and the *Journal of the American College of Cardiology*. According to Google Scholar, his work has been cited over 120,000 times, and he is part of a select group of impactful scholars worldwide with an h-index of over 110. From 2021 to 2023, he is listed among the top 2% of scientists globally as reported by Stanford University.

In addition to his significant contributions to clinical, research, and educational missions, Dr. Nasir is heavily engaged in issues concerning health equality, diversity, and social justice, particularly on illuminating the scope of health inequities and developing pragmatic interventions to eliminate disparities in health and health care. As director of the Center for Cardiovascular Computational & Precision Health, Dr. Nasir's efforts are focused on leveraging big data, artificial intelligence, and digital health to revolutionize cardiovascular care via cutting-edge research and clinical care integration, improving outcomes, and reducing healthcare costs with an emphasis on cardiovascular disease prevention and management.


Nationally, Dr. Nasir has served on the board of directors for the Society of Cardiac CT and the American Society of Preventive Cardiology. He is currently associate editor for *Journal of the American College of Cardiology* and served in the same capacity for *Circulation: Quality & Outcomes Research*. He was an inaugural chair for the SCCT Future Leadership Program and was recently appointed as a Senior Advisor for the International Atherosclerosis Society. Dr. Nasir also serves as a visiting professor at the London School of Economics and is a joint investigator and Co-PI as well as steering committee member for a national study in Pakistan (Pak-Sehat).

In recognition of his contributions, Dr. Nasir has received the Johns Hopkins Distinguished Alumni Award in 2013, honoring alumni who have brought credit to the university through personal accomplishment, professional achievement, or humanitarian service. In 2020, he received the Arthur S. Agatston Cardiovascular Disease Prevention Award recognizing individuals whose pioneering efforts have saved lives from coronary artery disease. In 2024 Dr. Nasir received the inaugural Game Changer Award by the Texas Asia Society in the category of Innovator, an award that honors individuals, institutions, or corporations breaking barriers in science, technology, health care, education, or business.

COMPETING INTERESTS

Dr. Nasir is on the advisory boards of Novo Nordisk, Novartis, Esperion, Merck Sharp & Dohme, and ER Squib & Sons; his research is partly supported by grants from the National Institutes of Health, Patient-Centered Outcomes Research Institute, Novartis, and Esperion & Ionis. Dr. Al-Kindi has no competing interests to declare.

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