Symposium on Integrating the Science of Environmental Justice into Decision-Making at the Environmental Protection Agency: An Overview

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In March 2010, the Environmental Protection Agency (EPA) collaborated with government and nongovernmental organizations to host a groundbreaking symposium, "Strengthening Environmental Justice Research and Decision Making: A Symposium on the Science of Disproportionate Environmental Health Impacts."

The symposium provided a forum for discourse on the state of scientific knowledge about factors identified by EPA that may contribute to higher burdens of environmental exposure or risk in racial/ethnic minorities and low-income populations. Also featured were discussions on how environmental justice considerations may be integrated into EPA's analytical and decision-making frameworks and on research needs for advancing the integration of environmental justice into environmental policymaking.

We summarize key discussions and conclusions from the symposium and briefly introduce the articles in this issue. (*Am J Public Health.* 2011;101:S19–S26. doi:10.2105/AJPH.2011.300368)

IN 2009, THE US ENVIRON-mental Protection Agency (EPA) initiated activities to formalize and ensure the assessment and consideration of environmental justice issues in its regulatory decisions, particularly in the context of developing regulations. EPA's direction reflects a commitment to fully implement a 1994 executive order, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (EO 12898),[1] which requires EPA to identify and address any disproportionate environmental and health impacts that its policies, activities, and programs may have on minority and low-income populations. This direction is also consistent with the stated commitment of EPA administrator Lisa P. Jackson to include environmental justice principles in all of the agency's decisions.[2]

The mandate of EO 12898 and the actions of the agency are grounded in a body of evidence that demonstrates a disproportionate distribution of environmental harms and risks to racial/ethnic minority, indigenous, and low-income populations in the United States. Ample evidence shows that these populations reside in communities where sources of environmental hazards are more likely to be located and to be more concentrated.[3–9] These populations are more likely to experience higher exposures to environmental pollution because of where they live, work, and play[10–19] and to bear higher burdens of such adverse health outcomes as elevated blood lead, asthma, preterm births, and morbidity and mortality from cardiovascular diseases.[18–28] Additional information on the subject of disproportionate environmental and health impacts experienced by these population groups is available in the general scientific and public health literature.[29–52]

ENVIRONMENTAL JUSTICE IN REGULATORY DEVELOPMENT

Environmental regulations (e.g., standards setting) by design aim to reduce or prevent the release of environmental hazards into ambient environmental media. Regulations are grounded in sound science and the rule of law and supported by scientific and analytical evidence that a preferred regulatory option will help EPA achieve its mission of quantifiable reductions in the risk of adverse health outcomes, as well as meet other goals articulated in relevant governing and secondary statutes, authorities, and executive orders, such as the Clean Air Act and EO 12898 (e.g., selection of regulatory options for which the benefits justify costs). During the process of regulatory development, a policymaker is theoretically driven toward a particular policy by data that address the nature and scope of the problem, types of policy options that address the problem, and the societal benefits and possible costs associated with each option. Expanding this process of inquiry to provide actionable data on social group inequalities in environmental health is crucial to integrating environmental justice into regulatory development.

Environmental justice is currently considered in the process of developing regulations. However, a formal framework for its integration into analysis to support this process remains to be developed. Nonetheless, such integration necessitates certain modifications to the analytic process, such that data yielded by the process are informative about social group inequalities in environmental health before and after a proposed policy action. For example, a restructured analytical process could introduce additional inquiries such as how and why the problem for which regulatory action is necessary may be disproportionately experienced by different social groups, which factors and mechanisms foster these inequalities, and to what extent a particular policy option reduces existing social group inequalities in environmental health outcomes or prevents new ones.[53,54]

Recognizing these emerging needs for environmental justice–relevant data, EPA recently developed a road map and codified it in several sections of its environmental justice implementation plan (Plan EJ 2014).[55] The objectives of the plan are to advance understanding of the science of environmental justice, foster development of methods and tools for identifying environmental justice issues, help EPA identify data gaps and research needs, and

facilitate research planning within EPA and with EPA's funding partners to ensure that identified needs are met.

As a first step toward implementing this plan, EPA identified key factors that likely contribute to higher burdens of environmental exposure and risk borne by racial/ethnic minority and low-income communities (Figure 1). EPA then commissioned technical papers on each topic,[51,52,56–67] with the overarching goal of articulating the state of scientific knowledge on each topic, sometimes with a focus on exploring conceptual models, analytical methods, or data relevant to that issue. Finally, EPA hosted "Strengthening Environmental Justice Research and Decision Making: A Symposium on the Science of Disproportionate Environmental Health Impacts," March 17 to 19, 2010, to share key findings from these papers. The symposium also prominently featured several discussions about how equity may be integrated into EPA's decision-making.

SYMPOSIUM OVERVIEW

EPA partnered with several governmental and nongovernmental organizations to organize the symposium, held in Washington, DC. The broad themes were (1) understand the state of scientific knowledge on factors that likely contribute to disproportionate environmental health impacts in racial/ethnic minority and low-income populations; (2) explore current and conceptual frameworks, analytical tools, and methods for informing policy- and decision-making to protect environmental health; and (3) develop an action agenda, including a research and data agenda to advance the integration of environmental justice into decision-making. Scientific sessions focused on a variety of topics, such as

- the state of scientific knowledge on the 7 factors (Figure 1) identified by EPA as important contributors to disproportionate impacts (the commissioned papers);
- data sources and methodology needs for incorporating each factor into decision-making;
- frameworks for cost–benefit analysis, risk assessment, and legal authorities for integrating environmental justice into decision-making and other analytical frameworks generally used for policymaking, such as health impact assessments;
- community-based tools for assessing disproportionate impacts and methods for investigating the joint contributions of physical and social environments to health disparities.

Plenary sessions provided a forum for decision-makers, researchers, and community advocates and representatives to discuss crosscutting and foundational issues such as community perspectives on environmental justice issues, research and data needs, and next steps for advancing the integration of environmental justice into decision-making.

More than 200 participants attended the symposium over 2.5 days. Among the participants were tribal and community representatives and advocates, representatives of community organizations, regulatory and policy analysts and decision-makers, public health scientists, human health and ecological risk assessors, researchers in government and academia, and regulatory toxicologists. Discussions were organized around the 3 broad themes identified by EPA.

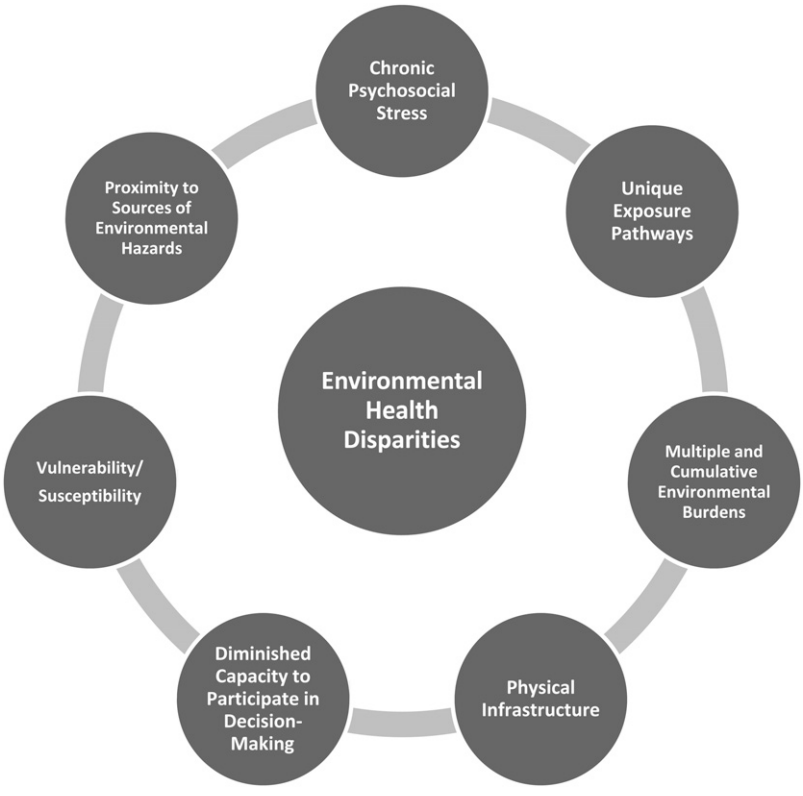

FIGURE 1—Factors likely to contribute to environmental health disparities.

State of Scientific Knowledge

In 2007 EPA developed a white paper, *Factors for Identifying and Assessing Disproportionate Environmental Health Impacts*,[68] in which the agency recognized that disproportionate environmental justice impacts were the result of more than just differential exposures. In this white paper, EPA noted that disproportionate impacts can arise from inequities in levels of harmful environmental exposures, deficient services or benefits, and differentials in the ability to withstand or mitigate

harms, because of the complex interplay of factors in communities with a history of social and economic disadvantage, inadequate services, and environmental hazards. EPA posited that disproportionately great and adverse human health and environmental effects could result from a combination of several—if not all—of the factors. EPA's list of factors was inspired by an earlier publication that highlighted their relevance to environmental justice issues.[69]

In 2009, EPA commissioned technical papers to elucidate the state of scientific knowledge on how each factor contributes to differences in environmental health outcomes across different social groups. EPA also identified another factor, chronic psychosocial stress, in response to emerging evidence of the potential contributions of social context and psychosocial hazards to differential environmental health outcomes. These factors formed the basis for the commissioned articles, presented in this issue, and were extensively discussed at the state-of-the-science sessions at the symposium. Each article was developed to highlight specific scientific issues for which better understanding and articulation appeared necessary to advance the consideration of a given factor within an analytical framework.

Proximity to sources of environmental hazards. Concern about proximity to industrial facilities and other noxious land uses originates from the understanding that industrial areas generally carry higher environmental burdens, such as poor air quality, noise, storage of hazardous materials, and emissions of toxic substances than do purely residential neighborhoods.[70] Although several studies have focused on the disproportionate proximity of environmental hazards to low-income and minority communities, no systematic review of the literature has been conducted on how proximity relates to environmental health impacts in these populations. Also, a variety of methods are employed in proximity studies, and a critical assessment of the weaknesses and strengths of each of these methods in the context of their application in environmental health assessments is not available.

Two articles published in this issue and discussed at the symposium were commissioned to tackle these issues. Brender et al. systematically reviewed 94 studies that examined residential proximity to environmental hazards in relation to adverse reproductive outcomes, childhood cancer, respiratory and cardiovascular conditions, and other adverse health outcomes.[56] Chakraborty et al. present a critical assessment of (1) analytical approaches used to spatially define boundaries of areas potentially exposed to environmental hazards, such as spatial coincidence, distance-based analysis derived from both discrete buffers and continuous distance methods, and pollution plume modeling; (2) methods for estimating population characteristics, such as polygon containment, centroid containment, buffer containment, and dysametric mapping; and (3) emerging geostatistical techniques (e.g., geographically weighted regression) that address limitations of conventional approaches.[59]

Unique exposure pathways. Despite the importance of exposure data in environmental and public health decision-making, analysis to inform such decisions may not always be formulated to incorporate the exposure experience of population groups that have unusually or atypically high exposures. An important issue that limits the integration of the exposure experience of population groups with such unusual exposures is that pathways through which these populations are exposed (e.g., ingestion of herbal medicines of Ayurvedic origin) are less common in the general population and therefore likely to be overlooked.

Gochfeld and Burger discuss populations with high-end exposures and unique exposure pathways whose exposures from combined pathways are likely to be underestimated.[57] In a second commissioned article, the same authors present a conceptual model for identifying important but unique exposure pathways; this model can be used to adequately examine how these exposures contribute to health disparities and to incorporate the exposures of minority, low-income, and tribal populations into risk and health assessments.[58]

Multiple and cumulative impacts. Several populations in the United States experience exposures to multiple environmental stressors (both chemical and nonchemical) that cumulatively may induce adverse impacts on health or result in higher risks or more severe adverse health outcomes. EPA has made significant progress on evaluating cumulative risks by developing analytical frameworks and methods for assessing and taking action on risks from exposures to multiple chemical stressors.[71–73] However, these methods are still unable to assess and account for the impacts of combined exposure to chemical and nonchemical stressors, a common scenario for many communities with environmental justice issues. An important milestone toward the development of methods for assessing and accounting for the combined effects of chemical and nonchemical stressors is consensus on a framework that illuminates key variables and relationships between these variables.

In this issue, Sexton and Linder briefly examine the state of the art regarding cumulative risk assessment, with emphasis on challenges and complexities of advancing from the status quo with chemical stressors to the incorporation of nonchemical stressors such as social context into cumulative risk assessment.[67] In another article, the same authors identify 3 main families of conceptual models for understanding and estimating combined health risks from environmental, social, and psychological factors (social determinants models, health disparities models, and multiple-stressor models from ecological risk assessment). Their article also examines why decisions about theoretical frameworks are critical for cumulative risk assessment.[51]

Susceptibility and vulnerability. Some of the emerging conceptual frameworks to explain environmental health disparities suggest that enhanced vulnerability attributable to factors other than chemical exposure may explain observations of environmental health disparities.[45,48] Three commissioned articles, all by Schwartz et al., propose approaches for integrating vulnerability and susceptibility in risk assessment. The first discusses common assumptions in risk assessment that fail when there is differential vulnerability in the population and briefly highlight useful approaches for addressing departures from these assumptions to avoid masking pockets of inequity in population risk assessments.[63]

These concepts are further illustrated in the second article with examples from epidemiological studies of environmental hazards

such as lead and air pollution.[64] The third article focuses on methodological issues in analyzing epidemiologic data to better assess the distributional effects of exposures and hypotheses about effect modification. The article addresses 3 key methodological issues: complex interactions and synergies, nested data at multiple spatial scales, and methods to quantify risk inequality that can detect hidden pockets of vulnerability.[65]

Vulnerable physical infrastructure. Infrastructure such as housing, transportation, and water systems contribute to human exposure to environmental hazards and to conditions that promote health and well-being. For example, housing, which is among the most studied physical infrastructures, is associated with human exposure to hazards such as lead, mold, pesticide residues, and tobacco smoke,[74] and transportation is a source of noise and air pollution.[75] Discussions at the symposium took a holistic perspective on how infrastructure contributes to poor health outcomes and disparities across sociodemographic groups.

Two articles in this issue address housing and drinking water infrastructure. Jacobs provides a review of the scientific literature on disparities in housing and associated health outcomes.[62] VanDerSlice reviews the less studied issue of drinking water infrastructure and focuses on racial and income disparities in infrastructure to identify its disparity-prone aspects.[66] This article also proposes a conceptual framework that can advance our understanding about aspects of the drinking water system that may trigger or enable disparities.

Diminished capacity to participate in decision-making. Communities with fewer social, economic, and political resources may as a consequence experience greater environmental exposure to noxious land uses and poor physical conditions. This phenomenon is affirmed in a 1999 report by the Institute of Medicine, which notes, "There are identifiable communities . . . that experience a certain type of double jeopardy in the sense that they: (1) experience higher levels of exposure to environmental stressors in both terms of frequency and magnitude, and (2) are less able to deal with these hazards as a result of limited knowledge of exposures and disenfranchisement from the political process."[24(p6)] Meaningful participation in decision-making is an important element of integrating environmental justice into the regulatory development process[76] and is a key element in environmental justice.

To explore approaches for enhancing the meaningful engagement of environmental justice stakeholders in decision-making at the EPA, a state-of-the-science session at the symposium centered on a commissioned article by Freudenberg et al. that features a proposed conceptual model of participation. This model embodies strategies for strengthening community capacity and characteristics that enable communities to protect and improve their well-being, through the lens of determinants of participation in public policy.[61]

Chronic psychosocial stress. How chronic psychosocial stress may modify the effects of exposure to environmental hazards is an emerging research interest with potential practical implications for policy.[41-44,77,78] Chronic psychosocial stress can also be the product of perceived or existing chronic environmental contamination from pollution sources.[79,80] Two commissioned articles address these perspectives. Couch and Coles examine how the presence or perception of environmental contamination may lead to psychosocial stress in a community.[60] The authors recommend using this information to inform environmental risk management decisions for communities affected by negative environmental conditions. McEwen and Tucker review the issue of critical biological pathways for psychosocial stress, with emphasis on the concept of allostatic load, which holds promise as a composite indicator for capturing information on multiple physiological systems adversely affected by chronic psychosocial stress exposure.[52]

Recently, Morello-Frosch and Shenassa have proposed pathways through which the stressful effects of negative conditions in the social and built environments, which can be captured at the individual level by measuring allostatic load, can influence environmental health outcomes resulting from exposure to pollution.[48]

In addition to the discussions on the state of scientific knowledge on these 7 issues, the symposium convened several concurrent data and methods sessions to demonstrate approaches to assess a particular factor or integrate information on how the factor may result in disproportionate impacts in various decision-making arenas.

Frameworks, Analytical Tools, and Methods

A variety of analytical approaches and decision frameworks, such as risk assessment and cost–benefit analysis, traditionally provide the necessary input to support decision-making in regulatory activities, including development of regulations. In addition, decisions in the process of developing regulations are made within the context of specific legal and statutory frameworks. The symposium featured sessions to discuss how these frameworks could be adapted to consider environmental justice.

At the session on legal frameworks, participants discussed the use of race in decision-making and a variety of approaches for acting on evidence of environmental injustice, such as adopting a human rights or civil rights legal framework. Advocates for indigenous people and tribes suggested increasing access to resources to allow tribes to operate similarly to states to improve their capacity to protect health and the environment.

One session addressed the utility of community-based tools to demonstrate the presence of environmental justice issues and provide the basis for action to reduce or prevent disproportionate environmental health impacts. Tools and databases developed and used by states, researchers in academia, and EPA were presented at this session. Participants discussed several issues regarding screening tools, such as the rationale for selecting one indicator over another, accessibility and ease of use from the community perspective, indicator-weighting schemes in different models, and access to useful data at an acceptable level of resolution.

Discussants at the session on cost–benefit analysis provided an overview of its framework, discussed the application of quantitative indicators (inequality indices) to inject inequality into this framework, and explored potential weaknesses of traditional approaches in economic analysis, such as willingness to pay. Case studies provided examples of how assessments for disproportionate impacts could be integrated into regulatory analysis and could support and inform regulatory decision-making.

Discussion during the session on risk assessment highlighted the utility of geographic information system mapping to identify disproportionate impacts to certain populations and the challenges with assessing risk for disproportionately affected populations in the regulatory context. This session also featured a newly developed screening tool for decision-making that integrates information on cumulative risk and social vulnerability.

Other sessions provided an overview of health impact assessment as a process that explicitly considers equity in decision-making, with illustrative case studies of its application in government decision-making. The symposium also featured an introduction to the burden of disease–comparative risk assessment framework, which is used by the World Health Organization to assess health improvements across policy options. This framework has also been used to compare quantified health impacts across risk factors, spatially defined areas, and socioeconomically defined groups.

A plenary session on the final day featured presentations on improving quantitative approaches and frameworks for assessing environmental justice. Panelists highlighted merits and limitations of risk assessment, health impact assessment, and quantitative measures of inequality and presented an example of an operational EPA regulatory framework (primary standards for criteria air pollutants such as particulate matter and ozone) that has provisions for addressing disproportionate environmental health impacts among vulnerable populations.

Research Action Agenda

A primary purpose of the symposium was to develop an action agenda on issues such as research and data needs. Several research and data needs were discussed at most sessions at the symposium. Two sessions focused entirely on this objective.

In a plenary session dedicated to research needs to advance the integration of environmental justice into decision-making, research-funding and data collection agencies shared perspectives on directions to improve research and data. Panelists highlighted program interests in training scientists to increase the volume of community-based participatory research and in improving their understanding of EPA's regulatory development process in order to identify how their research programs can better generate data and methods to meet EPA's needs.

Participants questioned the utility of national data for informing health disparities and the significant limitations of extrapolating community-level data from national-scale surveys. However, they also proposed collaboration with localities on community health and nutrition examination surveys as a way to begin to generate local data. The New York City Health and Nutrition Examination survey was described as a successful example of this type of local-scale survey. Data from this survey has been used to develop risk reduction and prevention policies targeting highly and uniquely exposed populations.

Participants delineated other challenges: measuring social context and environmental exposure, developing and studying conceptual models that combine social context and environmental exposures for specific health outcomes, evaluating cumulative impacts over the life course, and understanding interactions between stressors.

The symposium also featured a session on methods for jointly investigating how social context and the physical environment yield disparities. Panelists presented a variety of modeling techniques currently used in research on the joint effects of social and physical environments. They punctuated their presentations with illustrative case studies that measured such aspects of social context as racial residential segregation and neighborhood characteristics (e.g., violence, social cohesion, walking environments, and aesthetic quality). Areas of need identified included better measures of neighborhood context, elucidation of the features of neighborhoods relevant to risk from environmental hazards, and epidemiological studies of the impact of social context on health and its interactions with environmental exposures.

CONCLUSION

The symposium was an opportunity for the worlds of policy, science, and environmental justice to intersect. Experts from various fields presented and discussed approaches that could advance EPA's ability to assess how its policies differentially affect minority and low-income populations. Key concepts that emerged over the course of the symposium included the following:

- A piecemeal approach to the issues faced by communities is unlikely to yield the desired result of improving overall health and well-being. Moving toward multimedia approaches to protect environmental health and collaboration across governmental agencies (both federal and local) is necessary to improve conditions in communities with environmental justice issues.
- More collaborative research in which community partners have equal standing and access to funding opportunities is necessary.
- Entities charged with developing policies (e.g., fiscal, trade, health, and other policies), including EPA, ought to move in the direction of evaluating the health and equity impacts of every major policy. This suggested approach reflects a key recommendation in the World Health Organization report *Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health* for governments to conduct regular health equity impact assessments of all major policies.[81] Also important is a shift in emphasis from risk factors to root causes and from pollution to inequalities in the distribution of power, if attaining health equity is the goal. The health impact assessment framework, a tested and proven decision support tool for evaluating policies, provides many lessons learned and valuable resources for evaluating the health impacts of different types of policies.
- Despite shortcomings in the use and interpretation of data used in risk assessment, as noted by symposium participants, risk assessment can be advantageous because it can be broad in principle, can be precautionary and oriented toward solutions, and can incorporate information on vulnerability and inequality. The revised framework for risk-based decision-making proposed in the National Research Council's *Science and Decisions: Advancing Risk Assessment* promotes the integration of key attributes that are important concepts in environmental justice (e.g., vulnerability, background

exposure, and mode-of-action information) and offers perspectives on how it can be integrated into risk-based decision-making.[82] This revised framework will help EPA advance its agenda to integrate environmental justice into regulatory decision-making. Decisions based on risk assessment can be improved if the process and output are focused on questions to inform risk management, such as what the options are for reducing hazards or exposures and the merits of individual policy options.

The symposium concluded with commitments from EPA managers to advance the administrator's priorities of environmental justice and children's health, continue the agency's work with communities to address issues of environmental justice, commit resources to fund research on topics most relevant to advancing the integration of environmental justice into decision-making, and continue EPA's efforts to integrate environmental justice into regulatory decision-making. They also committed to working toward the aggressive prosecution of polluters, enhancing relationships with the states, increasing oversight of state enforcement programs, and implementing community-based programs. EPA managers concurred with advocates on the need to work with other federal agencies on environmental justice issues.

Since the conclusion of the symposium, EPA has developed and finalized its plan for implementing EO 12898 (Plan EJ 2014), which includes specific actions the agency has committed to before the end of fiscal year 2014.[55] Many actions in the plan reflect suggestions and ideas shared at the symposium. The agency also developed the report, *An Update on Ongoing and Future EPA Actions to Empower Communities and Advance the Integration of Environmental Justice in Decision Making and Research*, which reflects EPA's commitment to provide timely information, encourage open dialogue, and be responsive to the needs of communities faced with environmental justice issues.[83] On the issue of working with other federal partners and ensuring synergy between health-shaping policies, EPA reconvened the Interagency Working Group on Environmental Justice, which is charged with ensuring vertical integration of environmental justice within these agencies' activities, and continues to engage with other federal agencies on significant policy and research initiatives, such as the National Prevention, Health Promotion, and Public Health Council; the National Partnership for Action to End Health Disparities; and the Federal Collaboration on Health Disparities Research. ■

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Contributors

O. C. Nweke, D. Payne-Sturges, C. Lee, H. Zenick, P. Grevatt and W. H. Sanders III conceptualized and commissioned the state-of-science papers presented at the symposium. All authors organized and shaped the symposium and contributed ideas to the development of the article O. C. Nweke and D. Payne-Sturges developed the outline for the article, and O. C. Nweke led its preparation.

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No protocol approved was required because no human participants were involved in this study.

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