EXECUTIVE SUMMARY

ASCERTAINMENT OF THE ESTIMATED EXCESS MORTALITY FROM HURRICANE MARÍA IN PUERTO RICO

IN COLLABORATION WITH THE UNIVERSITY OF PUERTO RICO GRADUATE SCHOOL OF PUBLIC HEALTH
ACKNOWLEDGMENTS

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We thank the Milken Institute School of Public Health for providing administrative and financial support at the beginning and throughout the study, specially the Executive Dean for Finance and Administration, Gordon Taylor. We want to thank the then acting Associate Dean for Research Melissa Perry, who took the risk with us, and the ITS team of the school, Regina Scriven and Joseph Creech. We are also grateful for the support of Dean Dharma Vázquez of the University of Puerto Rico Graduate School of Public Health and all of those who provided their help.

This project was supported by the dedication of the personnel of key institutions in Puerto Rico who provided team members with mortality information, and most importantly, for helping us to understand their work processes. We acknowledge the support of the Demographic Registry and particularly Dr. María Juiz Gallego and José López Rodríguez. At the Bureau of Forensic Sciences, we thank Monica Menendez and her staff for continued support. The project team is grateful to Dr. Mario Marrazzi at the Puerto Rico Institute of Statistics who provided us with information and data for establishing counterfactuals. From the Puerto Rico Planning Board (Junta de Planificación), Alejandro Díaz Marrero and his colleague Maggie Perez Guzmán provided information on the travel surveys. We thank Dr. Istoni Da Luz Sant’Ana and Dr. Israel Almodóvar for their advice on R programming.

We would like to thank Martie Sucec for editing the report, Cynthia Gorostiaga and Enrique Rivera Torres and the Rivera Group for translation and Kate Connolly for designing the report.

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EXECUTIVE SUMMARY

In order to accurately estimate the excess number of deaths due to Hurricane Maria, the Governor of Puerto Rico sought an independent assessment of mortality and commissioned The George Washington University Milken Institute School of Public Health (GW SPH) to complete the assessment.

The project had the following objectives: 1) assess the excess total mortality adjusting for demographic variables and seasonality, report a point estimate and confidence interval and make recommendations; 2) evaluate the implementation of Centers for Disease Control and Prevention (CDC) guidelines for mortality reporting in disasters and identify areas of opportunity for improvement; and 3) assess crisis and mortality communication plans and actions by the government as well as understand experiences and perceptions of key participant groups to make recommendations based on communications best practices.

METHODS

We implemented the project as three studies, each with specific yet complementary methodologies. Our excess mortality study analyzed past mortality patterns (mortality registration and population census data from 2010 to 2017) in order to predict the expected mortality if Hurricane Maria had not occurred (predicted mortality) and compare this figure to the actual deaths that occurred (observed mortality). The difference between these two numbers is the estimate of excess mortality due to the hurricane. We developed a series of generalized linear models (GLMs) with monthly data for the pre-hurricane period of July 2010-August 2017, accounting for trends in population size and distribution over this period in terms of age, sex, seasonality and residence by municipal level of socioeconomic development.

Our estimates also considered Puerto Rico’s consistently high emigration during the prior decade and dramatic population displacement after the hurricane. We used the model results to project forward mortality that would have been expected if the hurricane had not occurred for two scenarios— if the population had not changed (census scenario), and explicitly accounting for massive post-hurricane population displacement from the island (displacement scenario). For observed mortality, we used records for all deaths occurring from September 2017-February 2018, provided by the Puerto Rico Vital Statistics Records (PRVSR) division of the Puerto Rico Department of Health (DoH). The estimates of excess all-cause mortality attributable to the hurricane are the result of comparing the projections for the census and displacement scenarios to observed mortality in the vital registration data.

In order to respond to the Puerto Rican Government’s query about how well CDC guidelines for mortality reporting in a disaster were followed, we conducted a two-part study to assess both the death certification process and the quality of death certificate data. We conducted interviews with 26 individuals involved in the death certification and registration process to understand procedures under normal conditions and whether and how these were affected after the hurricane. In addition, we reviewed legislation and manuals related to death certification in Puerto Rico, as well as literature on death certification in general and specifically in disasters. With respect to quality of the death certificates and coding for causes of death, we consulted the relevant scientific literature. We conducted a series of checks on the mortality dataset, assessing it for completeness, timeliness, internal consistency and the quality of cause of death reporting by evaluating garbage codes, or mis-assignments, in the underlying cause of death.
Our third study assessed crisis and emergency risk communications by the Government of Puerto Rico before and after Hurricane María, with an emphasis on the communications plans in place at the time of the hurricane, trained staff dedicated to crisis and emergency risk communication, procedures for mortality reporting to the public, spokesperson interaction with the media and key participant perceptions of the government’s risk communication and mortality reporting. For the communication assessment methodology, instruments, and analytical framework, we applied established guidelines from CDC and the World Health Organization (WHO) for communication in emergencies, which are supported by a robust scientific evidence base. We also applied principles from the Federal Emergency Management Agency (FEMA) Whole Community Approach for community-based emergency preparedness (FEMA 2011). We interviewed 11 Puerto Rico Government agency leadership and communications personnel in order to understand: crisis and emergency risk communication plans, processes and interagency coordination for the preparation, approval and dissemination of information to the public; their experiences related to communications before and after Hurricane Maria; and recommendations for future communications in emergency situations. We also interviewed 22 key leaders from different communities in Puerto Rico, representing diverse stakeholder groups including municipal mayors, community and faith leaders, emergency responders, police, non-profit organization personnel, health care providers and funeral directors. In order to formulate recommendations for future communications, these interviews focused on understanding stakeholder experiences from Hurricane María, community involvement in disaster communications planning and perceptions of the government’s risk communication and mortality reporting.

**Total excess mortality post-hurricane using the migration displacement scenario** is estimated to be 2,975 (95% CI: 2,658 - 3,290) for the total study period of September 2017 through February 2018.

To assess the post-hurricane information environment, we reviewed 17 press releases and 20 press conferences from September 20, 2017-February 28, 2018 to evaluate information content and spokespeople performance, and to determine the extent to which trustworthiness, credibility and accountability were conveyed according to CDC and WHO guidelines. Finally, we analyzed 172 media coverage items from major English- and Spanish-language news outlets during the same time period, as well as related social media commentary, to identify factors that may have contributed to public concerns about mortality reporting, including: reasons and timing of mortality data reporting; contradictory information from spokespeople and alternative sources; information gaps; and perceptions of the accuracy and transparency of the Puerto Rico Government’s mortality reports.

**SUMMARY OF FINDINGS**

a) Excess mortality estimation

We estimate that in mid-September 2017 there were 3,327,917 inhabitants and in mid-February 2018 there were 3,048,173 inhabitants of Puerto Rico, representing a population reduction by approximately 8%. We factored this into the migration “displacement scenario” and compared it with a “census scenario,” which assumed no displacement from migration in the hurricane’s aftermath. We found that, historically, mortality slowly decreased until August 2017, and that rates increased for the period of September 2017 through February 2018, with the most dramatic increase shown in the displacement scenario accounting for post-hurricane migration.

**Table 1. Observed, Predicted and Excess (95% CI) Mortality, Puerto Rico, September 2017 to February 2018, Model 3, Displacement Scenario**

<table>
<thead>
<tr>
<th></th>
<th>SEPT-OCT 2017</th>
<th>SEPT-DEC 2017</th>
<th>SEPT 2017-FEB 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBSERVED</td>
<td>5,921</td>
<td>11,375</td>
<td>16,608</td>
</tr>
<tr>
<td>PREDICTED</td>
<td>4,650</td>
<td>9,277</td>
<td>13,633</td>
</tr>
<tr>
<td>EXCESS</td>
<td>1,271</td>
<td>2,098</td>
<td>2,975</td>
</tr>
<tr>
<td>95% CI</td>
<td>(1154, 1383)</td>
<td>(1872, 2315)</td>
<td>(2658, 2990)</td>
</tr>
<tr>
<td>OBSERVED/PREDICTED</td>
<td>1.27</td>
<td>1.23</td>
<td>1.22</td>
</tr>
</tbody>
</table>
The results of our analysis of total excess mortality by socio-demographic subgroups show that every social stratum and age group was affected by excess mortality. However, the impact differed by age and socioeconomic status. The risk of death was 45% higher and persistent until the end of the study period for populations living in low socioeconomic development municipalities (Figure 1), and older males (65+) experienced continuous elevated risk of death through February (Figure 2). Overall, we estimate that 40% of municipalities experienced significantly higher mortality in the study period than in the comparable period of the previous two years. We conclude that excess mortality is a good indicator for impact monitoring during and in the aftermath of a disaster.

Figure 1. Estimated Relative Excess Mortality from Hurricane María in Puerto Rico, Per Month, by SEI Category

Figure 2. Estimated Relative Excess Mortality from Hurricane María in Puerto Rico, Per Month, by Sex and Age Group
b) Death certification process evaluation

Our study shows that physician lack of awareness of appropriate death certification practices after a natural disaster and the Government of Puerto Rico’s lack of communication about death certificate reporting prior to the 2017 hurricane season limited the count of deaths that were reported as related to Hurricane María. Individuals authorized to complete death certificates include physicians and forensic physicians; however, most physicians receive no formal training in death certificate completion, in particular in a disaster. When asked about the CDC guidelines the PRVSR circulated after the hurricane that recommended physicians fill out a section in the death certificate with information or other conditions that contributed to the death, interview respondents indicated lingering confusion about the guidelines, while others expressed reluctance to relate deaths to hurricanes due to concern about the subjectivity of this determination and about liability.

The PRVSR offices sustained damage and did not have power to operate for some time after the hurricane, and death registration was delayed. Nevertheless, based on our findings in the assessment of death certification quality, the disaster does not appear to have affected the completeness of the certificates. For this assessment we compared Puerto Rico Vital Statistics System (PRVSS) data from September to December 2017 with the same period in 2015 and 2016 and found that completeness of death certificates was high with respect to age and sex, two indicators widely used to assess this aspect of mortality registration quality. On timeliness, there was a statistically significant delay in the number of days between date of death and date of death registration, with an average of 17 days in the period after the hurricane compared to 12 days in the prior year. Overall, there was a low percentage of garbage codes as the underlying cause of death and there appears to be no impact from the event on the percentage of codes that were mis-assigned. With respect to internal consistency, less than 1% of death certificates had medically inconsistent diagnoses in the underlying cause of death.

c) Assessment of Crisis and Mortality Communications and the Information Environment

According to interviews with Puerto Rico Government agency personnel, at the time of the hurricane, neither the Department of Public Safety (DPS) nor the Central Communications Office in the Governor’s Office had written crisis and emergency risk communication plans in place. The DoH’s Office of Emergency Preparedness and Response had an outdated emergency plan, including annexes for Risk Communication in Emergencies and Mass Fatality Management. Agency emergency plans that were in place were not designed for greater than Category 1 hurricanes, and risk messages conveyed to the public in preparedness campaigns were reported by key leaders to inadequately prepare communities for a catastrophic disaster. Key leader interview respondents also noted limited engagement of community stakeholders in strategic communication preparedness planning. Regardless, key leader interview participants described numerous strategic preparedness activities undertaken at the local level that they believed to minimize injuries and loss of life, especially for vulnerable populations.

According to Puerto Rico Government agency interviews, there were insufficient communication personnel at the time of the hurricane, and surge staffing was not adequately mobilized post-hurricane. Respondents reported a lack of formalized personnel structure for emergency communication functions, resulting in inadequate personnel and spokespeople training in crisis and emergency risk communication, deficiencies in coordination of communication between central and municipal governments and between central and federal government counterparts. Puerto Rico Government agency leadership interview respondents did not identify formalized protocols for the coordination and clearance of mortality reporting between the DPS and the DoH at the time of the hurricane.
The inadequate preparedness and personnel training for crisis and emergency risk communication, combined with numerous barriers to accurate, timely information and factors that increased rumor generation, ultimately decreased the perceived transparency and credibility of the Government of Puerto Rico.

Puerto Rico Government personnel and key leader interview respondents indicated that communication contingency plans were not in place to anticipate multiple cascading failures of critical infrastructure and key resource sectors. Consequently, the central government was not prepared to use alternative communication channels for health-related and mortality surveillance, public health information dissemination and coordination with communities, including radio and interpersonal communication. This contributed to delayed information availability, gaps in information and the dissemination of inconsistent information to the public. Furthermore, there were gaps in the information provided by the Government of Puerto Rico, including limited explanation of the death certification process, distinguishing between direct and indirect deaths, or explanations of barriers to timely mortality reporting. Despite the potential for information gaps to increase the risk of the propagation of misinformation and rumors, the Government of Puerto Rico did not systematically monitor and address misinformation or rumors in news outlets and on social media platforms. Efforts undertaken by outside groups to fill information gaps and identify hurricane-related deaths added to conflicting mortality reports in the information environment.

Key leader interview respondents perceived the death count to be much higher, and held viewpoints that government leadership was disconnected from the realities of Puerto Rican communities, that there was not transparency in reporting, that information was intentionally withheld to evade blame and that adequate systems were not in place to track the death count.

Our research identified the implementation of public information campaigns prior to the hurricane with public health and safety messages, but the messages did not adequately prepare Puerto Rican communities for a catastrophic natural disaster. There was limited community and stakeholder engagement in disaster communication planning, and ineffective communication contingency plans in place, resulting in limited public health and safety information reaching local communities post-hurricane and alternative communication channels that were not systematically utilized for disease surveillance and information dissemination.
RECOMMENDATIONS

OVERALL POLICY GOAL FOR MORTALITY SURVEILLANCE AND COMMUNICATIONS

To assure the capacity of mortality surveillance and crisis and emergency risk communication during natural disasters in Puerto Rico to support policies and interventions that protect life and health.

RECOMMENDATIONS ON MORTALITY SURVEILLANCE FOR NATURAL DISASTERS

I. Strategic Objectives

To have a reliable and resilient institutional mortality surveillance process that provides trustworthy and accurate evidence during natural disasters to: Establish the magnitude of the impact of the disaster, identify areas and groups of highest risk, monitor the performance of public health protection and prevention, and inform policy-making and program implementation. These principles are recommended:

- **Readiness**, establish a routine process
- **Rigorous**, based on valid methods
- **Timeliness**, delivering on time
- **Common good**, having as a priority the welfare of all

II. Programmatic Recommendations for Natural Disaster Mortality Ascertainment

**Development of an Organizational Agenda**

- Develop a federal and Puerto Rico policy architecture for preparedness and response to major emergencies and natural disasters.
- Establish clear leadership of the DoH on mortality surveillance and capacity building of medical personnel on death certification.
Assure complete staffing and professional capacity for the PRVSR and the Bureau of Forensic Sciences (BFS).

Review the legal framework for DoH accountability, for medical facilities and physician assurance on death certification.

Secure needed financial resources and reliable infrastructure with federal government support.

**Establish an Excellence Program on Mortality Surveillance for Performance Monitoring**

- Institute continuous mortality-based monitoring to assess disaster impact and the effectiveness of post-disaster interventions using the collaborations with UPR GSPH.
- Determine a quality improvement program for death certification with training for all physicians.

**Establish a mechanism for continuous flow of surveillance results and interpretation to decision makers**

- Improve efficiency and timeliness of flow of information to decision makers and engage stakeholders from civil society, the media and others.
- Ensure provision of feedback to those involved in the death certification process and in data analyses.

### III. Recommendations for Future Advancement of Mortality Surveillance and Natural Disaster Preparedness

- Implement a cause-specific mortality analysis to establish causal pathways and identify priority areas
- Assess and strengthen public health functions.
- Evaluate the burden of disease related to mortality following Hurricane María.
- Advance the work on the analysis of small area statistics to identify heterogeneity within municipalities related to mortality from Hurricane María.
- Disseminate globally the experience gained by Puerto Rico in this major event.
RECOMMENDATIONS ON CRISIS AND MORTALITY COMMUNICATION IN NATURAL DISASTERS

I. Strategic Objectives

To use credible, transparent and effective crisis and risk communication during natural disasters as a mechanism for informing populations, protecting lives and instilling public trust. These principles are recommended:

- **Preparedness**, with planning as fundamental for effective crisis and emergency risk communication
- **Credibility**, as a critical factor for facilitating partnerships and protecting public health
- **Transparency**, as a mechanism for strengthening and informing decision-making
- **Compassion**, with acknowledgment and validation of individual and societal emotions and concerns

II. Programmatic Recommendations for Natural Disaster Crisis and Mortality Communications

**Create an Integrated Puerto Rico Crisis and Emergency Risk Communication Plan and Planning Process**

- Establish clear leadership by the Puerto Rico Emergency Management Bureau (EMB) and the Central Communications Office for the development of a Puerto Rico Crisis and Emergency Risk Communication Plan. Define roles, levels of engagement, and specific tasks for municipalities and all responsible agencies. Identify teams responsible for Plan updates at municipal, agency, and central government levels.

- Engage key stakeholders and local communities in the development of Crisis and Emergency Risk Communication Plans at municipal, agency, and Puerto Rico Government levels.

**Coordinate and Build Capacity for Crisis and Emergency Risk Communication**

- Coordinate the Puerto Rico Plan with Agency and Municipal Crisis and Emergency Risk Communication Plans.
Establish an inter-agency committee to coordinate and oversee mortality surveillance clearance and reporting to the public in disasters, to include communications and technical experts.

Formalize a network of municipal communication liaisons to facilitate the timely exchange of information with the central government pre- and post-disaster.

Ensure expertise in emergency communication planning and management, crisis and risk communication, and mortality communication of government communication personnel from agencies responsible for public health and safety functions in disasters.

Identify a cadre of official spokespeople for disasters, including subject matter experts.

III. Recommendations to Build Crisis and Mortality Communications Preparedness Capacity for Natural Disasters

- Update all Crisis and Emergency Communication Plans annually and following disasters.
- Provide crisis and emergency risk communication training for communications personnel, to include monitoring and addressing rumors and the effective use of social media in disasters.
- Implement media training for disasters with designated spokespeople.
- Conduct annual emergency communication exercises, including stakeholders and local communities.
- Develop a dashboard that characterizes current crisis and mortality communication capacity in disasters and tracks advancement over time for management and accountability.
- Conduct a KAP (knowledge, attitude and perception) population study to identify communication strategies, messages, key audiences, vulnerable groups, and communication channels in disasters.
- Disseminate broadly promising practices and lessons learned for community-based disaster.
REFERENCES


GW Team

Dr. Elizabeth Andrade, Dr.P.H., M.P.H.
Behavioral Scientist, Project Researcher

Elizabeth Andrade is Assistant Professor in the Department of Prevention and Community Health and the Administrative Core Director of the Avance Center for the Advancement of Immigrant/Refugee Health at GW’s Milken Institute School of Public Health. Dr. Andrade is a behavioral scientist with expertise in planning, implementing, and evaluating public health interventions, health communications, and health disparities research using community-based participatory methods. She has worked extensively with immigrant Latino populations in the Washington DC Metropolitan Area and with communities in Latin America.

Nicole Barrett, M.P.H.
Senior Research Associate, Project Research Assistant

Nicole Barrett is a Senior Research Associate at GW’s Milken Institute School of Public Health, Department of Prevention and Community Health. She has expertise in qualitative research, community-based participatory research, and social marketing and health communication. She supports various research projects with instrument development; IRB submissions and approvals; manuscript, report and conference presentation development; data collection and analysis; and grant proposal submissions.

Dr. Uriyoan Colon-Ramos, Sc.D., M.P.A.
Nutritionist, Project Researcher

Uriyoan Colón-Ramos is a Professor in GW’s Department of Global Health and the Department of Exercise and Nutrition Science. She is a public health nutrition investigator. She has published about mortality and diet-related chronic disease morbidity in Puerto Rico. Her work has contributed to the knowledge of existing dietary disparities among Hispanic subgroups, the process of translation of science into nutrition policy in Latin America and the social and environmental determinants of dietary behaviors among vulnerable populations in the US, Latin America and the Caribbean.
Dr. Mark Edberg, Ph.D., M.A.
Anthropologist, Project Researcher

Mark Edberg is an Associate Professor in the GW's Department of Prevention and Community Health, with appointments in the Department of Anthropology and Elliott School of International Affairs. Dr. Edberg is currently principal investigator and director of the Avance Center for the Advancement of Immigrant/Refugee Health, an exploratory research center with funding from the National Institute on Minority Health and Health Disparities and the CDC. He is also founder and director of the Center on Social Well-Being and Development.

Alejandra Garcia-Meza, M.P.H.
Consultant, Project Researcher

Alejandra Garcia-Meza is a Research Associate at GW's Milken Institute School of Public Health, Global Health Department. She has experience in policy analysis, stakeholder mapping, program impact evaluation, qualitative and quantitative analysis, clinical research and grant management. She is currently collaborating with the Yale School of Public Health and the Pan American Health Organization on developing a course for health ministries in Latin-America to evaluate and develop continuous quality control systems for nutrition programs and interventions.

Dr. Ann Goldman, Ph.D., M.P.H, M.A.
Epidemiologist, Economist, Project Coordinator

Ann Goldman, originally from Puerto Rico, has worked on researching the costs of prevention programs and other economic topics within different institutional settings for the last 15 years. She has been involved in designing and implementing protocols for cost analysis and cost effectiveness studies on population health intervention initiatives. The projects she has worked on have sought to enhance the abilities of members of vulnerable groups, in the developing world as well as in the US, to achieve improved health and enjoy a better quality of life.

Dr. Lynn Goldman, M.D., M.S., M.P.H.
Dean of the Milken Institute School of Public Health, Environmental Health Specialist, Project Researcher

Lynn Goldman’s responsibilities are informed by her broad and deep public policy and academic experience. Dr. Goldman was Assistant Administrator for Toxic Substances in the Environmental Protection Agency under President Bill Clinton. Under her watch, the EPA overhauled the nation’s pesticide laws, expanded right-to-know requirements for toxin release, among other achievements. She participated in several discussions on Hurricane Katrina’s environmental public health impact. She is a member of the National Academy of Medicine and serves on the National Academy of Medicine Council, the Governing Board of the National Academy of Sciences and as a member of the Advisory Committee to the CDC Director and a member of the Food and Drug Administration Science Board.
Dr. Amira Roess, Ph.D., M.P.H.
Epidemiologist, Project Researcher

Amira Roess is an assistant professor at GW’s Milken Institute School of Public Health, Department of Global Health. She is an epidemiologist with expertise in infectious diseases and interventions to reduce the transmission and impact of infectious diseases, especially emerging and zoonotic diseases globally. Dr. Roess has expertise in mortality analysis and addressing US health disparities.

Dr. John Sandberg, Ph.D., M.A.
Demographer, Project Researcher

John Sandberg is an Associate Professor in GW’s Department of Global Health, trained as a social demographer. He has published several works on US children’s time use, including analyses of how they spend time and changes occurring in time use in the last 20 years, as well as determinants and patterns of children’s time use with fathers in two-parent families. His current research explores the relationship of children’s time use to parental child-socialization values and gender-role attitudes.

Dr. Carlos Santos-Burgoa, M.D., Ph.D., M.P.H.
Epidemiologist, Principal Investigator

Carlos Santos-Burgoa is a Professor in GW's Department of Global Health, where he also serves as the Program Director for the Global Health Policy MPH program. Dr. Santos-Burgoa is raising awareness of the importance for equity and development of the public health functions within the health systems and seeking to advance their performance. He was Dean of the School of Public Health of Mexico at the National Institute of Public Health, Director General of the Health Environment and Work Institute—a private consulting and research firm, Director General at Mexico’s Ministry of Health and Senior Advisor and Acting Department Director at the Pan American Health Organization. As Director General for the Ministry of Health in Mexico, Dr. Santos-Burgoa was in charge of disaster management in the 2007 Tabasco floods and the non-pharmacological response to the 2009 Pandemic Influenza A(H1N1) in Mexico. He was also responsible for chemicals emergency management in Mexico and updated the Radiologic Emergency Program for nuclear facilities.

Dr. Scott Zeger, Ph.D., M.S.
(Johns Hopkins University, Bloomberg School of Public Health)
Biostatistician, Project Researcher and Expert Panel Member

Scott Zeger is a Professor of Biostatistics at the Johns Hopkins Bloomberg School of Public Health. He conducts statistical research on regression analysis for correlated responses in surveys, time series and longitudinal or genetics studies. Professor Zeger has been elected Member of the National Academy of Sciences’ Institute of Medicine, Fellow of the American Association for the Advancement of Science and of the American Statistical Association. He was originally invited as an external panel expert. He is incorporated in this list as he got heavily involved in the project’s analysis of excess mortality component.
UPR GSPH Team

**Noel Estrada Merly, M.S.**  
*Graduate Research Assistant, Project Research Assistant*

Noel Estrada is in Graduate School of Public Health, Department of Epidemiology and Biostatistics. He received a bachelor's degree in Cellular & Molecular Biology from the University of Puerto Rico, Rio Piedras Campus. He is currently studying the differences in survival for hepatocellular carcinoma and underlying diseases. His research interests are cancer, chronic diseases and emergency management. He also served as research assistant in the Eastern Caribbean Health Outcomes Research Network (ECHORN) collaborative project.

**Dr. Cruz María Nazario, Ph.D.**  
*Epidemiologist, Project Researcher*

Cruz María Nazario is a professor in the Biostatistics and Epidemiology Department, Graduate School of Public Health, University of Puerto Rico. She has mentored over 130 master's and doctoral students. Her career combines long experience in fieldwork and epidemiologic study design and analysis, with her academic work and the defense of the right to health for poor communities in Puerto Rico. Dr. Nazario is a member of the Robert Wood Johnson Foundation National Advisory Committee, Clinical Scholars Program.

**Dr. Cynthia Pérez, Ph.D.**  
*Epidemiologist, Project Researcher*

Cynthia Pérez is a Professor of Epidemiology in the Graduate School of Public Health at the University of Puerto Rico. She has directed mentoring and training of public health students, medical students, residents, fellows and faculty in the fields of epidemiology and biostatistics for the past 20 years. Her research has spanned public health issues in Puerto Rico, where she has designed, implemented and administered population-based studies targeting various geographic areas in the island. She has also devoted some of her time to coauthor various books including *Biostatistics in Public Health Using Stata* and *Applications of Regression Models in Public Health*.

**Dr. Erick Suarez Pérez, Ph.D., M.A.**  
*Biostatistician, Project Researcher*

Erick Suarez is a biostatistician in the Graduate School of Public Health, University of Puerto Rico. He has been involved in various research projects, where he developed the experience to apply statistical analysis and rigorous methodologies to public health problems in population-based studies and secondary data analysis. He has coauthored two books related to public health: *Biostatistics and Public Health* (CRC/Press, 2016) and *Applications of Regression Models in Epidemiology*. In addition, he has worked with microarrays data analysis to assess the gene expression and DNA repair capacity among breast cancer patients.
Additional GW Team Members

**Ljubica Latinovic, M.D., M.H.A.**
*Communications Expert, Consultant*

Ljubica Latinovic is a specialist in risk communication. She currently serves as a risk communications advisor for the Pan American Health Organization, providing support to countries when necessary. She has long-term experience at the Health Promotion Department of the Ministry of Health of Mexico where she worked in risk communication and managed social marketing. She has also worked in crisis risk communication for the Ministry of Health in Mexico during the 2009 Influenza Pandemic. She has coordinated and designed strategies for risk communication in emergencies and disasters with Collaborating Centers for International Health Regulations.

**Ivonne Rivera, M.P.H.**
*Expert in Qualitative Analysis, Consultant*

Ivonne Rivera is an expert with over 15 years of experience in qualitative research. She leads a consulting practice that provides services to organizations in designing and conducting qualitative research studies, as well as supporting research activities with transcription and translation. Her clients have included government agencies, research companies and advertising agencies. She has expertise working with various communities nationwide, allowing her to take a culturally and linguistically appropriate approach with research participants. She also has 13 years of experience working in clinical research.
External Panel of Experts

Samuel Clark, Ph.D., M.A.
Demographer

Samuel Clark is a demographer who works on African demography and epidemiology and developing new methods for population sciences. His work includes improving the ‘verbal autopsy’ method used to quantify the burden of disease for populations without full-coverage vital statistics systems. He also works in developing new population indicator measurement strategies, and in a variety of projects investigating levels and trends in fertility and mortality, mostly in Africa, and sometimes building models of age schedules of fertility and mortality that can be used widely as inputs to other analyses. His work involves collaborations with the CDC, WHO, UNICEF, among others. He was invited to join the Puerto Rico expert panel due to his expertise in verbal autopsies and his wealth of experience as a demographer, which helped inform the methods for estimating excess mortality from Hurricane María.

Debarati Guha Sapir, Ph.D.
Epidemiologist

Debarati Sapir is the Director of the Center for Research on the Epidemiology of Disasters and a Professor at University of Louvain School of Public Health, in Brussels, Belgium. She holds an Adjunct Professorship at Tulane University Medical Centre (New Orleans) for Health and Humanitarian Aid. The GW SPH team invited Dr. Sapir to join the expert panel due to her expertise in research methods for disaster epidemiology. Since 1984, she has been involved in field research and training in emergency and humanitarian aid issues, working closely with WHO, UNHCR, UNDP and European Commission in various regions of the world. Her experiences provided seasoned input in the study design and methods and critical and constructive feedback on the project results.
Bernardo Hernández Prado, DSc., M.S.
Epidemiologist, Mortality Estimation Expert

Bernardo Hernández Prado is an Associate Professor at the Institute for Health Metrics and Evaluation (IHME) at the University of Washington. He works with IHME’s Integrated Surveillance Systems research team in evaluating the Salud Mesoamérica 2015 project. Dr. Hernández has collaborated with IHME on the Population Health Metrics Research Consortium project for validating verbal autopsy and chronic disease diagnosis questionnaires. Dr. Hernández’s work on verbal autopsies, a key component of Phase II of this project helped inform the methods. His research has focused on maternal health and mortality, social and health program evaluation and the effect of physical activity and improved nutrition on the health of children and mothers. His overall work experience with research and data analysis also proved to be incredibly useful for the mortality estimation component.

Matthew Seeger, Ph.D.
Communications Expert

Matthew Seeger is currently Dean of the College of Fine, Performing and Communication Arts at Wayne State University. His research concerns crisis and risk communication, health promotion and communication, crisis response and agency coordination, the role of media (including new media), crisis and communication ethics, failure of complex systems and post-crisis renewal. He has worked with the CDC and the National Center for Food Protection and Defense. He is also a member of the WHO Guidelines Development Group for Emergency Risk Communication. He is currently involved in a multi-year, interdisciplinary project focusing on contamination of the Flint, Michigan water system. His expertise provided invaluable guidance on the methods and findings for the project’s communications component.

Dr. Scott Zeger, Ph.D., M.S.
(Johns Hopkins University, Bloomberg School of Public Health)
Biostatistician

Scott Zeger is a Professor of Biostatistics at the Johns Hopkins Bloomberg School of Public Health. He conducts statistical research on regression analysis for correlated responses in surveys, time series, longitudinal or genetics studies. Dr. Zeger has been elected a Member of the National Academy of Sciences’ Institute of Medicine, Fellow of the American Association for the Advancement of Science and of the American Statistical Association. He was originally invited as an external panel expert and is listed here as he got heavily involved in the analysis of excess mortality component of the project.
Internal Technical Experts

Daniel Hoffman, Ph.D., M.P.H.,
Epidemiologist

Daniel Hoffman’s career has blended research, public service and a commitment to training a new generation of public health professionals. Dr. Hoffman has pursued interests in environmental hazards, cancer epidemiology and leadership capacity-building. He was appointed the School’s first Associate Dean for Public Health. He currently directs the School’s Eastern and Central European Health Leadership Program, funded by USAID. Dr. Hoffman was asked to join the internal expert panel due to his experience in building capacities for National Disaster Medical System Hospitals staff and work in disaster epidemiology.

Pietro Marghella, DHSc, MSc, MA, CEM, FACCP
Complex humanitarian emergencies expert

Pietro Marghella is an expert on medical and public health preparedness and response for large-scale disasters and complex emergencies. He served for 20 years as a Medical Plans, Operations, and Intelligence Officer in the United States Navy, retiring as the Director of Medical Contingency Operations for the Office of the Secretary of Defense. He is a Fellow in the American College of Contingency Planners (ACCP), which he co-founded and served as first President. Dr. Marghella was appointed as a Special Advisor to the Secretary of Health of Puerto Rico after Hurricane Maria. His knowledge of the disaster and experience in complex humanitarian emergencies made him an invaluable expert to advise on this project.

Sam Simmens, Ph.D., M.A
Biostatistician

Sam Simmens emphasizes the social and behavioral components of public health-related statistical methods. As a researcher, he collaborates with colleagues in all of the health-related fields, applying his skills to research focused on HIV, cancer, obesity, mental health, maternal and infant development, chemical and stress-related environmental exposures and numerous other health issues. He is the Director of GW’s Biostatistics and Epidemiology Consulting Service (BECS) for all faculty.

Ronald Waldman, M.D., M.P.H.
Complex humanitarian emergencies expert

Ronald Waldman began his career in WHO’s Smallpox Eradication Program. He joined CDC’s Epidemic Intelligence Service in 1979 and was assigned to the Refugee Health Unit in Somalia, where he worked intermittently through 1985. He then became Director of the Technical Support Division of CDC’s International Health Program Office. He has worked in numerous emergency settings in policy and coordination roles, including the Iraq War of 1991, the aftermath of the Rwanda genocide, and the Balkan Wars. He was the USG Coordinator of the health sector relief effort following the Haiti Earthquake and, later that year, a senior advisor to the UN Office for the Coordination of Humanitarian Affairs in Pakistan. He is currently Professor of Global Health at MISPH and the President of Doctors of the World – USA.