Minireview Article

An analysis of the deaths reported by Hurricane Maria: A Mini Review


Abstract:

The purpose of this mini review is to analyze the controversies surrounding the official death toll of Hurricane Maria, driven by the estimates of excess mortality rates by academics and investigative journalists. This review will be a critique of the aforementioned analyses and articles with the purpose of clarifying their figures, which all present different numbers of victims. In three publications (i.e., Kishore et al., 2018; Santos-Lozada et al., 2018; GWU, 2018), the Commonwealth of Puerto Rico reported different numbers of victims in the aftermath of HM on September 20, 2017. Since the occurrence of HM in PR, the reported number of victims of this disaster has varied. According to the PR government, the official number of deaths is 64 CPI (2017), while Kishore et al.'s (2018) report puts the figure at 4,645 and 2,975 deaths, as reported by George Washington University. This article analyzes why these sources disagree on the number of the dead and the possible reasons why there are discrepancies.

Introduction

On September 20, 2017, Hurricane Maria (HM) struck Puerto Rico (PR) (Figure 1). HM made landfall on the southeast side of PR and was on the island for about 12 hours (Pasch et al., 2018). HM entered PR as a Category IV hurricane with winds of 250 km/h; although it weakened a little, its slow displacement over the island's geography caused the total destruction of the island's infrastructure. When the HM hits PR, its eye changes shape, which creates a double wall inside, causing it to move more slowly and doing more damage (Méndez-Tejeda, 2018).

On October 3, the U.S. president visited the island, and the PR government announced that 16 people had lost their lives and several had disappeared; this information … indicated that the number of people who died was lower than those who had lost their lives in the aftermath of Hurricanes Katrina and Harvey (ENDI, 2017).

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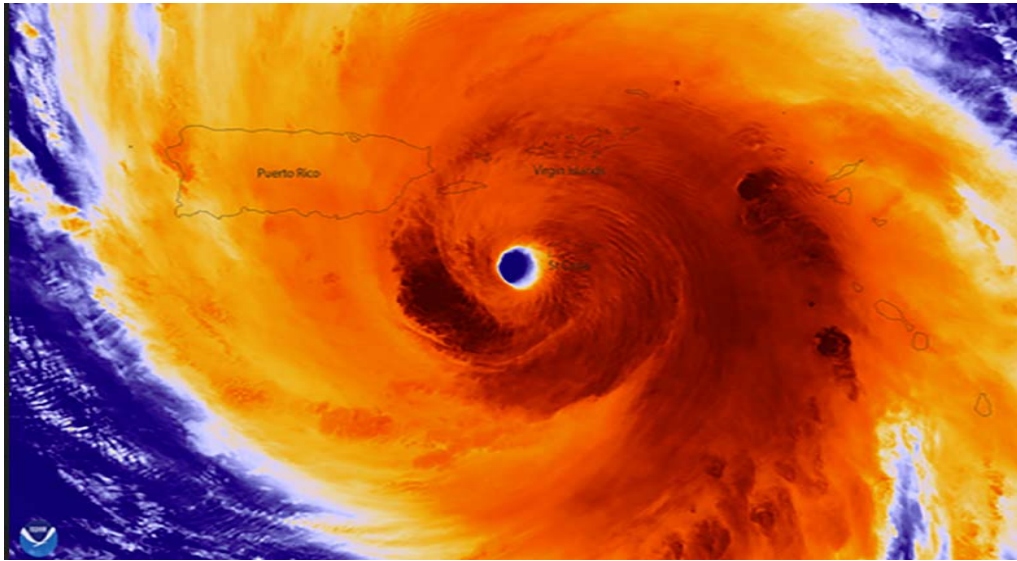
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32 **Figure 1.** Taken on September 20, 2017, at 2:15 a.m. This image shows the well-defined eye of HM,
33 skirting the island of St. Croix. Approximately four hours later, at 6:15 a.m., the storm made landfall
34 in PR as a Category IV hurricane with constant winds of around 250 km/h. Source: NOAA/NASA
35 Suomi NPP satellite.
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37
38 On November 22, 2017, the PR government presented a preliminary report of the
39 damage caused by HM. The report indicated that the number of deaths caused by
40 HM had increased to 64 direct deaths and that the hurricane had destroyed an
41 estimated number of 472,000 homes; the report added that 11,229 people had been
42 displaced from their homes and the economic losses amounted to US$94 billion. In
43 addition, 100% of the territory lost access to energy, 60% of the population had no
44 access to drinking water service, 92.7% of communications services were affected,
45 and only seven hospitals had been restored (FEMA, 2017). These figures (fig.1)
46 illustrate that HM has been the most expensive hurricane in the territory of the
47 United States of America (ENDI, 2017).

48 Puerto Rico is an island in the Caribbean Sea and is a commonwealth of the United
49 States. It is bordered by the Caribbean Sea to the south and the Atlantic Ocean to the
50 north, with an area of approximately 9,104 sq. km. PR are densely populated within
51 a small geographic area. PR is located at a latitude of 18–18.5 degrees north and a
52 longitude of 65–67.4 degrees west. The highest point in PR is Cerro de Punta, a
53 mountain peak in the Cordillera Central at an elevation of 1,338 meters. Sierra de
54 Luquillo is an isolated range, located on the northeast part of the island (Mendez-
55 Tejeda, 2017). The political division of PR is represented by 78 municipalities,
56 including two municipal islands (i.e., Vieques and Culebra). According to the U.S.
57 census taken in July 2017, the population was 3.34 million before the Island was

affected by HM in September 2017—the worst hurricane in Puerto Rico's modern history (JP, 2017).

2.- Method

The most relevant scientific articles that reported the number of deaths caused by HM were analyzed and the findings were compared as follows:

 Harvard University reported 4,635 deaths between September 20 and December 31, 2017 (Kishore et al., 2018). Using a representative, stratified sampling strategy, we surveyed 3,299 randomly chosen households across PR from January 17 through February 24, 2018 to produce a complete and independent estimate of mortality after the hurricane. Questions were asked about displacement, loss of infrastructure, and causes of death, which helped establish a relationship between excess deaths by comparing our estimated post-hurricane mortality rate with the official rates for the same period in 2016. This analysis yielded a total of 4,645 excess deaths during this period (95% CI, 793–8,498)—a 62% increase in the mortality rate compared to the same period in 2016.

Santos-Lozada et al. (2018) from Pennsylvania State University used public statements from the PR Department of Public Safety to estimate the number of deaths for September and October 2017. The expected number of deaths for September and October was 2,383 (95% CI, 2,296–2,469) and 2,428 (95% CI, 2,380–2,476), respectively. The estimated total deaths for September and October 2017 were 2,987 (95% CI, 2,900–3,074) and 3,043 (95% CI, 2995–3,091), respectively. The difference between our estimates and the abovementioned 95% CI for the average deaths was 518 deaths for September and 567 deaths for October.

The School of Public Health of the Milken Institute of George Washington University (Washington, DC, USA) (GWU, 2018) was contracted by the PR government to carry out an independent investigation into the excess post-hurricane mortality and death certification evaluations as well as the processes of communicating the public risks. This research was carried out in collaboration with the Graduate School of Public Health of the University of PR. Using the displacement scenario, the results showed that the excess mortality due to HM was estimated at 1,271 in September and October (95% CI, 1,154–1,383), 2,098 from September to December (95% CI, 1,872–2,315), and 2,975 for the total study period of September 2017 through February 2018 (95% CI, 2,658–3,290).


3.- Results

The public relations department of the PR government used the data sources of the Department of Public Security (DPS) for the period from September 20 to November 22 and reported that the number of direct deaths was officially 64 (Zorrilla, 2017;

99   Sosa, 2017). However, different media sources estimated that the number of deaths
100 was approximately 1000 for this period. Using interviews, IPC (2017) reported 985
101 deaths for the same period, without clarifying whether they were direct or indirect.
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Percent increase

| | 0 to 10% | 11% to 16% | 17% to 27% | 28% or more |

Population areas
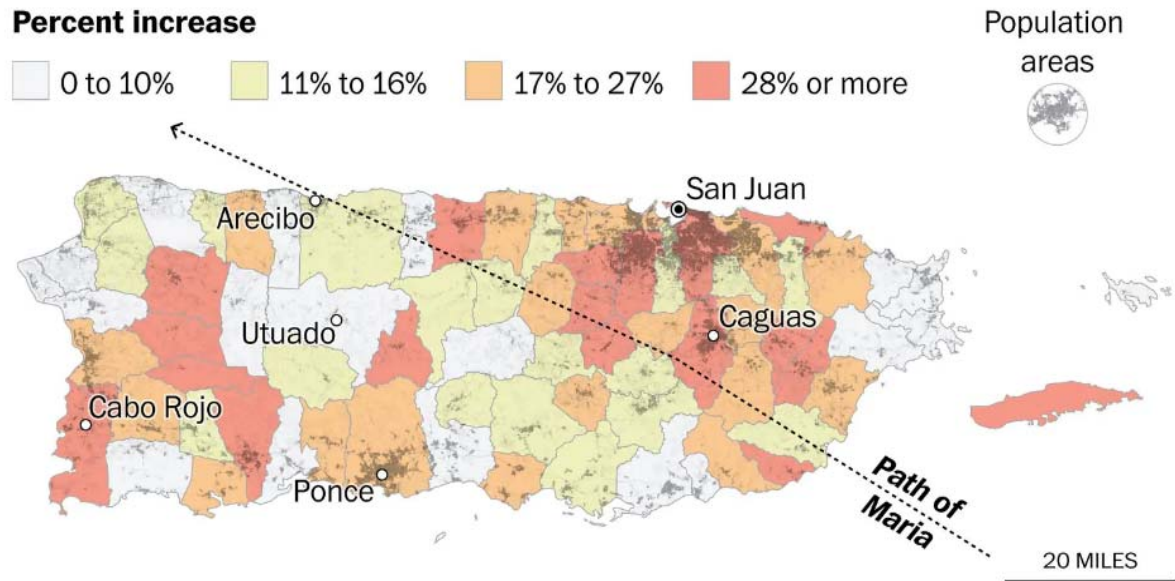
Sources: The George Washington University Milken Institute
School of Public Health, University of Puerto Rico Graduate School Of Public Health

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104
105 **Figure 2.** Estimated percentage increase in crude mortality rates by municipality in PR from
106 September 2017 to February 2018. Source: The George Washington University Milken Institute

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108 In the case of HM, the highest number of deaths occurred in the metropolitan areas
109 (San Juan, Bayamón, Guyana, and Carolina); this zone corresponds to the northeast
110 quadrant of HM (Figure 2), and this is the region that experienced the most intense
111 wind and rain. According to GWU (2018), 77% of those who lost their lives were
112 adults over 65 years of age with low socioeconomic status; lack of energy, water, or
113 communications for several months contributed to the deaths of these people;
114 therefore, these deaths can be construed as indirect, mainly because the largest
115 nursing homes, hospitals, etc. are located in the metropolitan areas.

116 The PR government and the U.S. state and federal governments show a lack of
117 coordinated communication and training among the media of the government
118 agencies of PR and their spokespersons. This lack of communication made it
119 impossible for aid to reach the places where it was most needed (GWU, 2108). When
120 Hurricane Harvey in Texas and Hurricane Irma in Florida and the Virgin Islands
121 occurred, the most qualified personnel were called upon to attend to these
122 emergencies. However, most of the personnel who were recruited for HM in PR
123 were less competent and ill prepared to deal effectively with the magnitude of the

124 emergency. DPS must have prepared people for the worst case; however, PR was
125 only prepared for a Category I hurricane (GWU, 2018).

126

127 In their analysis of the controversies surrounding the reports of deaths, Santos-
128 Burgoa et al. (2018) concluded that "the lack of a standardized methodology for the
129 analysis of mortality related to the disaster, and provides a point estimate with a
130 relatively narrow CI for excess mortality, this greater degree of certainty helps to
131 move on to the next stage of interventions." This analysis also found that the
132 government's official estimate of 64 deaths from the hurricane on death certificates
133 could contain errors, mainly because many doctors were unfamiliar with the
134 certification protocol, which led to an inadequate monitoring of mortality after the
135 hurricane's consequences.

136
137 **4.- Discusion and conclusion**

138 • Develop alternative means to restore hospital minimum medical operations,
139   prioritizing the data obtained from studies after HM. Plans should account for
140   damage to facilities or medical machinery and the potential failure to deliver
141   supplies or information.

142 • Review all the emergency protocols in communities and schools to ensure
143   that they include immediate and ongoing recovery plans, which agencies can
144   draw on before the onset of disasters. Schools should receive children in
145   stages as soon as possible to begin preventative post-traumatic stress disorder
146   (PTSD) assessments.

147

148 • Review and update all the emergency protocols in communities, hospitals,
149   and schools to ensure that they include immediate and continuous recovery
150   plans, which agencies can utilize before the start of each cyclonic season.

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152 • The author is of the opinion that the direct victims of HM are those who died
153   48 to 72 hours after the impact, whether, whether due to floods,
154   thunderstorms, landslides, gusts of wind, falling trees, etc. Included in this
155   classification are also the victims of the preparation phase for the impact of a
156   tropical storm (storms, hurricanes, etc.) After a few weeks, the cause of
157   victims would be considered indirect and the reasons would have to be
158   evaluated.

159

160 • As can be seen in the analysis, the discrepancy in the number of victims is
161   mainly due to the difference in the period selected in each of the reports.
162   Moreover, various factors that have been analyzed by various researchers

have concentrated on PR; we will list some of the most relevant factors below.

- There is a lack of protocol among national organizations and agencies (e.g., the Centers for Disease Control and Prevention (CDC), PR Department of Public Safety, PR Department of Health (DoH), etc.), international organizations (e.g., the World Health Organization, the World Meteorological Organization, the International Red Cross, etc.), and other agencies dealing with disasters on how to classify direct and indirect deaths.

- 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 (GWU, 2018).

- In his essay on the problem of economic and energy crisis in PR, Onís CM (2018) states that we must address the problem of energy democracy for at least two reasons: (a) "make the unsustainability of our hydrocarbon frenzy feel urgent, and (b) demonstrate that energy transitions must consider the role of energetic colonialism in shaping contemporary realities and how to deal with them, and ultimately root out relationships based on extractivism."

- Several authors such as Rodríguez-Díaz (2018) and Lloréns (2018) have focused their analysis on the devastation caused by HM due to the colonial condition of PR. If something has become evident after the hurricane, in addition to the sociopolitical crisis in PR, it is the ability of the people of PR to overcome adversity, which has worsened since the introduction of PR Oversight Management and Economic Stability Act (PROMESA).

- Finally, poverty and social inequality had existed before the impact of this hurricane; HM was only the trigger for an economic and social crisis. To reduce the vulnerability of PR, it is imperative to develop social capital and foster unity among social classes when facing disasters. These steps will create a stronger nation and help minimize the undermining of the potential development of a mental health crisis (Rodríguez-Díaz, 2018).

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