Association between Stressors after Hurricanes Irma and María and Psychological Distress in Patients with Active Breast and Colorectal Cancer Treatment

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Objective: This study aimed to explore the stressors faced by breast and colorectal cancer patients following Hurricanes Irma and María in Puerto Rico and to evaluate their association with post-hurricane psychological distress.

Methods: A telephone-based survey was conducted with 241 cancer patients (140 with breast cancer and 101 with colorectal cancer) aged ≥40 years, diagnosed at least six months before September 2017, and undergoing treatment at the time of the hurricanes. Data on traumatic stressors (e.g., experiences directly related to life-threatening situations), non-traumatic stressors (e.g., difficulties accessing basic needs), and psychological distress (measured using the Kessler 6-item Psychological Distress Scale) were collected. Poisson regression estimated the prevalence ratio (PR, 95% CI) for psychological distress according to hurricane-related stressors, adjusting for age, cancer type, pre-hurricane preparedness, and social support.

Results: Nearly 25% of participants faced traumatic stressors, 57.5% were exposed to nontraumatic stressors, and 45.6% presented elevated psychological distress. Those who faced traumatic and non-traumatic stressors demonstrated elevated psychological distress compared to their counterparts (PR=1.73, 95% CI=1.36, 2.20; PR=1.69, 95% CI=1.21, 2.35; respectively) after adjusting for age, cancer type, pre-hurricane preparedness, and social support.

Conclusion: Breast and colorectal cancer patients experienced heightened psychological distress due to exposure to various hurricane-related stressors. It is crucial to prioritize an action plan that addresses disaster preparedness, response, and the mental well-being of vulnerable populations like cancer patients to enhance their overall health and resilience.

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Key words: Cancer, Natural disasters, Pre-hurricane preparedness, Hurricane-related stressors, Psychological distress

People with chronic medical conditions, such as cancer, are particularly vulnerable to severe consequences during hurricanes and other natural disasters due to significant disruptions in the delivery of oncology care. These disruptions often result from compromised infrastructure, communication systems, medication access, and patients' medical records (1, 2). In addition to the logistical challenges, disaster events also have a detrimental impact on the psychological well-being of cancer patients, who face heightened psychological distress due to the diagnosis, treatment, and fear of cancer recurrence (3-9). The prevalence of psychological distress varies by cancer type and timing of diagnosis, reaching as high as 52% in some cases (4, 6, 8). Despite few studies have examined racial/ethnic disparities in psychological distress among cancer patients, one study among 370 Hispanic/Latino survivors of adolescent and young adult cancers found that 41% reported moderate or severe psychological distress (10).

Hurricane María, the most devastating and costly hurricane in Puerto Rico's history, led to widespread mortality, devastation, and disruptions across essential services, notably impacting the healthcare system (11-18). Cancer patients who endured Hurricanes Irma and María in Puerto Rico reported heightened levels of psychological distress (19-22), placing them at an elevated risk of medical complications, reduced quality of life, and mortality. These findings highlight the dual challenges faced by cancer patients: the logistical interruptions to care and the emotional toll of surviving a disaster.

While prior research has shown that hurricane-related stressors, both traumatic and non-traumatic, can trigger psychological problems, including depression, post-traumatic stress disorder, and anxiety in the general population (14, 16-18, 23-28), little is known about how such events impact the mental health of cancer patients. This knowledge gap is particularly significant for

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Hispanics in Puerto Rico, a population with unique vulnerabilities and healthcare challenges (19, 21).

As climate change increases the frequency and severity of hurricanes, understanding the impact of these disasters on vulnerable populations, such as cancer patients, is critical for public health planning (20). In Puerto Rico, cultural and socioeconomic factors, including limited healthcare infrastructure and systemic inequities, may amplify the challenges faced by cancer patients during and after disasters, underscoring the importance of this study in addressing these disparities (13, 19-22).

To address this gap, the present study assessed the association between stressors experienced during and after Hurricanes Irma and María and post-hurricane psychological distress among individuals undergoing active treatment for breast and colorectal cancer—the cancers with the highest incidence and mortality rates in Puerto Rico (29). By focusing on this vulnerable population, the study provides essential insights into the intersection of natural disaster experiences and psychological distress within the Hispanic population, particularly in Puerto Rico. These findings can guide healthcare systems in designing disaster preparedness plans that address the unique needs of cancer patients, ensuring continuity of care and psychological support during and after natural disasters.

Materials and Methods

Study design

The present study involved a secondary analysis of data collected for a mixed-methods study to identify barriers, facilitators, and factors associated with disruption and continuation in cancer care in the aftermath of Hurricanes Irma and María in Puerto Rico (19). Eligible participants were patients diagnosed with breast or colorectal cancer six months before September 2017, aged 40 years or older at the time of cancer diagnosis, undergoing active treatment in Puerto Rico before, during, or after the hurricanes, and living and receiving treatment in the archipelago at the time of the event. A total of 401 participants were identified through the Puerto Rico Cancer Registry database. Following permission from their physicians, participants were contacted via mail for screening between December 2019 and March 2021. Among them, 241 patients (140 with breast cancer and 101 with colorectal cancer) met the eligibility criteria for participation in the study. Participants completed a computer-assisted telephone interview conducted by trained interviewers in Spanish, their native language, and received a financial incentive ($20.00) for their participation. The University of Puerto Rico Institutional Review Board approved this study (protocol number 6050222). All participants provided written informed consent prior to participation.

Measures

The primary outcome variable, post-hurricane psychological distress, was measured with the Kessler scale (K6), a six-item screening tool designed to measure non-specific psychological distress in the general population (30, 31). The K6 items are scored on a 5-point scale from 0 (none of the time) to 4 (all of the time), assessing feelings of nervousness, hopelessness, restlessness, depression, perceived effort, and worthlessness experienced in the 30 days preceding the study recruitment period. Scores from the six items were summed to generate a total score ranging from 0 to 24, with higher scores indicating greater psychological distress (Cronbach's $\alpha = 0.84$). Psychological distress was categorized into moderate or high (score ≥ 5) and low (score <5), given that K6 ≥ 5 maximized the sum of sensitivity and specificity values in previous studies (31, 32). The validity of this screening tool is demonstrated across various racial and ethnic groups, including adults residing in Puerto Rico following Hurricane María (14, 31-33).

Experiencing hurricane-related stressors during and six months after the hurricane were assessed using a 17-item checklist specifically tailored to Hurricane María, following the methodology of Galea and colleagues (23). Traumatic stressors included feeling that one's life was in danger, the death of a loved one, being a victim of crime, or having a loved one affected by crime. Non-traumatic stressors assessed challenges associated with physical adversity (e.g., evacuation, displacement), property loss, and difficulties accessing basic needs (e.g., water, fuel, medications). Each exposure to traumatic and nontraumatic stressors was coded as 1 for respondents who experienced the stressor and 0 for those who did not. The total number of affirmative responses to traumatic stressors was summed (possible score range: 0-4) and categorized into either at least one or none. Similarly, the total number of affirmative responses to nontraumatic stressors was summed (possible score range: 0-13) and dichotomized into low (score ≤ 5) and high (score >5) based on its median value. Additionally, the total number of affirmative responses to all stressors was summed (possible score range: 0-17, Cronbach's $\alpha = .70$) and dichotomized into (low: ≤ 5, high: >5) based on its median value. Higher scores indicated greater exposure to hurricane-related stressors.

Covariates of interest study included participants' age (years), educational attainment (high school or less versus college or higher), pre-hurricane preparedness level, and social support. Pre-hurricane preparedness level was defined according to guidelines from the Centers for Disease Control and Prevention (34), emphasizing actions such as seeking shelter, storing food and water for at least three days, possessing essential supplies like flashlights, batteries, a portable radio, cistern, electric generator, and a first aid kit with necessary medications, as well as securing the home (e.g., doors, windows, and roof). Response options for each item were categorized as either yes (1) or no (0), and a total score, ranging from 1 to 8, was calculated by summing all responses. Higher scores indicate greater pre-hurricane preparedness. The scores were then categorized into low (score ≤ 6) or high (score >6) pre-hurricane preparedness based on their median value.

Patients were also asked to self-assess the degree of support received from family, friends, and the community following both hurricanes using a 3-point scale: no support (0), some support (1), and a lot of support (2). The responses were summed, yielding a total support score ranging from 0 to 6 (Cronbach´s $\alpha = 0.68$), where higher scores indicate greater support. Social support received was dichotomized as high (score=6) or low (score <6) based on its median value.

Statistical analysis

Frequency distributions were used to describe baseline characteristics, hurricane-related stressors, and psychological

distress. The chi-square test was employed to compare differences in age, sex, educational attainment, pre-hurricane preparedness, social support, and cancer type according to psychological distress status. Separate Poisson regression models with robust variance errors were fit to evaluate the association between psychological distress status and the categories of traumatic, non-traumatic, and total hurricane-related stressors (35). In sensitivity analyses, we also assessed the associations between psychological distress status and the continuous scores of traumatic, non-traumatic, and total hurricane-related stressors using Poisson regression. Prevalence ratios (PR) and 95% confidence intervals (95% CI) were presented. All models were adjusted for age, sex, cancer type, social support, and pre-hurricane preparedness level. All analyses were performed in Stata 17 (StataCorp LLC, College Station, TX).

Results

The mean age of participants was 60.7±10.3 years; 80.9% were women, and 64.3% had more than high school education (Table 1). Regarding the cancer diagnosis, 58.1% had breast cancer, with only one man diagnosed with this cancer type. Among those diagnosed with colorectal cancer, 44.6% were men. Less than a third reported a high pre-hurricane preparedness, 53.1% reported receiving high social support from family, friends, and community, and nearly 46% reported experiencing high psychological distress following the impact of the hurricanes.

Table 1. Baseline characteristics of study participants exposed to Hurricanes Irma and María (n=241)

Characteristic	Frequency or Mean (SD)	Percent
Age		
Mean (SD)	60.7 (10.3)	-
< 60 years	113	46.9
≥ 60 years	128	53.1
Sex		
Men	46	19.1
Women	195	80.9
Education level		
≤ 12 years	86	35.7
> 12 years	155	64.3
Cancer type		
Colon	101	41.9
Breast	140	58.1
Pre-hurricane preparedness		
Low	173	71.8
High	68	28.2
Social support		
Low	113	46.9
High	128	53.1
Psychological distress		
Low	131	54.4
High	110	45.6

All participants reported experiencing at least one hurricane-related stressor, with 24.5% experiencing at least one traumatic stressor and 57.5% experiencing high non-traumatic stressors (Table 2). The most reported traumatic stressor was feeling that one's life was in danger (21.6%). Conversely, the most reported non-traumatic stressors were sleep disturbances (82.2%) and shortages of fuel (81.7%), water (80.5%), and money (78.8%).

Bivariate analyses showed that elevated psychological distress was significantly more frequent among younger participants, women, and those with low pre-hurricane preparedness, low social support, and a diagnosis of breast cancer compared to their counterparts (Table 3). Poisson regression models showed that those who experienced at least one traumatic stressor had elevated psychological distress compared to their counterparts (PR=1.73, 95% CI=1.36, 2.20) after adjusting for age, sex, cancer type, pre-hurricane preparedness, and social support, the prevalence ratios were slightly attenuated but remained significant (Table 4). Similarly, those who experienced a high number of non-traumatic stressors showed elevated psychological distress compared to their counterparts (PR=1.69, 95% CI=1.21, 2.35). Combining both types, individuals facing a high number of stressors exhibited heightened psychological distress compared to those experiencing fewer stressors (PR=1.95, 95% CI=1.42, 2.68). In sensitivity analyses, the associations between

Table 2. Stressors experienced during and after Hurricanes Irma and María (n=241)

	Frequency	Percent
Traumatic stressors		
Feeling that one's life was in danger	52	21.6
Death of a loved one	10	4.2
Victimized	3	1.2
Loved one victimized	2	0.8
Non-traumatic stressors		
Sleep disturbance	198	82.2
Lack of fuel	197	81.7
Shortage of water	194	80.5
Shortage of money	190	78.8
Damage to home	136	56.4
Shortage of food	105	43.6
Lack of personal hygiene products	82	34.0
Flooding on household	66	27.4
Lack of medications	44	18.3
Household evacuation	32	13.3
Household displacement	16	6.6
Home loss	9	3.7
Vehicle damage	8	3.4
Exposure to traumatic stressors		
No	182	75.5
Yes	59	24.5
Exposure to non-traumatic stressors		
Low	100	42.6
High	135	57.4
Total number of stressors		
Low	128	54.5
High	107	45.5

psychological distress status and the continuous scores of traumatic (PR=1.49, 95% CI=1.24, 1.78), non-traumatic (PR=1.15, 95% CI=1.09, 1.22), and total number of stressors (PR=1.15, 95% CI=1.09, 1.21) were also significant (data not shown).

Table 3. Factors associated with psychological distress after Hurricanes Irma and María (n = 241)*

	Psychological distress		
	Elevated (n=110)	Not elevated (n=131)	P value
Age, years			0.007
<60	62 (54.9)	51 (45.1)	
≥60	48 (37.5)	80 (62.5)	
Sex			<0.001
Women	101 (51.8)	94 (48.2)	
Men	9 (19.6)	37 (80.4)	
Years of education			0.251
≤12	35 (40.7)	51 (59.3)	
>12	75 (48.4)	80 (51.6)	
Hurricane preparedness			0.021
Low	87 (50.3)	86 (49.7)	
High	23 (33.8)	45 (66.2)	
Social support			<0.001
Low	68 (60.2)	45 (39.8)	
High	42 (32.8)	86 (67.2)	
Cancer type			0.017
Breast	73 (52.1)	67 (47.9)	
Colon	37 (36.6)	64 (63.4)	

*Note: Values in the table represent frequency (n) and percentage (%), with percentages computed using row totals.

Table 4. Crude and adjusted prevalence ratios and 95% confidence intervals for psychological distress and categorical and continuous measures of hurricane-related stressors (n=241)

	Psychological distress	Crude PR (95% CI)	Adjusted PR* (95% CI)
	n (%)		
Traumatic stressor			
No	67 (36.8)	1.00	1.00
Yes	43 (72.9)	1.98 (1.55, 2.53)	1.73 (1.36, 2.20)
Non-traumatic stressor			
Low	29 (29.0)	1.00	1.00
High	77 (57.0)	1.97 (1.40, 2.76)	1.69 (1.21, 2.35)
Total stressors			
Low	36 (28.1)	1.00	1.00
High	70 (65.4)	2.33 (1.71, 3.17)	1.95 (1.42, 2.68)

*Note: Values in the second column of the table represent frequency (n) and percentage (%), with percentages computed using row totals.

**Model adjusted for age, sex, cancer type, hurricane preparedness, and social support.

Discussion

The findings of this study underscore the vulnerability of cancer patients to mental health conditions, particularly psychological distress, in the face of natural disasters such as hurricanes. Our study reveals that exposure to hurricane-related stressors was widespread among breast and colorectal cancer patients included in the study. Moreover, both traumatic stressors, such as feeling that life was in danger, and non-traumatic stressors, like sleep disturbances and shortages of fuel, water, and money, were frequent and associated with heightened psychological distress among patients.

These results aligned with previous research conducted in Puerto Rico, which indicated that water and fuel shortages, along with financial problems, were frequent stressors experienced by cancer patients and survivors (19-22) and adults of the general population (13, 15-18). A qualitative study examining the treatment experiences of breast and colorectal cancer patients revealed that a significant stressor was the prolonged lack of electricity, water, and fuel, with some patients expressing that the stressors resulting from the disaster were even more daunting (19). However, our findings contrast with two studies by Galea and colleagues (23, 24) conducted in the general population of the New Orleans metro area, which identified housing adversity and property loss (71.7% and 70.2%, respectively) as primary stressors following Hurricane Katrina. The intensity and category of both hurricanes, as well as their impact on lives, were different. While Hurricane Katrina caused a significant proportion of deaths immediately during the hurricane, with many people drowning due to failing levees and inundated homes, most deaths from Hurricane María occurred in the aftermath, as the storm disrupted the archipelago's infrastructure and essential services.

The study also showed that cancer patients who encountered both traumatic and non-traumatic stressors experienced heightened psychological distress. Although studies examining the effect of hurricane-related stressors on mental health exclusively on cancer patients are limited, particularly among Hispanics, findings from disaster research have consistently indicated that hurricane-related stressors are associated with adverse mental health outcomes in the general population (14, 16-18, 23-28). For instance, Galea and colleagues found that stressors resulting from Hurricane Katrina played a significant role in the increased prevalence of anxiety and mood disorders (23, 24). Similar patterns were observed among individuals displaced by Hurricanes Sandy and Harvey (25), as well as among adults affected by Hurricane Ike (26) and the Florida hurricanes Charley, Frances, Ivan, and Jeanne (27). Moreover, three studies conducted among adults in Puerto Rico also showed a positive association between greater exposure to adverse hurricane-related experiences and symptoms of depression, anxiety, and PTSD (14, 17, 18). Similar effects of Hurricane María on mental health were observed among youths in Puerto Rico (16) and survivors who relocated to the US mainland (36, 37). These findings highlight the importance of monitoring psychological distress outcomes in vulnerable populations and integrating psychological support into the comprehensive treatment of cancer patients (38-41).

It is worth mentioning that pre-hurricane preparedness emerged as a significant factor associated with psychological distress among patients. Those reporting lower preparedness experienced heightened distress, aligning with findings from previous investigations in Puerto Rico (15, 42). For example, one study noted that reduced preparedness was associated with increased negative effects of hurricanes on overall health, and to some extent, non-communicable diseases (15). These findings underscore the importance of educating and preparing cancer patients for natural disasters, emphasizing the need for comprehensive action plans before, during, and after such events. They also highlight the crucial role of healthcare providers, government agencies, and all stakeholders involved in cancer patient care in educating and equipping patients to develop comprehensive action plans for disaster preparedness (43-45).

While interpreting the results of this study, several limitations should be considered. First, psychological distress was evaluated for approximately two years following exposure to hurricanes, during which the cancer diagnosis, other life events, and environmental stressors may have influenced the psychological distress scores. Second, while the Kessler scale has demonstrated the ability to discriminate DSM-IV cases from non-cases (30), it does not provide the depth of assessment achievable through clinical interviews. Third, the self-reported nature of the data may have introduced some bias, which may affect the reliability of the findings. Participants could have overestimated or underestimated their psychological distress levels or their exposure to hurricane-related stressors. While hurricane-related stressors were assessed, the study may not have captured detailed data on specific situations that led to participants feeling that their lives were in danger or other significant stressors or protective factors that could have influenced psychological outcomes. Finally, important factors such as disease stage, comorbidities, access to mental health services, and pre-hurricane psychological history—critical for a comprehensive understanding of the associations of interest—were unavailable for the current analysis. Despite these limitations, the study adds valuable insights to the literature by highlighting the multitude of stressors and high levels of psychological distress experienced by cancer patients in Puerto Rico.

Conclusions

The study showed an association between hurricane-related stressors and psychological distress among cancer patients. Strengthening emergency protocols is crucial to safeguard this vulnerable population and ensure access to essential needs, medications, treatment, and psychological support. Future research endeavors should aim to include a larger cohort of patients to comprehensively assess the prevalence of psychological distress and other mental disorders in the presence of stressors and explore factors contributing to cancer patients' resilience and well-being post-natural disaster. In conclusion, our study highlights the critical need for integrating psychological support into the care of cancer patients, particularly in the context of natural disasters. Healthcare providers and government agencies must work collaboratively to ensure that patients are adequately prepared to navigate the challenges posed by emergencies effectively.

Resumen

Objetivo: Este estudio describió los estresores experimentados por pacientes con cáncer de seno y colorrectal luego del paso de los huracanes Irma y María y evaluó las asociaciones con el distrés psicológico posterior a los eventos. Métodos: Se administró una encuesta telefónica a 241 pacientes con cáncer (seno: 140; colorrectal: 101) de 40 años o más, diagnosticados al menos seis meses antes de septiembre 2017 y recibiendo tratamiento al momento de los huracanes. Se obtuvo información sobre estresores traumáticos (ej. situaciones que amenazan la vida) y no traumáticos (ej. dificultades para acceder a las necesidades básicas) y distrés psicológico (Escala de 6 ítems de Kessler). Se utilizó la regresión de Poisson para estimar la razón de prevalencias (RP, IC 95%) para distrés psicológico en función de los estresores, ajustando por edad, tipo de cáncer, preparación para el huracán y apoyo social. Resultados: Aproximadamente 25% de los participantes experimentaron estresores traumáticos, 57.5% experimentó estresores no traumáticos y 45.6% presentó distrés psicológico elevado. Los participantes que enfrentaron estresores traumáticos y no traumáticos tuvieron mayor distrés psicológico en comparación con sus contrapartes (RP=1.73, IC 95%=1.36, 2.20; RP=1.69, IC 95%=1.21, 2.35; respectivamente) luego de ajustar por edad, tipo de cáncer, preparación para el huracán y apoyo social. Conclusión: Los pacientes con cáncer de mama y colorrectal experimentaron múltiples estresores relacionados al huracán, resultando en distrés psicológico elevado. La priorización de un plan de acción durante un huracán que considere el bienestar mental de los pacientes con cáncer es esencial para su salud y resiliencia.

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