Emergency Department Burden of Mental Health and Substance Misuse After Hurricane Helene: Insights from Rural Appalachia

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Structured Abstract

Objectives: To quantify temporal changes in mental health and substance use emergency department (ED) utilization following Hurricane Helene (09/26) in Western North Carolina (WNC) and identify disparities across vulnerable populations.
Methods: A cross-sectional analysis was conducted using ED surveillance data from WNC counties. Incidence rate ratios (IRRs) with 95% confidence intervals (CIs) were calculated by comparing three recovery periods (immediate, early, short-term) with their corresponding 2023 dates.
Results: Alcohol-related visits increased across all periods (immediate: IRR=1.35, 95% CI: 1.14–1.60; early: IRR=1.47, 95% CI: 1.31–1.65; short-term: IRR=1.36, 95% CI: 1.21–1.52). Anxiety disorders increased across all periods, mood disorders increased during early recovery, schizophrenia visits increased during short-term recovery (IRR=1.19, 95% CI: 1.02–1.40), and opioid-related visits showed marginally significant increases during short-term recovery (IRR=1.21, 95% CI: 1.00–1.45). Counties with higher elderly populations showed amplified alcohol and anxiety effects; counties with higher uninsured/Medicaid rates showed lower utilization.
Conclusions: Helene was associated with sustained increases in alcohol and anxiety-related ED visits. Disparities across age and insurance status highlight differential vulnerability and access patterns requiring targeted interventions.

Introduction
Hurricane Helene caused unprecedented destruction in the Appalachian region of Western North Carolina (WNC) in September 2024, resulting in 108 fatalities and catastrophic infrastructure damage that isolated entire communities.[1] Even before Helene, the Appalachian region faced unique challenges, including persistent socioeconomic and health disparities, elevated youth suicide risk and substance misuse, and limited access to behavioral health services.[2–4] Previous hurricanes and extreme floods across the Southeast demonstrate sustained increases in depression, anxiety, and substance use disorder,[5–6] yet little is known about the mental health and substance use impacts of disasters in rural Appalachia, an inland location with pronounced health disparities.

Objective
To quantify temporal changes in mental health and substance use ED utilization following Hurricane Helene in Western North Carolina and identify disparities across vulnerable populations.

Methods
A cross-sectional analysis was conducted using North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) emergency department (ED) surveillance data. ED visits were analyzed for residents of 19 WNC counties most affected by Hurricane Helene.[7] Outcomes were identified using ICD-10 codes in any diagnostic position (primary or secondary) and included: mental health (ICD-10: F01–F99) and substance misuse disorder (ICD-10: F10–F19) with associated sub-disorders (Supplemental Table 1).

Recovery periods were based on Helene's September 26, 2024, landfall and regional recovery context: *immediate impact* (September 26-October 10, 2024; 2 weeks post-landfall), *early recovery* (October 11-November 15, 2024; weeks 3-7), and *short-term recovery* (November 16-December 31, 2024; weeks 8-14). The reference period spanned the corresponding calendar dates in 2023 (September 26–December 31). We calculated incidence rate ratios (IRRs) comparing recovery periods to the baseline using Poisson regression, with negative binomial models for overdispersed data (dispersion > 2.0). Models included

county-level demographics derived from the American Community Survey (ACS) (proportions aged 65+, female, Black, Hispanic, and uninsured/Medicaid), temporal controls (month and day of the week), and log(person-time) as an offset. Effect modification was assessed using individual-level patient characteristics (age, sex, insurance status) and county-level measures (rurality, derived from ACS data), employing interaction terms with counties dichotomized at median values. Significance was set at $p<0.05$. Analyses used R version 4.2.3.

Results

A total of 24,981 mental health ED visits (including 17,762 substance use visits) were analyzed across both periods. The 2024 post-hurricane period included 12,834 visits compared with 12,147 during the 2023 reference period (Supplemental Table 2).

Main Effects

Compared to 2023, alcohol-related visits increased across all post-Helene periods (immediate: IRR=1.35, 95% CI: 1.14–1.60; early: IRR=1.47, 95% CI: 1.31–1.65; short-term: IRR=1.36, 95% CI: 1.21–1.52). Anxiety disorders increased across all periods (immediate: IRR=1.15, 95% CI: 1.02–1.28; early: IRR=1.12, 95% CI: 1.03–1.21; short-term: IRR=1.17, 95% CI: 1.09–1.26). Mood disorders increased during early recovery (IRR = 1.13, 95% CI: 1.04–1.23). Schizophrenia visits increased significantly during short-term recovery (IRR=1.19, 95% CI: 1.02-1.40), while opioid-related visits showed elevated point estimates that reached marginal significance (IRR=1.21, 95% CI: 1.00-1.45). Overall mental health, depression, PTSD, suicide-related, and cannabis-related visits showed no significant changes (Figure 1).

Effect Modification

Age: Counties with higher elderly ED patient populations (≥31.8% aged 65+) experienced greater alcohol impacts across all periods (immediate: IRR=1.79 vs. 0.96; early: IRR=1.98 vs. 1.21; short-term: IRR=1.85 vs. 1.18, interaction $p<0.001$) and amplified anxiety effects (immediate: IRR=1.42 vs. 0.82, interaction $p<0.001$).

Insurance: Counties with higher uninsured/Medicaid rates (≥31.7%) showed lower post-hurricane utilization compared to counties with lower rates for alcohol (immediate: IRR=1.15 vs. 1.59, interaction $p=0.048$), anxiety (IRR=0.99 vs. 1.31, interaction $p=0.010$), and suicide-related visits (early: IRR=0.87 vs. 1.41, interaction $p=0.007$).

Rurality: Rural counties experienced greater increases in mood disorders during early recovery (IRR = 1.38 vs. 1.07, interaction $p = 0.001$).

Race/Ethnicity: Counties with higher minority ED patient populations showed smaller alcohol increases (early: IRR=1.40 vs. 1.81, interaction $p=0.037$; short-term: IRR=1.29 vs. 1.75, interaction $p=0.009$) and mood disorder increases (early: IRR=1.09 vs. 1.33, interaction $p=0.023$), but larger opioid increases during immediate impact (IRR=1.55 vs. 0.88, interaction $p=0.039$).

Sex: No significant modification was found.

Discussion

This analysis reveals sustained increases in alcohol and anxiety-related ED visits following Hurricane Helene, with marginally significant elevations in opioid-related and schizophrenia visits during short-term recovery. The absence of increases in overall mental health, PTSD, depression, and suicide-related visits, contrary to disaster literature,[5-6] may reflect infrastructure-related access barriers rather than actual reduced morbidity. Widespread road closures and bridge failures that isolated entire communities likely prevented care-seeking for non-acute conditions,[1,7] while competing survival priorities delayed mental health treatment.

Disparities across county-level characteristics reveal differential vulnerability and access patterns. Counties with higher elderly ED populations experienced amplified alcohol and anxiety increases.

In contrast, counties with higher uninsured/Medicaid rates had lower post-hurricane utilization than those with lower rates, suggesting that disaster-imposed access barriers (e.g., transportation and infrastructure damage) may have compounded otherwise typical utilization patterns.[8] Rural counties demonstrated greater mood disorder increases, and counties with higher minority populations showed smaller alcohol increases but larger opioid increases, indicating complex interactions between disaster exposure, healthcare access, housing instability, and substance use patterns requiring further investigation.

ED visits represent only the most severe, acute presentations requiring emergency care, substantially underestimating the population burden of mental health and substance use impacts. Less severe cases, managed in primary care or outpatient settings, or left untreated, are not captured in this surveillance system. Potential biases include selection bias due to access barriers and cultural factors, information bias related to ICD-10 coding, and confounding by secular trends (e.g., changes in regional insurance networks). Future research can leverage Medicaid claims data to track shifts in utilization across care settings, including primary care and outpatient behavioral health services, or employ multilevel designs that incorporate disaster impact gradients across affected and control groups to strengthen causal inference. Despite these limitations, the observed increases in severe presentations signal a broader crisis requiring multi-level surveillance approaches beyond emergency care to capture the full spectrum of disaster mental health impacts.

Public Health Implications

Public health officials should anticipate evolving mental health needs over the recovery period, as the SAMHSA community disaster recovery model suggests these early increases may represent only the initial phase of behavioral health impacts, with subsequent surges in depression expected 6-9 months post-Helene during the disillusionment phase and a potential rise in PTSD prevalence 18 - 24 months later as longer-term recovery challenges emerge.[9-10] As disasters are becoming more frequent, practitioners should be aware of the recurring expressions of trauma among first responders, local officials, and community members, and avoid re-traumatization by incorporating trauma-informed practices in recovery.[11] Given the disproportionate impacts observed among elderly and rural populations, strategies such as community-based peer support and targeted outreach to high-risk groups will be crucial to reducing unmet needs.

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Contributions
M. M. Sugg conceptualized the study, conducted the statistical analyses, and drafted the manuscript. S. C. Ryan assisted with data processing and reviewed the manuscript. A. Preaux, C. Quattro, and B. Alexander-Eitzman critically reviewed the manuscript and provided feedback. M. Thompson and A. Hege obtained funding and critically reviewed the manuscript. J. D. Runkle contributed to the study methodology and critically reviewed the manuscript. All authors approved the final version of the manuscript.

Conflicts of Interest
The authors have no conflicts of interest to disclose

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Figure 1. Incidence Rate Ratios (IRR) with 95% confidence intervals for mental health and substance use emergency department visits across three recovery periods following Hurricane Helene (2024) compared to 2023. Dark gray circles = Immediate Impact (September 26-October 10, 2024); Light gray circles = Early Recovery (October 11-November 15, 2024); Gray circles = Short-term Recovery (November 16-December 31, 2024). We analyzed ED visits for residents of 19 WNC counties most affected by Hurricane Helene: Alleghany, Ashe, Avery, Buncombe, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Swain, Transylvania, Watauga, and Yancey