

# Monitoring Public Health During the 2023 Maui Wildfire Using Google Search Trends

Jim P. Stimpson, PhD<sup>1</sup>, Ketan Tamirisa<sup>2</sup>, Joseph Keawe'aimoku Kaholokula, PhD<sup>3</sup>, Alexander N Ortega, PhD<sup>4</sup>

<sup>1</sup> Department of Health Economics, Systems, and Policy, The University of Texas Southwestern Medical Center, <sup>2</sup> Washington University in St. Louis, <sup>3</sup> Department of Native Hawaiian Health, University of Hawai'i at Mānoa, <sup>4</sup> Thompson School of Social Work & Public Health, University of Hawai'i at Mānoa

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## Abstract

*Wildfires pose acute and long-term threats to public health. This study used Google Trends to assess real-time public interest in health-related topics before, during and after the August 2023 Maui wildfires. Search terms were grouped into four categories: health care access, physical health, mental health, and help-seeking behavior. Daily search interest scores were aggregated and analyzed across three periods: pre-wildfire, wildfire, and post-wildfire. Findings revealed that physical health and health care access search interest remained relatively stable throughout the study period, with no measurable surge during or after the wildfire event. This lack of increase may reflect reliance on pre-established care plans among individuals with chronic respiratory conditions, in-person care-seeking, or prioritization of immediate safety over online information-seeking. In contrast, mental health-related searches rose substantially in the weeks following the wildfire, while help-seeking searches showed episodic fluctuations with notable peaks post-disaster. These findings illustrate how online search patterns can reveal evolving public health priorities in the wake of disasters. Google Trends offers a timely and scalable tool to monitor evolving health concerns during disasters, complementing traditional surveillance systems. Integrating search data into disaster response planning could enhance resource allocation, guide communication strategies, and ensure timely support for emerging needs, particularly mental health recovery following wildfire events.*

## Introduction

In August 2023, the Hawaiian island of Maui experienced a devastating wildfire that led to loss of life, destruction of homes and businesses, and widespread disruption. Wildfires pose serious public health threats, contributing to direct injuries and exacerbating physical and mental health conditions.<sup>1,2</sup> These events may also influence health-seeking behaviors, prompting individuals to seek information about symptoms, treatment options, or health care access.<sup>3</sup>

<sup>4</sup> Recent work found significant increases in suicides, overdoses, depressive symptoms, and heightened use of crisis counseling and behavioral health services in the weeks following the Maui wildfires.<sup>4-6</sup> Together, these studies suggest that mental health consequences may be among the most immediate and pronounced health impacts of major wildfires, underscoring the need for timely surveillance and focused interventions.

Moreover, such crises often unfold rapidly, outpacing traditional data collection methods such as hospital records or epidemiological reports, which may lag for weeks or months. Consequently, Google Trends (Google, LLC, Mountain View, CA), which provides publicly available, anonymized data on search query volume, has gained traction as a near real-time tool for monitoring population-level information needs and concerns.<sup>7</sup> These search patterns can reflect immediate community responses, disruptions in care, or calls for help, making Google Trends a powerful information surveillance or "infoveillance" tool.<sup>8-11</sup> The most prominent application, Google Flu Trends, was initially lauded for anticipating seasonal influenza spikes, though it later revealed notable forecasting errors, illustrating the importance of validation and cautious interpretation.<sup>12,13</sup> Search trends have also been used to monitor mental health-related concerns during crises, such as fluctuating searches for anxiety and depression during the COVID-19 pandemic, which were found to correlate with self-reported therapy use and other indicators of treatment need.<sup>14-18</sup> Additionally, emerging studies have demonstrated how Google Trends can reflect public reactions to geohazards like earthquakes and hurricanes, with search activity spiking in affected regions and aligning with media coverage and disaster timelines.<sup>19</sup> Similarly, social media platforms have increasingly been leveraged for disaster surveillance and research. For instance, analyses of Twitter and Facebook data have tracked public concerns, information diffusion, and behavioral responses during crises.<sup>20-24</sup> In another example, a recent analysis of TikTok posts spanning the crisis, immediate aftermath, and long-term recovery phases of the Maui wildfires revealed that the platform played a central role in public information exchange and emotional support.<sup>25</sup> Posts shared during the active wildfire period drew particularly high engagement demonstrating TikTok's importance as a real-time communication channel. These findings underscore how digital tools offer complementary real-time insights into evolving public concerns during disasters, supporting more responsive public health surveillance.

This study used Google Trends search data to examine health-related search interest, including physical and mental health, health care access, and help-seeking before, during, and after the August 2023 wildfires in Hawai'i. While previous research has documented increased mental health needs following disasters, including the Maui wildfires, much of this evidence comes from clinical or administrative

data that become available only after substantial delays, limiting their usefulness for rapid response. In contrast, Google Trends provides a near real-time, population-level signal of information-seeking behavior related to physical health, mental health, health care access, and help-seeking. These data can reveal whether changes in public interest and concern are driven by symptom onset, service disruption, or heightened awareness that may not yet be visible in health care utilization statistics. By examining search trends across the disaster timeline, this study aimed to identify emerging health needs, potential barriers to care, and patterns of help-seeking that could inform response strategies and resource allocation in the critical days and weeks after a major wildfire. Such insights can help public health agencies anticipate demand, tailor risk communication, and deploy services more effectively during future disasters.

## Methods

Google Trends data were collected for the state of Hawai‘i using the web search option and covered the period from June 1, 2023, to December 31, 2023. The analysis focused on health-related information-seeking behaviors potentially associated with the August 2023 wildfires. Since Google Trends does not provide individual-level data, the population included in this analysis comprises all internet users in Hawai‘i who conducted searches using selected health-related terms during the study period. Google estimates user location primarily through IP address, GPS data for mobile users, and account settings. However, data are typically only available at the state level or for large metropolitan areas. In Hawai‘i the only metropolitan area available for Google Trends data is Honolulu, likely because it meets Google’s minimum search-volume threshold to preserve user anonymity. Maui and other regions do not meet this threshold, preventing access to their localized data. Therefore, Hawai‘i was used as the geographic unit for analysis.

Because Google Trends does not report raw search counts, the exact number of searches underlying each trend is unknown.<sup>26,27</sup> Google Trends suppresses data when search volume is too low, which is a privacy threshold mechanism that maps sparse data to zeros even for regions or terms that were previously stable. These constraints mean that searches cannot be disaggregated to Maui County and that the precise number of users represented is not measurable, which is noted as a limitation in this study.

Search items were organized into 4 thematic categories: health care access (eg, “emergency room,” “hospital near me”), physical health (eg, “asthma,” “burn treatment”), mental health (eg, “anxiety,” “depression”), and help-seeking behavior (eg, “counseling,” “talk to someone”). Search terms shown in [Table 1](#) were developed through a combination of expert consensus, review of previous infodemiology studies, and preliminary searches in Google Trends to assess term relevance during the wildfire time period. Search term categorization was conducted independently by 2 study authors. Each author reviewed a primary list of search items and assigned them to 1 of the 4 thematic cat-

egories based on prior literature and conceptual relevance. Discrepancies and categorization were resolved through discussion with a third author and consensus was reached on final groupings.

Google Trends normalizes search interest on a 0–100 scale, with 100 representing peak popularity during the selected time and region. It does not provide the absolute number of searches. Rather, each value is normalized against all Google search activity in that location and time period, which helps control for population size and overall internet use. However, this normalization depends on the chosen query, time frame, language, and geographic area, which means values are not directly comparable across regions or search terms, as each index is relative to its own search environment.<sup>27</sup>

To capture overall public concern within each category, daily search interest scores were aggregated by summing the individual keyword scores. To reduce day-to-day volatility and facilitate comparison over time, daily aggregated search interest scores were converted to weekly averages. Specifically, the daily summed scores for each category were first totaled across the seven days of each week, then divided by the number of days with data available for that week. To preserve Google Trends’ standardized 0–100 scaling, these weekly sums were further divided by the number of included search terms in the category, ensuring that resulting weekly values reflected the average relative search interest per term while maintaining comparability across weeks and categories.

To examine changes in search interest before, during, and after the 2023 Maui wildfires, 3 temporal phases were defined: pre-wildfire (calendar year weeks 27–31), wildfire (weeks 32–33), and post-wildfire (weeks 34–39). The wildfire period was defined using the official timeline of the 2023 Maui wildfires, which identifies August 8–19, 2023 (calendar weeks 32–33), as the main emergency period when active burning, evacuations, and immediate health impacts were most acute.<sup>28</sup> Although some fires were not fully contained until September 28, this analysis focused on the concentrated emergency period to minimize potential confounding effects of unrelated events before and after the disaster.

A line graph was generated using Microsoft Excel for Mac Version 16.1(Microsoft Corporation, Redmond, WA) to visualize temporal trends and identify potential spikes in search interest corresponding to key dates during the wildfire event. Descriptive statistics, including means and standard deviations, were calculated for each category by disaster period. In addition, one-way analysis of variance (ANOVA) was used to compare mean weekly search interest across the three phases for each category. Effect sizes were calculated using eta-squared ( $\eta^2$ ) to assess the proportion of variance explained by phase. Values of .01, .06, and .14 for  $\eta^2$  were considered as benchmarks for small, medium, and large effects, respectively.<sup>29,30</sup> As a sensitivity analysis, the analysis was repeated using a broader time window (weeks 22–52) with the same wildfire definition (weeks 32–33), which increased the number of pre- and post-wildfire observations but introduced greater temporal imbalance. Sta-

Table 1. Components of Health-Related Google Search Term Categories: State of Hawai'i, June 1, 2023, to December 31, 2023

Health Care Access	Physical Health	Mental and Cognitive Health	Help-Seeking Behavior
emergency room	asthma	anxiety	counseling
urgent care	smoke	can't sleep	mental health hotline
hospital near me	difficulty breathing	depression	talk to someone
	inhaler	difficulty concentrating	
	burn	dizziness	
	burn treatment	headache	
	urgent care for burns	insomnia	
		mental fatigue	
		mental health	
		migraine	
		nausea	
		panic attacks	
		post-traumatic stress	
		PTSD	
		sadness	
		stress	

stistical analyses were conducted using Stata 19.5 software (StataCorp LLC, College Station, TX).

## Results

**Figure 1** displays weekly average Google Trends scores from week 22 to week 52 of 2023 for 4 search categories: health care access, physical health, mental health, and help-seeking behavior. The Hawai'i wildfire period (weeks 32–33) is marked by vertical dashed lines. Health care access searches consistently had the highest interest, ranging from 12 to 32, with a notable peak in week 52. Physical health searches remained minimal throughout ranging from 0 to 5. Mental health searches showed moderate variation across the study period, ranging from 5–12, with peaks post-wildfire observed in weeks 35, 41, and 44. Help-seeking behavior searches ranged from 0 to 17, with peaks post-wildfire observed in weeks 36, 40, and 43.

As shown in **Table 2**, mental health search interest showed a statistically significant difference across phases ( $P = .02$ ), with a very large effect size ( $\eta^2 = .56$ ). Mean search interest for mental health declined during the wildfire phase (mean = 5.67) compared with both the pre-wildfire (mean = 8.56) and post-wildfire periods (mean = 9.11). Health care access showed a large effect size ( $\eta^2 = .27$ ) but did not reach statistical significance ( $P = .24$ ). Physical health showed a small effect size ( $\eta^2 = .09$ ) and was not statistically significant ( $P = .56$ ). Help-seeking behavior showed a medium effect size ( $\eta^2 = .05$ ) and was not statistically significant ( $P = .78$ ).

## Discussion

Google Trends data from the August 2023 Maui wildfires reveal distinct temporal shifts in internet searches, with stable interest in physical health and health care access topics, episodic peaks in help-seeking, and a significant increase in mental health-related searches in the weeks following the disaster. Contrary to expectations, searches related to physical health symptoms did not spike during or immediately after the wildfire period despite well-documented smoke exposure in Maui.<sup>31</sup> This absence of a visible surge in online interest does not necessarily indicate a lack of symptoms; rather, individuals with chronic respiratory conditions such as asthma or COPD may have relied on pre-established action plans or sought care directly through urgent care centers, clinicians, or emergency departments, reducing the need for online searches. Health care access searches also showed no significant increases and dipped only slightly during the wildfire period. Together, these patterns suggest that physical health concerns, including respiratory issues and potential disruptions in care, may not have driven substantial online search activity during the acute phase of the disaster, possibly because people relied on existing care pathways or prioritized immediate safety over information-seeking.

In contrast, mental health-related searches were consistently among the highest categories and showed marked increases in the weeks following the wildfire. This pattern is consistent with prior research showing that psychological distress often intensifies after traumatic events, underscoring the need for sustained access to mental health services well into the recovery phase.<sup>32–34</sup> This observed trend may suggest potential barriers to in-person services or limited public awareness of available resources.<sup>4</sup>

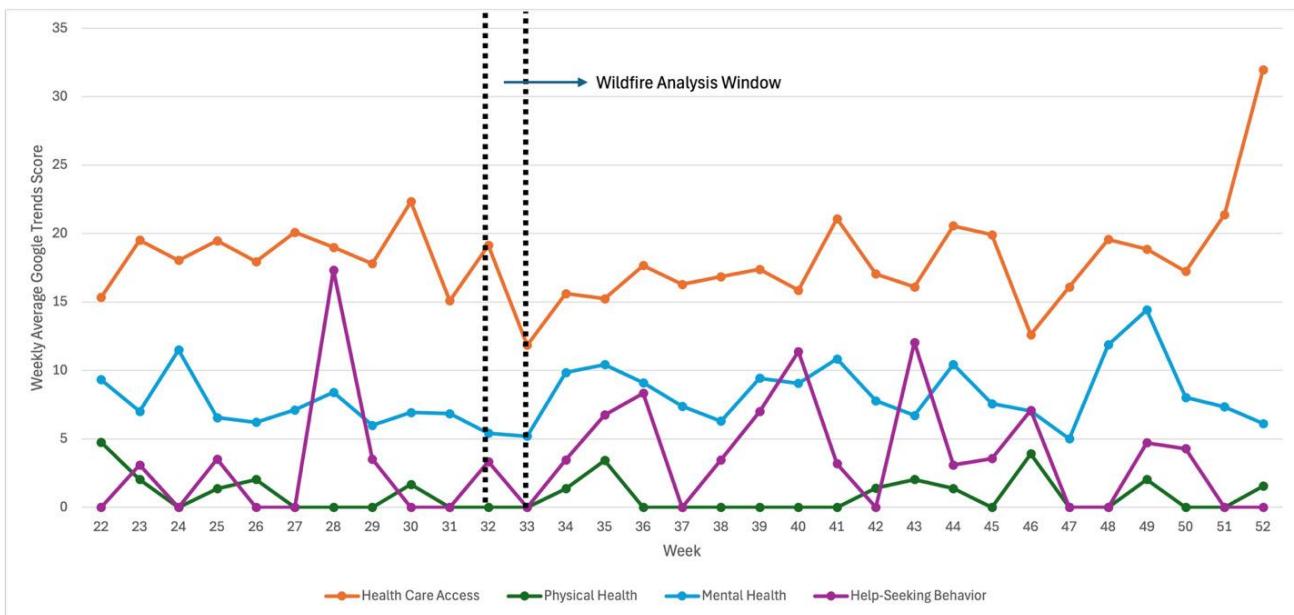


Figure 1. Weekly Average Google Search Trend Score by Health-Related Category in the State of Hawai'i from June 1, 2023 (week 22) to December 31, 2023 (week 52)

Table 2. Mean and Standard Deviation (SD) of Daily Google Search Interest by Health-Related Category and Time Period, State of Hawai'i, July 2, 2023 – September 30, 2023, with Results of One-Way ANOVA and Effect Sizes

Category <sup>a</sup>	Pre-Wildfire <sup>b</sup> , mean (SD)	Wildfire, mean (SD)	Post-Wildfire, mean (SD)	One-Way ANOVA P-value	Eta-squared $\eta^2$ (effect size) <sup>c</sup>
Health Care Access	17.56 (2.56)	16.63 (3.35)	18.57 (3.50)	.24	.27
Physical Health	1.33 (1.65)	1.88 (2.10)	1.00 (1.15)	.56	.09
Mental Health	8.56 (1.07)	5.67 (1.15)	9.11 (1.05)	.02	.56
Help-Seeking Behavior	3.89 (4.91)	3.50 (1.00)	2.78 (2.17)	.78	.05

Notes:

<sup>a</sup>Health-related categories are based on aggregated daily Google search interest scores (0–100 scale) within each category: health care access, physical health, mental health, and help-seeking behavior.

<sup>b</sup>Time periods are defined as: pre-wildfire = weeks 27–31 (July 2 – August 5, 2023); wildfire = weeks 32–33 (August 6 – August 19, 2023); post-wildfire = weeks 34–39 (August 20 – September 30, 2023).

<sup>c</sup> $\eta^2$  (eta-squared) is reported as a measure of effect size, interpreted as: small (.01), medium (.06), large (.14) following Cohen's guidelines.

Several prior studies have explored the utility of Google Trends for public health surveillance across diverse illnesses, including influenza, COVID-19, environmental exposures, and mental health.<sup>8–12,14–17</sup> This study adds to a growing body of work demonstrating the value and limitations of Google Trends for public health surveillance.<sup>26,27</sup> Since the discontinuation of Google Flu Trends, methodological refinements have improved the use of search data when triangulated with traditional epidemiologic indicators.<sup>13,18</sup> While these prior studies have shown that search behavior can capture acute concerns such as evacuation and mental health needs, relatively less is known about how these behaviors evolve across the full disaster timeline or how they can complement existing data sources. This study illustrates how thematic analysis of search queries can illuminate shifting public priorities during and after a wildfire, providing a window into emerging health needs

and communication gaps. By highlighting these dynamics, the findings demonstrate the potential for internet search data to strengthen disaster preparedness and facilitate more responsive public health communication.

## Limitations

This study has several limitations. First, Google Trends provides only relative, not absolute-search interest, and does not capture clinical outcomes or care seeking behaviors. Aggregating keyword scores allowed the team to assess broader topic-level attention; however, this method introduces interpretive limitations. Second, this study used Google Trends data from the state of Hawai'i because more granular data at the county or city level were not available. Consequently, the results are disproportionately weighted toward O'ahu, the island on which the majority of Hawai'i's

residents live, limiting the generalizability of findings for the Maui population. Third, online search behavior may not represent all populations, particularly those with limited internet access or digital literacy challenges, or strong reliance on in-person care may be underrepresented in this data set. Fourth, although the authors observed heightened mental-health-related search activity in the post-wildfire period, the retrospective design of the study precludes any claim that these observations influenced resource allocation. The analysis was conducted after the event and thus could not inform real-time decision-making. Future investigations designed for prospective monitoring, integrating real-time search analytics with health-system planning, would be needed to evaluate whether Google Trends can serve as an actionable tool for allocating resources during crises. Finally, the increase in mental-health searches likely reflects a broader shift toward emotional recovery after trauma, whereas physical-health concerns among individuals with chronic pulmonary conditions may have been addressed through established care pathways that did not generate additional online queries.

## Conclusion

Overall, findings indicate that the wildfire was accompanied by heightened online attention to mental health, underscoring the unique role of disasters in shaping public information needs beyond physical health concerns. This pattern may reflect the acute, immediate nature of physical health and access needs that are often addressed offline

through established care plans or emergency services. In contrast, mental health needs may emerge more gradually and be shaped by stigma, leading individuals to seek information online.<sup>35-37</sup> These findings highlight the potential value of Google Trends as a complementary tool for real-time public health surveillance. While the data alone are insufficient to guide immediate disaster response, search trends can provide early signals of shifting public concerns, particularly in the post-disaster phase, especially when integrated with clinical data, environmental indicators, and social media data. As digital surveillance methods continue to evolve, incorporating such behavior into multi-source monitoring systems may enhance situational awareness and guide more responsive, data-informed public health initiatives during and after natural disasters, such as wildfires.

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## ***Conflict of Interest and Disclosures***

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