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DATA NOTE

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Methods for integrating public datasets: insights from youth disaster mental health research

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ABSTRACT

Introduction: Weather-related disasters pose significant risks to youth mental health. Exposure to multiple disasters is becoming more common; however, the effects of such exposure remain understudied. This study demonstrates the application of integrative data approaches and FAIR (Findable, Accessible, Interoperable, Reusable) data principles to evaluate the relationship between cumulative disaster exposure and youth depression and suicidality in the United States, taking into account contextual factors across levels of social ecology.

Methods: We combined data from five public sources, including the Youth Risk Behavior Surveillance System (YRBS), Federal Emergency Management Agency (FEMA), United States Census Bureau, Center for Homeland Defense and Security School Shooting Safety Compendium, and Global Terrorism Database. The integrative dataset included 415,701 youth from 37 districts across the United States who completed the YRBS between 1999 and 2021. The YRBS served as the core dataset.

Results: This data note highlights strategies for harmonizing diverse data formats, addressing geographic and temporal inconsistencies, and validating integrated datasets. Automated data cleaning and visualization techniques enhance accuracy and efficiency. Planning for sensitivity analyses before data cleaning is recommended to improve the data integration process and enhance the robustness of findings.

Discussion: This integrative approach demonstrates how leveraging FAIR principles can advance trauma research by facilitating large-scale analyses of complex public health questions. The methods provide a replicable framework for examining population-level impacts of phenomena and highlight opportunities for expanding trauma research.

Métodos para la integración de conjuntos de datos públicos: perspectivas de la investigación sobre la salud mental de los jóvenes en desastres

Introducción: Los desastres relacionados con el clima representan riesgos significativos para la salud mental de los jóvenes. La exposición a múltiples desastres es cada vez más común; sin embargo, los efectos de esta exposición siguen siendo poco estudiados. Este estudio demuestra la aplicación de enfoques de integración de datos y los principios FAIR (sigla en inglés para: Localizable, Accesible, Interoperable, Reutilizable) para evaluar la relación entre la exposición acumulativa a desastres y la depresión y suicidalidad en jóvenes en los Estados Unidos, considerando factores contextuales en distintos niveles de la ecología social.

Método: Combinamos datos de cinco fuentes públicas, incluidas el Sistema de Vigilancia del Comportamiento de Riesgo en Jóvenes (YRBS por sus siglas en ingles), la Agencia Federal para el Manejo de Emergencias (FEMA por sus siglas en ingles), la Oficina del Censo de los Estados Unidos, el Compendio de Seguridad sobre Tiroteos Escolares del Centro para la Defensa y Seguridad Nacional, y la Base de Datos sobre Terrorismo Global. El conjunto de datos integrados incluyó a 415.701 jóvenes de 37 distritos en los Estados Unidos que completaron el YRBS entre 1999 y 2021. El YRBS sirvió como el conjunto de datos principal.

Resultados: Esta nota de datos resalta estrategias para armonizar diversos formatos de datos, abordar inconsistencias geográficas y temporales, y validar conjuntos de datos integrados. Las técnicas automatizadas de limpieza y visualización de datos mejoran la precisión y la eficiencia. Se recomienda planificar análisis de sensibilidad antes de la limpieza de datos para optimizar el proceso de integración y aumentar la solidez de los hallazgos.

Discusión: Este enfoque integrador demuestra cómo la aplicación de los principios FAIR puede impulsar la investigación sobre el trauma al facilitar análisis a gran escala de cuestiones complejas de salud pública. Los métodos presentados ofrecen un marco replicable para examinar los impactos a nivel poblacional y destacan oportunidades para ampliar la investigación sobre el trauma.

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HIGHLIGHTS

- This paper outlines methods used to develop a dataset to evaluate the population-level impact of cumulative disaster exposure on youth mental health in the United States.
- Five public datasets were merged in alignment with FAIR data principles.
- Challenges in public data integration are discussed, with an emphasis on strategies used which can be applied to enhance the transparency, reproducibility, and the applicability of trauma research.

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1. Introduction

Youth today are experiencing unprecedented exposure to climate-related disasters, which are increasing in frequency and intensity due to climate change (Ripple et al., 2022; Thiery et al., 2021). Disaster exposure is associated with mental health distress, including symptoms of post-traumatic stress, anxiety, depression, suicidal ideation, and externalizing symptoms (Lai et al., 2013; Pfefferbaum, Jacobs, Griffin, et al., 2015; Pfefferbaum, Jacobs, Houston, et al., 2015; Self-Brown et al., 2017). However, research has been limited by a focus on single disaster events and examinations of risk at the individual level. These are critical gaps in the literature, as repeat disaster events are becoming more common in the face of climate change, and it is well documented that disasters impact youth at multiple levels (e.g. from the individual to contextual levels).

To address these gaps, we used integrative data analysis. We merged data from five data sources in order to evaluate the relationship between cumulative disaster exposure and depression and suicidality risk while taking into account contextual factors across multiple ecological systems (Bronfenbrenner, 1979).

Addressing the impact of multiple disasters on youth mental health requires large, diverse samples. Integrating data from multiple public data sources while adhering to FAIR (Findable, Accessible, Interoperable, Reusable) principles offers researchers an opportunity to use large datasets to address complex research questions and advance the field of trauma research (Prakash et al., 2023).

This paper outlines the approaches used and challenges encountered in our study of cumulative disaster exposure and youth depression and suicidality. Our study used FAIR principles. Specifically, the public data used in this study were *findable* and *accessible*. In addition, by leveraging these data, we created a new dataset that achieved *interoperability* across diverse data formats through the alignment of geographic and temporal variables and standardization of variable definitions across datasets. The integrated dataset and methods are *reusable* and supported by automated data cleaning processes and detailed documentation, making them adaptable to other research contexts.

2. Materials & methods

The five data sources used in this study, the Youth Risk Behavior Surveillance System (YRBS), U.S. Federal Emergency Management Agency (FEMA) Disaster Declarations Dataset, US Census Bureau data, CHDS School Shooting Safety Compendium, and Global Terrorism Database, are all publicly available for download. The datasets are also frequently updated, providing a foundation for replicable research and enabling continuous analysis of the relationships of interest (disaster exposure and youth depression and suicidality) (Table 1).

Dataset 1: Youth Risk Behavior Surveillance System (YRBS). The YRBS, administered biennially since 1991, is a self-report survey of U.S. high school students (14–18 years) in grades 9–12 (Mpofu et al., 2023; Underwood et al., 2020). The current study used a subset of data from a merged YRBS dataset (1999–2021) which included 415,701 youth from 37 districts across 18 states. The YRBS collects data on demographic information, health behaviours, and mental health outcomes, with specific measures for depression and suicidality (ideation, plan, and attempt) (CDC, 2023). The data are weighted to adjust for non-responses and ensure representativeness based on student demographics and survey year (Mpofu et al., 2023). The YRBS served as the core dataset, with additional datasets merged into it using geographic and temporal indicators.

Dataset 2: FEMA Disaster Declarations Dataset. The FEMA Disaster Declarations Dataset provides information on all federally declared emergencies, disasters, and fire management assistance events that have occurred in the United States from 1953 to the present (FEMA, 2023a, 2023b). For this study, we used variables regarding declaration type (e.g. major disasters, fire management, and emergencies), disaster type (e.g. hurricanes, fires), and disaster timing (start and end dates). New variables were created from these to evaluate cumulative disaster exposure over the two years preceding YRBS survey completion by district. The two-year timeframe was chosen to capture a meaningful period of cumulative exposure likely to influence youth mental health, acknowledge the long-term impacts of disasters on communities, and align with the biennial frequency of the YRBS survey. Created variables included the frequency of weather-related disaster declarations, major weather-related disaster declarations, and non-weather-related disaster declarations within each district, as well as the total number of days spent in and between disaster declarations over the two years prior to YRBS survey completion.

Dataset 3: US Census Bureau. County-level poverty rates and race/ethnicity data for YRBS districts (which were converted to counties to align with Census data) were collected from multiple US Census Bureau sources, including the Historical County Level Poverty Estimates Tool and the Small Area Income and Poverty Estimates data tool (US Census Bureau, 2021a; US Census Bureau, n.d.-a). These datasets provide yearly county-level characteristics (US Census Bureau, 2021b). Data were pulled from the 2000, 2010, and 2020 censuses and merged with the

Table 1. Overview of data integration procedures.

Dataset	Procedure	Variables
Dataset 1: YRBS	1. **Downloaded YRBS Data**: Retrieved the merged YRBS dataset (1991–2021) from the CDC website. 2. **Cleaned Dataset**: Updated variable and value labels using the CDC codebook.	1. Location (District) 2. Sampling Weights 3. Time (Year of YRBS) 4. Depression 5. Suicidal Ideation 6. Suicide Plan 7. Suicide Attempt 8. Assigned Sex 9. Age 10. Race/Ethnicity 11. Safety Concerns
Dataset 2: FEMA	3. **Integrated Disaster Data**: Downloaded FEMA disaster declaration data and uploaded it into Stata. a. Truncated dataset to counties within YRBS districts only, between 1997 and 2021. b. Categorized disasters as weather-related or non-weather-related based on FEMA disaster type variables. c. Filtered disaster declarations to align with YRBS survey dates. d. Exported data into Excel. 4. **Created Variables.** Used Excel commands (e.g. MAXIFS, SUMIFS) to create disaster variables for the two-year period preceding YRBS survey completion. a. For example: The days in disaster variable was created for each YRBS year using the command = SUMIFS(M2:M69, B2:B69, 1991, M2:M69, ‘<>’, P2:P69, 1). b. Merged variables into the YRBS dataset using district (converted from county) and year.	1. Cumulative Weather-Related Disaster Exposure 2. Disaster Type 3. Days in Weather-Related Disasters 4. Days Between Weather-Related Disasters 5. Major Weather-Related Disasters 6. Cumulative Non-Weather-Related Disaster Exposure
Dataset 3: US Census Bureau	5. **Integrated US Census Data:** Downloaded U.S. Census data on poverty rates and race/ethnicity and imported into Excel, organized by county and year. a. Created variables that aligned data with counties within districts for the most proximal YRBS survey year. b. Merged variables into the YRBS dataset using district and year.	1. Poverty Rate 2. Race/Ethnicity
Dataset 4: CHDS (School Shootings)	6. **Integrated School Shootings Data**: Consolidated school shooting data from CHDS sources (e.g. Mother Jones, Everytown Research) into one Excel sheet using towns within counties data. a. Applied inclusion criteria for events occurring between fall and spring YRBS survey dates in the corresponding districts. b. Created a district-level summary variable of the number of school shooting events by district across years using Excel commands and used Stata commands to add to the dataset.	1. Frequency of School Shooting Events
Dataset 5: GTD (Terrorism Events)	7. **Integrated Terrorism Events Data**: Collected terrorism data from the GTD. a. Applied inclusion criteria for terrorism events within YRBS districts that matched survey years. b. Created a district-level summary variable of the number of terrorism events by district across years using Excel commands and used Stata commands to add to the dataset.	1. Frequency of Terrorism Events

YRBS dataset using county and most proximal year as linking variables.

Dataset 4: Center for Homeland Defense and Security (CHDS) School Shooting Safety Compendium. This school shooting database is a comprehensive resource that integrates data from multiple reputable sources, including public databases (e.g. Mother Jones' Mass Shootings Database), media outlets, law enforcement reports, and academic research (CHDS School Shooting Safety Compendium, n.d.). School shootings that occurred within YRBS districts (towns within counties within districts) in the year before the survey were linked to the YRBS dataset (Hodges et al., 2023). The one-year timeframe was chosen to capture the immediate psychological and community-level impacts of these events.

Dataset 5: Global Terrorism Database (GTD). The Global Terrorism Database, captures worldwide terrorism incidents, including their location, type, and severity (START National Consortium for the Study of Terrorism and Responses to Terrorism, 2022). We linked past-year terrorism events occurring in towns within YRBS districts within the year preceding completion of the survey to evaluate the influence of these events on a sense of safety within the affected districts.

Data Integration and Cleaning. Data were merged using geographic (county, district, town/city) and temporal indicators (month and year). The YRBS served as the core dataset, with FEMA, Census, CHDS, and GTD data linked to it by district (counties within districts and towns within counties) and year. The integrative dataset was organized with each row representing a single youth, incorporating individual-level demographics and mental health outcomes alongside district-level data on disasters and other traumatic events (school shootings, terrorism events, and non-weather-related disasters).

3. Data description

We built an integrative dataset by combining five public sources. In this section, we outline the challenges we encountered in achieving interoperability – including how we managed diverse data formats, established geographic and temporal consistency – and the strategies we developed to address them. A detailed overview of the data integration and analysis procedures has been published on Open Science Framework (Riobueno-Naylor et al., 2025).

Managing Diverse Data Formats. Merging the five public datasets required harmonization across different data formats. For example, FEMA data are formatted with one disaster declaration per row and county, with disaster declarations appearing multiple times within the dataset. To configure the data, the FEMA dataset was first filtered by district and year and exported into Google Sheets/Excel. Then, the data was reorganized into summary tables using Google Sheets/Excel, where district-specific disaster event variables were calculated by time period (e.g. past two-year exposures). A column was created indicating the frequency of disasters per district and year, which allowed for additional summary variables to be created using Google Sheets or Excel MAXIFS functions. The preprocessed FEMA dataset was exported and merged with the YRBS dataset using Stata. Cleaning and preparing variables before merging datasets ensures that values are temporally and geographically aligned.

Geographic Consistency Over Time. A key challenge in working with public datasets is maintaining geographic consistency over time. The YRBS dataset includes district-level geographic indicators, while FEMA and US Census Bureau data are on the county-level. Therefore, a list of the associated county/counties within the YRBS district for the specific year was compiled and added to the YRBS dataset to use for the merge. Importantly, county and district boundaries often change by year in the U.S. To address this, historical geographic boundaries were cross-referenced with current ones using US Census data geography reference files (US Census Bureau, n.d.-b).

Timing of Disaster Exposure. Another challenge was coding the timing of disaster exposure relative to YRBS survey administration. Since the YRBS is conducted in the fall or spring of each survey year, we had to synchronize the disaster data with the survey periods to avoid time discrepancies. This process involved coding FEMA's disaster start and end dates and aligning them with the YRBS survey periods to ensure that only disaster events occurring within the relevant time frame were accurately linked to youth.

Minimizing Human Error. To minimize human error and enhance reproducibility, automation was critical. Excel was used to write commands for calculating disaster exposure and prepare the data for merging. For instance, formulas were used to automatically generate commands that calculated the number of weather-related disasters in each district over the past two years. The final merged dataset was compiled in Stata, and the commands used to merge the data were organized and compiled in Google Sheets or Excel (e.g. using the CONCATENATE command). Relying on automated processes reduced the likelihood of manual errors and allowed for quicker updates to the dataset if new data or methodological changes were needed.

Data Validation. Data validation involved multiple team members to ensure accuracy, consistency, and completeness at every stage of the process. Planned data checks were performed by multiple people on the research team, which involved reviewing geographic boundaries, timing variables, and disaster exposure calculations. For example, when verifying FEMA data, two researchers cross-checked the disaster events recorded for each district to ensure that events were included and coded correctly.

Data Visualizations and Quality Assurance. Data visualizations played a vital role in the validation and cleaning processes. Scatterplots were used to compare disaster exposure variables across districts and years, helping to identify outliers, discrepancies, and trends in the data. Histograms were used to assess the distribution of variables to evaluate variable frequency and outliers. In addition, data visualizations were used to highlight differences in disaster frequency between the YRBS sample and the broader US, offering insight into regional patterns of disaster exposure among sampled youth. These visualizations allowed the research team to quickly validate that the integrated dataset was both accurate and complete before proceeding with statistical analyses.

Anticipate Sensitivity Analyses. A key lesson was the value of planning for sensitivity analyses before finalizing the dataset. Secondary data analysis often requires justifying analytical choices due to inherent limitations of the data. Sensitivity analyses help verify that findings are robust to different assumptions or subgroup definitions. Planning for these analyses from the outset, including defining alternative models and coding structures, can streamline the process during the analysis phase. For example, we prepared variables that counted disaster exposure both with and without fire events to assess their impact on our results, given that fire events can be weather or non-weather related. Recognizing that secondary data imposes unique constraints on analysis allowed us to approach these analyses proactively, treating them as a necessary step to bolster the credibility of our findings.

4. Discussion

4.1. Strengths & limitations

The methodological approach used in this study not only advances the field of disaster research but provides a blueprint for other studies. Integrating data offered several important advantages: the ability to leverage pre-existing public data, evaluate large-scale phenomena (cumulative disaster exposure and youth mental health), examine diversity across various dimensions (race/ethnicity, disaster type, geography, and developmental stage), test external validity by controlling for adverse experiences at individual and district levels, and propose a model with implications beyond depression and suicidality outcomes. These are questions that could not have been tested with any single existing data source. Further, creating an integrative dataset allowed us to evaluate disaster impacts on a large and diverse sample of youth (N = 415,701, 20.8% non-Hispanic White). As a comparison point, two of the top cited youth disaster studies included 63 and 384 youth, respectively (Asarnow et al., 1999; La Greca et al., 2010). By leveraging large public data sources, researchers can better understand the population-level impacts of disasters and other traumatic stressors to help guide prevention and intervention efforts.

Several limitations warrant consideration. First, data are cross-sectional, rather than longitudinal, which limits the ability to make causal claims. In addition, each dataset included in an integrative secondary data analysis brings with it its own set of constraints (e.g. the YRBS does not include data from all states and does not capture the complexities of disaster exposure). Within large-scale datasets in particular, the precision, sensitivity, and comprehensiveness of analysed outcomes are limited, reflecting the challenge of balancing large-scale data collection with the need for more nuanced measures. Further, integrating multiple data sets generates its own set of limitations (e.g. race and ethnicity were defined differently across the YRBS and US Census datasets, which was resolved by relying on individual-level data to define race/ethnicity and using less specific indicators of race/ethnicity at the district-level [i.e. non-Hispanic White vs. Else]). Finally, there are weaknesses in the level of specificity of variables (e.g. socioeconomic status was measured using a district-level variable), whereby these variables may not reflect the measured concept with full accuracy. Despite these limitations, integrative secondary data analyses provide a useful framework for using large-scale data to examine population-level disaster impact and inform policy.

4.2. Future directions

To address the limitations of working with large public datasets, future research should prioritize advancing FAIR research principles. These principles serve as a framework to make datasets more accessible and usable for researchers across disciplines. A key component of this objective involves publishing data notes, such as this one, that document the challenges encountered during data development, the steps taken to address these issues, and the lessons learned. Such transparency not only supports collective learning but also provides a valuable resource for researchers embarking on similar projects.

In addition, researchers should make their data cleaning and preparation code publicly available. The cleaning and analysis code for this project was made publicly available on the Open Science Framework (Riobueno-Naylor et al., 2025). Publishing code provides insight into the data transformation process, allowing others to better understand assumptions, decision-making and potential sources of error. This level of transparency is important for ensuring the integrity and reproducibility of research findings. It also facilitates collaboration by enabling other researchers to build on existing datasets more effectively, rather than duplicating efforts, and making data integration and analysis more accessible to individuals with different levels of experience and resources. Collaboration and accessibility have important implications for researcher-community partnerships, potentially allowing local communities to co-develop research questions relevant to their geographic areas and lived experiences alongside researchers, fostering participatory research and generating insights for local policymakers. Although analyses were conducted in Stata, which required purchasing a license, the data cleaning and integration processes for this project could be completed using free software (e.g. web versions of Excel, Google Sheets, R analysis software), increasing accessibility.

Implementing FAIR data practices requires a cultural shift in how scholarly contributions are recognized and rewarded. Currently, the emphasis on publishing research findings in high-impact journals may discourage researchers from dedicating time to creating detailed documentation or sharing preparatory work. To overcome this barrier, tenure and promotion committees should consider data notes, cleaning protocols, and similar outputs as legitimate and valuable scholarly products. Recognizing these contributions formally would motivate more researchers to prioritize the transparency and reusability of their data.

Collaboration will remain a crucial aspect of advancing FAIR principles. Individuals and organizations should work together to align measurement strategies and definitions. Standardizing variables, such as demographic and outcome measures, would simplify future data integration efforts and improve the comparability of research findings. For instance, adopting shared frameworks for defining race/ethnicity, socioeconomic status, and other key variables across public datasets would minimize discrepancies and enhance the accuracy of analyses.

Finally, the authors emphasize the importance of safeguarding public datasets and ensuring their continued availability. Maintaining these datasets is essential for preserving the integrity of data-driven research and providing local communities and governments with the tools needed to address the impacts of disasters and other traumatic events on diverse populations.

5. Conclusion

As climate change drives the increasing frequency of disaster events, the number of youth exposed to such events is expected to rise, underscoring the urgent need for effective, evidence-based interventions to support youth (National Academies of Sciences, Engineering, and Medicine, 2021; Redlener & Reilly, 2012; SAMHSA, 2018). This data note demonstrates the use of an integrative data approach to understand the population-level impact of multiple disaster exposure on youth mental health. Guided by FAIR data principles (Prakash et al., 2023), we leveraged accessible, reusable datasets to ensure utility over time. By pooling diverse data sources and prioritizing interoperability, we demonstrate how this method facilitates cross-study comparisons, deepens our understanding of trauma across various communities, informs the development of evidence-based interventions, and advances trauma research.

Author contributions

Alexa Riobueno-Naylor: funding acquisition, conceptualization, project administration, supervision, data collection & curation, investigation, writing – original & edited drafts. Isabella Gomez: data collection & curation, project administration, writing – original & edited drafts. Sarah Quan: data collection & curation, project administration, writing – original & edited drafts. Chloe Hutt Vater: investigation, Writing – original & edited drafts. Mauricio Montes: investigation, writing – original & edited drafts. Barbora Hoskova: investigation, writing – original & edited drafts. Betty S. Lai: funding acquisition, conceptualization, supervision, writing – review & editing.

Disclosure statement

The authors have no conflicts of interest to disclose. This research was approved as exempt by the Institutional Review Board at Boston College, as it involves the analysis of publicly available secondary data.

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Data availability statement

Data and analysis code used in this study have been published via Open Science Framework and can be found using the following https://doi.org/10.17605/OSF.IO/AF3PX.

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