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Association between Oklahoma earthquakes and anxiety-related Google search episodes

Joan A. Casey[a]*, Sidra Goldman-Mellor[b], Ralph Catalano[a]

Background: Oklahoma has experienced a rise in seismicity since 2010, with many earthquakes induced by wastewater injection. While large single earthquakes have documented mental health repercussions, health implications of these new, frequent earthquakes remain unknown. We aimed to examine associations between Oklahoma earthquakes and statewide anxiety measured by Google queries.

Methods: The U.S. Geologic Survey's Advanced National Seismic System Comprehensive Catalog supplied earthquake dates and magnitudes. We used the Google Health application programming interface to compile the proportion of weekly Oklahoma-based health-related search episodes for anxiety. A quasi-experimental time-series analysis from January 2010 to May 2017 evaluated monthly counts of earthquakes ≥ magnitude 4 (a level felt by most people) in relation to anxiety, controlling for US-wide anxiety search episodes and Oklahoma-specific health-related queries.

Results: Oklahoma experienced an average of two (SD = 2) earthquakes ≥ magnitude 4 per month during the study period. For each additional earthquake ≥ magnitude 4, the proportion of Google search episodes for anxiety increased by 1.3% (95% confidence interval = 0.1%, 2.4%); 60% of this increase persisted for the following month. In months with 2 or more ≥ magnitude 4 earthquakes, the proportion of Google search episodes focused on anxiety increased by 5.8% (95% confidence interval = 2.3%, 9.3%). In a sub-analysis, Google search episodes for anxiety peaked about 3 weeks after ≥ magnitude 4 quakes.

Conclusions: These findings suggest that the recent increase in Oklahoma earthquakes has elicited a psychological response that may have implications for public health and regulatory policy.

Introduction

United States natural gas production increased by 40% and crude oil by 82% from 2006 to 2016.[1] Access to previously undeveloped shale formations through horizontal and directional drilling and pressurized high-volume hydraulic fracturing has fueled this increase. Each of the approximately 300,000 hydraulically fractured or "fracked" wells in the United States[2] requires initial injection of 6–20 million liters of water.[3,4] In Oklahoma, oil and gas production returned 35 billion liters of wastewater to the surface in 2007.[5] Well operators usually inject wastewater into class II injection wells to enhance oil and gas recovery or for disposal.[4,5] Fluid injection, particularly at high rates, can induce earthquakes.[6–8] By 2014, the percent of ≥ magnitude (*M*) 3 earthquakes associated with wastewater injection wells reached 98% in the central and eastern United States.[8] In 2010, Oklahoma experienced two earthquakes ≥ *M* 4; by 2016, it experienced 21.[9] A ≥ *M* 4 quake feels like a heavy truck striking a building. Cars rock noticeably, dishes and windows may shift, and if at night some individuals will awaken.[10]

Although many factors—economic, political, and social—appear to shape public opinion regarding unconventional natural gas production,[11–13] individuals living near production facilities have reported reduced life satisfaction, social stress, negative psychological states, and disruption in sense of place.[14–17] The contribution of injection-induced earthquakes to these associations has not, however, been empirically explored despite two circumstances that suggest a link. First, environmental disasters (e.g., large earthquakes) induce psychological distress, especially anxiety.[18] Second, people apparently judge man-made hazards as more provocative than those that occur naturally.[19,20] An online survey of 325 participants from 40 U.S. states revealed

What this study adds

Understanding the health implications of environmental hazards requires temporally resolved health indicators. The lack of real-time measures of anxiety, an established response to earthquake exposure, represents a major limitation in environmental psychological research. In a novel application of Google search data, we use time-series analysis and find increased anxiety-related Google search episodes following Oklahoma earthquakes of ≥ magnitude 4 between January 2010 and May 2017. Our analysis highlights the importance of rapid mental health surveillance at the state and local levels and illustrates the utility of leveraging internet search data to investigate the public health implications of environmental hazards.

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Data sharing: The earthquake data is publicly available through the U.S. Geologic Survey's Advanced National Seismic System Comprehensive Catalog, and we have provided the Google search data in the Supplemental Material; http://links.lww.com/EE/A10.

SDC Supplemental digital content is available through direct URL citations in the HTML and PDF versions of this article (www.epidem.com).

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that induced earthquakes elicited more negative feelings than equivalent but naturally occurring earthquakes.[21] Research in the Netherlands, moreover, finds that residents exposed to earthquakes caused by energy production express not only concern over quake-associated damage to homes and housing values but also feelings of powerlessness, worry, and anger.[22]

In 2013 in the United States, anxiety disorders were the fourth leading cause of years lived with disability.[23] Anxiety, moreover, may worsen the course of other illness,[24] such as cardiovascular disease,[25,26] and may also increase the risk of adverse birth outcomes.[27,28] Understanding the health implications of environmental hazards requires temporally resolved epidemiologic indicators of anxiety, which currently do not exist. Prior studies have, however, have demonstrated the utility of using Google searches[29] to estimate the incidence of anxiety.[30–32] These data avoid, for example, social desirability biases associated with mental health disorder reporting.[33]

We used time-series methods to estimate the relationship between earthquakes Oklahomans could sense (≥ *M* 4) and population anxiety, as measured by Google queries. We not only identified relevant Google queries by search term but rather gained access to Google's machine-learning techniques that categorize searches into health-related and non-health related categories. The analysis relied on 2010–2017 Google search data to track monthly online queries related to anxiety and U.S. Geological Survey (USGS) monthly counts of earthquakes. We hypothesized that during months with one or more earthquake of *M* 4 or greater, the percentage of searches related to anxiety would increase significantly.

Methods

Oklahoma covers 177,660 km^2 and had a 2010 population of 3.8 million people, mostly non-Hispanic whites (68.7%) and of whom 16.1% lived below the federal poverty threshold.[34] In essence, our analyses compare anxiety, measured as described below, among Oklahomans in months with no *M* 4 earthquakes to anxiety in months in which one to six such tremblors occurred. Our analyses begin in January 2010, the year in which the first recorded *M* 4 earthquake occurred in Oklahoma, and end with the last month, in May 2017, for which we could obtain anxiety data.

Earthquake data

We obtained earthquake location, date, time, and magnitude data from the publicly available USGS Advanced National Seismic System's comprehensive earthquake catalog.[9] We aggregated earthquakes to the monthly level. The USGS notes that their website may not contain all smaller earthquakes (i.e., <*M* 2). As our exposure of interest, we used monthly counts of earthquakes ≥ *M* 4 under the assumption that Oklahomans would have sensed quakes of this size.[35] We also implemented a negative exposure control by collating the monthly number of earthquakes between *M* 1 and *M* 2.5, a level captured by monitoring equipment, but rarely felt by humans.[35] While earthquakes between *M* 2.5 and *M* 4 may damage infrastructure, particularly after chronic exposure, we did not include these quakes in our analyses because Oklahomans may or may not feel them.

Our test period began in January 2010 (i.e., first year with earthquakes of magnitude *M* 4) and ended in May 2017 (last month with data at the time of our analyses). We used months in our main test primarily to simplify correction, as described below, for anticipated seasonality in our estimates of anxiety in the population.

Google Health Data

Individuals may search for information about anxiety for reasons unrelated to their health (e.g., "test anxiety") or out of general interest in the topic. We therefore obtained estimates of search episodes that reflected health-related concern about anxiety. Google uses machine learning to generate rules that categorize searches based on similar types of queries and on what users "click on."[30] Using these proprietary rules, Google identified a search episode as health-related and about anxiety if it included "anxious" or "anxiety," as well as a subsequent click indicating a concern for health (e.g., a click on "webmd.com"). We used searches for the term anxiety as our main dependent variable of interest because, compared to other queries like "jitters" or "nervous," anxiety likely has higher specificity for underlying psychological distress. We obtained these anxiety-related search episodes for Oklahoma and the entire United States at the weekly resolution.

Google estimated the frequency of anxiety-related search episodes based on a random 5%–15% sample of total episodes, resampled daily. To estimate the probabilities of anxiety-related episodes, for each week we drew 75 samples through the Health API.[36] For the main analysis, we used the mean monthly proportion of search episodes for anxiety across the 75 samples (see eTable 1 in the Supplemental Content; http://links.lww.com/EE/A10).

We also obtained Google search data for two covariates in our tests. First, we added the proportion of Google anxiety-related search episodes for the entire United States. We included the anxiety variable for the United States as a whole to reduce the threat of a type I error due to any similar temporal trends between earthquakes in Oklahoma and monthly anxiety-related search episodes among Americans nationwide.

Second, we specified within-Oklahoma monthly Google queries for "toothache" as a covariate. We included Oklahoma searches for toothache in an effort to reduce type I error arising from coincidence between earthquakes and nonspecific or hypochondriacal pain among Oklahomans. Research suggests that much reported tooth pain has psychosomatic origins and that populations living in noisome, but not otherwise toxic, environments report toothache more than other populations controlling for socioeconomic and demographic characteristics.[37,38]

To describe interest in earthquakes over time, we also downloaded the monthly proportion of Google searches in Oklahoma for the term "earthquake." We transformed the proportion of Google search episodes for anxiety and toothache to their natural logarithms. This transformation makes the distributions of these variables closer to normal and allowed us to express any association as percent change in the outcome Y attributable to a unit change in the exposure X.

Statistical analysis

Statistical analyses of time series assume that variables exhibit constant means over time. The proportion of Google search episodes concerned with anxiety trend upward in both Oklahoma and the United States, violating this assumption. To remedy this problem, we transformed the time series to their first differences (i.e., value at time *t* subtracted from value at *t* + 1). We, therefore, estimated monthly changes in the proportion of queries for anxiety. The analysis was conducted in 2017.

The analyses followed several steps. First, we regressed monthly changes in the Oklahoma Google anxiety search episodes on changes in anxiety search episodes for the United States and on changes in the Oklahoma Google toothache search episodes.

Second, consistent with prior epidemiologic literature,[39,40] we used Box–Jenkins methods[41] to identify and specify autocorrelation (i.e., trends, seasonality, and the tendency to remain elevated or reduced after high of low values) in the residuals of the regression estimated in step 1. Any detected autocorrelation would appear specific to anxiety among Oklahomans because the US anxiety covariate would capture any variance shared

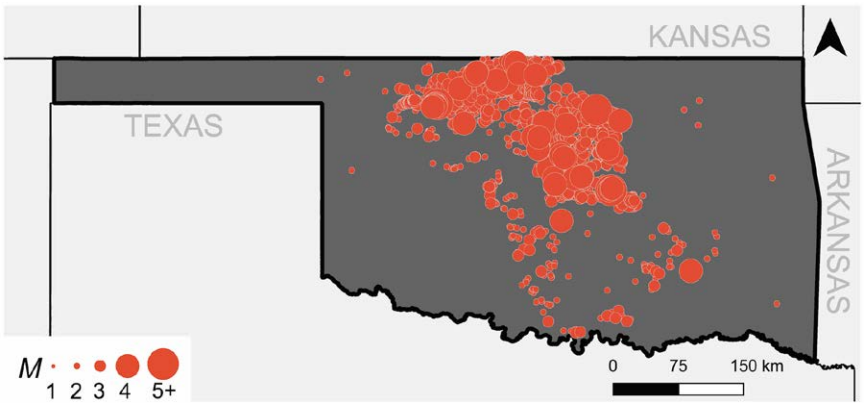

Figure 1. Location of instrumentally recorded earthquakes from January 2010 to May 2017 in Oklahoma. Larger circles denote higher magnitude earthquakes. Data from the U.S. Geological Survey's Advanced National Seismic System Comprehensive Earthquake Catalog (ComCat; https://earthquake.usgs.gov/earthquakes/search/).

with other Americans. This base model predicted changes in the monthly proportion of Google search episodes in Oklahoma—focused on anxiety from changes in the proportion in the United States similarly focused as well from changes in the proportion of searches in Oklahoma related to toothache and from autocorrelation including seasonality.

Third, we estimated the main test model by adding the monthly differences in *M* 4 earthquakes to the base model. We specified the model to include a persistence parameter that measured the proportion of the association, if any, between *M* 4 earthquakes and Oklahoma anxiety search episodes that carried into the month after the earthquakes. This test equation determined whether adding monthly changes in the number of *M* 4 earthquakes significantly improved counterfactual predictions, that is, those assuming *M* 4 earthquakes did not occur (test transfer function in the Supplemental Content; http://links.lww.com/EE/A10).

We performed data assembly and analyses using R Statistical Software version 3.3.2 (R Core Team, Vienna, Austria), Python Software version 2.7.13 (Python Core Team, Python Software Foundation), and Scientific Computing Associates Statistical System (Scientific Computing Associates, 2017).

Results

Between January 2010 and May 2017, the USGS measured 8,908 earthquakes across the state of Oklahoma (Figure 1), with an average of 218 (SD = 99) earthquakes per month. The average number of ≥ *M* 4 earthquakes each year increased from 3 to 22 during the periods 2010–2013 and 2014–2016, respectively (Figure 2A). Interest in earthquakes as measured by the proportion of Google searches for "earthquake" tracked with actual events in Oklahoma during the study period (eFigure 1; http://links.lww.com/EE/A10, available as a supplement).

The observed proportion of Google search episodes originating in Oklahoma and focused on anxiety increased over the test period (Figures 2B, 3). These Google searches in Oklahoma appeared significantly positively associated with similar search episodes nationwide (Table 1, base model). The coefficient for the Oklahoma toothache search episodes did not indicate an association with Oklahoma anxiety Google searches, but we nevertheless elected to include this covariate in our test equation.

The inclusion of a moving average parameter at $t - 1$ (i.e., 0.648; SE = 0.097) and an autoregressive parameter at $t - 12$ (i.e., 0.377; SE = 0.085) suggested that anxiety among Oklahomans

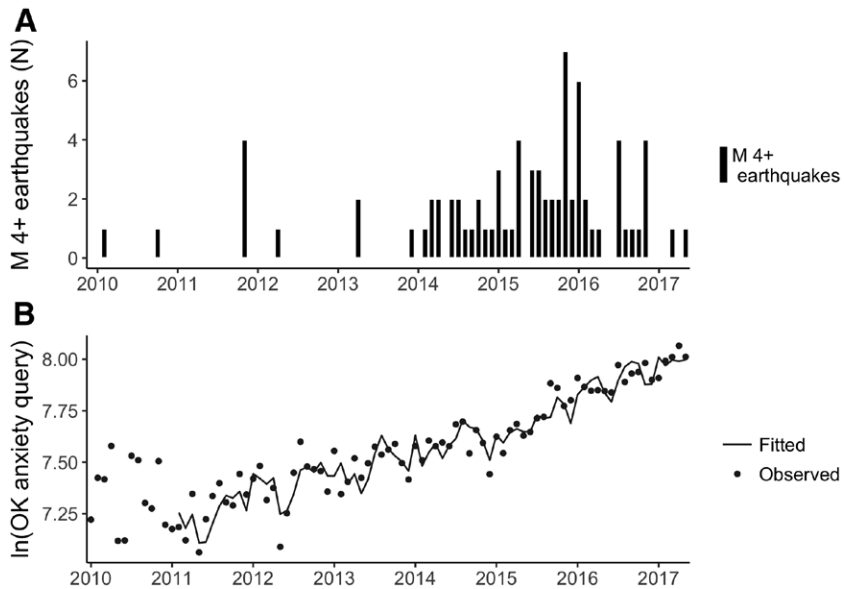

Figure 2. Distribution of earthquakes and monthly Google searches from January 2010 to May 2017 in Oklahoma. A, Monthly total of ≥*M* 4 earthquakes. B, Natural log of monthly trend for all Google anxiety-related search episodes in Oklahoma with fitted values from the time series model. Thirteen months of fitted values were lost to modeling. Search probabilities were multiplied by 10 million prior to log transformation for readability.

Table 1

Associations between earthquakes ≥ magnitude (*M*) 4 and change in the monthly proportion of Google search episodes in Oklahoma focused on anxiety from January 2010 to May 2017[a]

	Base Model,[b] B (95% CI)	Test Model,[c] B (95% CI)	Binary *M* 4 Model,[d] B (95% CI)
Earthquake variables			
≥ *M* 4 earthquake		0.013 (0.010, 0.025)	0.059 (0.024, 0.094)
Proportion of ≥ *M* 4 earthquake association persisting to following month		0.592 (–0.010, 1.190)	0.572 (0.204, 0.940)
Control variables			
US anxiety searches	0.940 (0.580, 1.30)	0.890 (0.530, 1.25)	0.890 (0.550, 1.24)
Oklahoma "toothache" searches	–0.900 (–0.970, 7.90)	–0.420 (–0.140, 0.52)	

[a]Estimates from a time-series model. Google data were modeled as natural logarithms of the monthly proportion of Google searches over n = 89 months; Oklahoma earthquake data were collected from the US Geological Survey.

[b]Change in proportion per 1-unit change in control term Google searches.

[c]Change in proportion per additional *M* 4 earthquake.

[d]Earthquake exposure equal to 1 in months with > 1 *M* 4 earthquake and 0 otherwise.

CI, confidence interval; *M*, magnitude.

exhibited autocorrelation not shared with other Americans and different from any shown by Oklahoma Google searches on "toothache" (eTable 2; http://links.lww.com/EE/A10, available as a supplement). That autocorrelation took the form of persistence into the following month (i.e., moving average at $t - 1$) and seasonality (i.e., autoregression at $t - 12$). Any attempt to explain these echoes would amount to post hoc speculation.

When we ran the test model (Table 1 and Figure 2B), we observed results consistent with our hypothesis. For each additional ≥ *M* 4 earthquake, the proportion of Oklahoma-based Google search episodes concerned with anxiety increased by 0.013. The persistence parameter (i.e., 0.59) implied that nearly 60% of that increase persisted into the following month, for an approximate 2% total increase over 2 months. Because our test model adjusted the anxiety indicator in Oklahoma for that in the United States, as well as for Google search episodes for toothaches in Oklahoma and for autocorrelation, it is unlikely that the association we report could be attributed to secular trends or seasonality or to any third variable that affected national curiosity in anxiety or Oklahoma-specific interest in health in general.

We conducted several robustness checks. We repeated the test but deleted the Oklahoma "toothache" search variable given that its coefficient did not differ from 0 in the counterfactual or test models. Results remained unchanged with this removal. We applied the methods of Chang et al.[42] to the full test model to identify and control outliers in our dependent variable that may have distorted our results. We detected no outliers. We estimated a falsification test in which we replaced earthquakes ≥ *M* 4 with those ≤ *M* 2.5 (eFigure 2; http://links.lww.com/EE/A10, available as a supplement). Oklahomans likely did not sense earthquakes of this small magnitude. Our theory, therefore, would predict no association with anxiety from Google searches. We repeated the steps in our test model and found no association (coefficient = –0.0001; SE = 0.0002).

We also assessed the robustness of our findings with two less-conventional approaches. Oklahoma experienced a marked increase in *M* 4 earthquakes beginning in 2015; therefore, we hypothesized that the proportion of Oklahoma-based Google search episodes concerned with anxiety would outpace the proportion nationwide (Figure 3). We tested this prediction by applying outlier detection methods to residuals from a regression of the Oklahoma anxiety variable on that for the United States. We found evidence of a significant ($P < 0.005$, single-tailed test) divergence between Oklahoma and the rest of the nation that began in September 2015, indicating that starting in autumn of 2015, the proportion of anxiety-focused search episodes in Oklahoma increased more than the proportion nationwide.

Second, we grouped our data into weeks rather than months. We did not use weekly data in our main test because they often exhibit week-of-month and moveable holiday effects that complicate the detection and specification of autocorrelation by interacting with other patterns in monthly and weekly data (e.g., seasonality).[43] Despite this difficulty, we found increases in the proportion of Oklahoma Google search episodes concerned with anxiety 3 weeks after *M* 4 earthquakes (coefficient = 0.0175; SE = 0.0103), a finding consistent with our main test results. The weekly analysis also controlled for US anxiety search episodes and Oklahoma toothache search episodes.

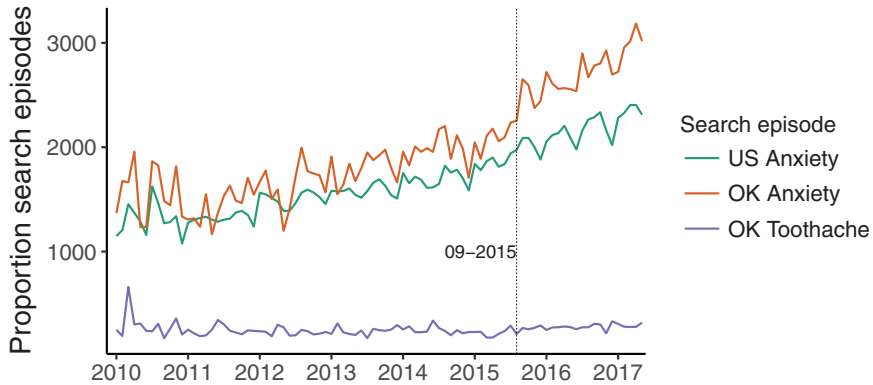

Figure 3. Monthly proportion of health-related Google search episodes from January 2010 to May 2017. The green line represents anxiety-focused queries in the United States. The orange line represents similar queries originating in Oklahoma, and the purple line represents Oklahoma search episodes related to toothache. Search proportions were multiplied by 10 million for readability. Both nationwide and Oklahoma-specific anxiety queries trended upwards over time. Beginning in September of 2015, we identified a statistically significant divergence between United States and Oklahoma queries ($P < 0.005$, single-tailed test), with Oklahoma queries increasing more rapidly.

Finally, we estimated a "binary-X" exposure model in which we replaced the continuous > *M* 4 earthquake variable with a binary variable scored 1 for months with more than one *M* 4 earthquake and 0 for all other months. Repeating the steps above with this variable, we observed a significant 5.8% increase in the proportion of Google anxiety search episodes in months with > 1 *M* 4 earthquake (Table 1). The persistence parameter (i.e., 0.57) implied that 57% of that increase carried in the following month. Therefore, we estimated that the proportion of Google search episodes concerned with anxiety increased by about 9.1% over a 2-month period when > 1 earthquake ≥ *M* 4 struck Oklahoma.

Discussion

In this quasi-experimental, time-series analysis, we found that the proportion of Google search episodes concerned anxiety increased in months with ≥ *M* 4 earthquakes in Oklahoma. This elevation of interest in anxiety on the internet persisted into the following month. With weekly search data, we discovered a peak in anxiety queries 3 weeks after ≥ *M* 4 quakes. Neither state-specific trends in health-related queries nor nationwide trends in anxiety queries explained these relationships.

Many factors contribute to earthquakes. In Oklahoma, however, scientists have linked a large proportion of ≥ *M* 3 quakes to high-rate fluid injection.[8] Wastewater disposal appears to have caused the two largest and most destructive earthquakes in the state's history, the 2011 Prague *M* 5.7 and the 2016 Pawnee *M* 5.8 earthquakes.[6,7,44,45] Over 60,000 people self-reported sensing the 2016 Pawnee quake on the USGS "Did you feel it?" website.[10] On the same website, Oklahomans reported feeling every ≥ *M* 4 quake in our analysis. Earthquakes that result from wastewater injection may elicit a more pronounced psychological response than earthquakes with no specified cause.[21] As the result of induced earthquakes, perceptions of the oil and gas industry in Oklahoma have shifted over time from fully supportive to various narratives of alarm, concern, and acceptance.[46] These perceptions may influence psychological responses to Oklahoma tremblors.

Data from the Behavioral Risk Factor Surveillance System (BRFSS) suggest that Oklahomans experience more poor mental health days than the national average.[47] Because BRFSS data are only collected annually, we could not use them to assess short-term response to frequent Oklahoma earthquakes as we could with real-time Google search data. Still, BRFSS data suggest Oklahomans may represent a high-risk group for adverse mental health outcomes. Oklahoma also has higher rates of poverty and lower levels of health insurance coverage than the national average.[47] These factors may make Oklahomans more likely to live in older and earthquake-susceptible housing, more vulnerable to mental health consequences of earthquakes,[18,48] and more apt to seek information online regarding mental health.[49]

Exposure to earthquakes may trigger anxiety through complex physiological pathways, including activation of the hypothalamic–pituitary–adrenal system, alterations to neural circuits such as the amygdala and insular cortex, and heightened reactivity of the nervous system (e.g., heart rate).[50,51] Evolution has conserved these pathways, underscoring the important role of anxiety as an adaptive response to stress that helps organisms defend against a variety of threats.[52] Excessive anxiety, however, may disable individuals and has long-term implications for health and functioning.[24–28] Such excessive symptoms of anxiety occur more readily in response to a recurrent and unpredictable stressor,[53] such as the Oklahoma earthquakes included in our study.

Previous research has documented adverse mental health effects among survivors of single major earthquake events using survey data of limited sample size.[54–56] One study from China found that fear and psychological response dampened after the first of two major earthquakes.[57] We present a novel finding that multiple more moderate earthquakes (*M* 4 to *M* 5.8), mostly manmade, may increase anxiety across a state's population. Two studies have documented psychological morbidity and post-traumatic stress disorder among survivors of single *M* 5.6 and *M* 5.9 earthquakes.[58,59] Other research implies that coping with the damage caused by earthquakes could induce psychological distress. Survey respondents living in an area with induced earthquakes in the Netherlands named property damage and reduced value of homes as their primary concern and a cause of anger and worry.[22] The value of homes in Oklahoma—where builders have not constructed earthquake-resistant structures—appears to drop after moderate earthquakes.[60,61] Governor Mary Fallin has also twice declared a state of emergency after earthquakes in 2016.[62] These events may result in concerns about safety and economic loss perhaps causing, in turn, the anxiety gauged by Google searches.

We chose to examine queries related to anxiety because, of all psychiatric disorders, anxiety has been the most frequently associated with disaster exposure.[18] While online searches for depression appear to correlate with positive screening for major depression,[63] we could not assess concordance between upticks in internet searches for anxiety and clinical mental health outcomes. Individuals may search for information about anxiety unrelated to health (e.g., "test anxiety"), on the behalf of others, or out of general interest in the topic. As noted above, however, Google identifies queries as health-relevant based on associated queries and internet "clicks."[64] Moreover, many searches may be provoked by subthreshold symptoms that would not meet clinical diagnostic criteria. Nevertheless individuals with these symptoms can experience emotional distress and functional impairment in work, school, and interpersonal relationships that can develop into full-blown disorder over time.[65]

Recent research suggests that the prevalence of serious psychological distress (a construct that includes anxiety as well as related psychological disorders, such as depression) has increased significantly in the United States during the past decade.[66,67] This increase appears to be more pronounced among low-income individuals[67] who may be overrepresented in Oklahoma relative to the broader US population. Treatment seeking for mental health conditions also appears to be rising,[66] perhaps due to gradually decreasing stigma related to mental health problems, as well as federal legislation mandating expansion of mental health insurance benefits. It is possible, therefore, that the increasing health-related anxiety Google searches in the United States overall reflect both true increases in the prevalence of anxiety and psychological distress, as well as increased willingness among individuals suffering from symptoms of distress to search for help. We note, however, that our finding of increased health-related anxiety Google searches in Oklahoma after earthquakes adjusted for levels of such searches in the United States as a whole.

Data collection through Google searches may bias our sample. We only captured searches in English, and certain groups—younger, more educated individuals—report using the internet more often for health information.[68] Within Oklahoma, specific subgroups—females, those with history of trauma or preexisting psychological disorders or a high degree of disaster exposure—may have particular susceptibility to adverse effects of earthquakes, including post-traumatic stress disorder.[55,57,69] Due to the ecologic nature of our study, we cannot specifically track these groups that may be under-represented among online searches. In 2013, however, most households in Oklahoma (71.1%) had high-speed internet access.[70] In addition, the majority of Americans seek health information online and most use the internet as their first source of health information.[68] Despite limitations, the use of Google search data allowed us to include timely, spatially comprehensive data in our study. Our results highlight the importance of real-time mental health syndromic surveillance at state and local levels.[71]

The decision to allow, deny, or further modify the wastewater injection linked to earthquakes in Oklahoma[72] likely reflects cost/benefit analyses that include accounting of associated health effects. We posit that better estimates of the suspected mental health consequences of induced earthquakes could improve the regulation of oil and gas extraction. We suggest that the application of time series methods to real-time Google search data would contribute to these estimates. Herein, we demonstrated such an application using data from Oklahoma. Google search data holds particular utility for the study of mental health outcomes,[33] for which many do not immediately, or perhaps ever, seek medical care. We found increased anxiety-related Google search episodes following earthquakes of ≥ magnitude 4. Such searches may indicate elevated rates of anxiety among Oklahomans. Our analyses have illustrated the potential contribution of internet search data to mental health surveillance and, in turn, to the regulation of environmental hazards at the state and local level.

Conflict of interest statement

The authors declare that they have no conflicts of interest with regard to the content of this report.

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