Quantifying the Effects of COVID-19 on Mental Health Support Forums

Laura Biester*, Katie Matton*, Janarthanan Rajendran, Emily Mower Provost, Rada Mihalcea

Computer Science & Engineering, University of Michigan, USA

* = equal contribution
Motivation

COVID-19 has negative consequences for mental health.

Image: eamesBot/Shutterstock
Objective

We aim to quantify how COVID-19 has impacted the behavior of people who post in mental health support forums on Reddit.

Research questions:

1. How often is COVID-19 discussed in mental health subreddits?
2. Has COVID-19 changed the number of users posting in mental health subreddits?
3. Has COVID-19 led to changes in the discussions that users have surrounding mental health?
Data

Reddit posts from three mental health subreddits from January 2017 – May 2020

<table>
<thead>
<tr>
<th></th>
<th>r/Anxiety</th>
<th>r/depression</th>
<th>r/SuicideWatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>95</td>
<td>279</td>
<td>91</td>
</tr>
<tr>
<td>2018</td>
<td>164</td>
<td>449</td>
<td>188</td>
</tr>
<tr>
<td>2019</td>
<td>211</td>
<td>622</td>
<td>285</td>
</tr>
<tr>
<td>2020</td>
<td>243</td>
<td>618</td>
<td>370</td>
</tr>
</tbody>
</table>

Mean Daily Post Count by Year
Anyone go years without knowing what they were experiencing was an anxiety disorder?

I always thought anxiety was all physical symptoms... But I realize now my symptoms include convoluted thoughts about people and situations, genuinely thinking I'm a bother to others... the list goes on.

....

I wanted to see if anyone has had similar experiences of being slow about coming to terms with their anxiety?
Approach Overview

1. Split data into pre-COVID and post-COVID periods

2. **Compute daily metrics** from posts in each period

3. Use **time-series intervention analysis** to measure how metrics in post-COVID period compare to what is expected based on pre-COVID data
Pre/post COVID period

We split the data into two time periods:

**Pre-COVID:**
Jan 1, 2017 – Feb 29, 2020

**Post-COVID:**
March 1, 2020 – May 31, 2020

~50% of Reddit traffic is from the U.S.


New COVID cases per day in the U.S.

Image: Sawyer Click / NBC News
Reddit Activity Metrics

**COVID-19 Discussion Rates**

- COVID-19 lexicon (adapted from [1]) to compute daily % of posts that mention COVID-19

**User Counts**

- Daily # of unique users who post

**Discussion Content**

- **LIWC dictionary** [2]: daily mean % of words in post in each category
- **LDA topic model** [3]: daily mean posterior probability of topic across posts

---

Topics

K=25 topics selected based on coherence scores
Themes include:

• **daily life concerns**: work, school, sleep and routine

• **personal relationships**: friends, family and children, relationships

• **mental health concerns**: anxiety, suicide, medical treatment
Time-Series Intervention Analysis

![Graph showing posterior probability over time with COVID start indicated.](image-url)
Time-Series Intervention Analysis

1. Fit time-series model to pre-COVID data
Time-Series Intervention Analysis

1. Fit time-series model to pre-COVID data
2. Forecast post-COVID values
Time-Series Intervention Analysis

1. Fit time-series model to pre-COVID data
2. Forecast post-COVID values
3. Examine difference between forecasted and observed values

Compute 95% prediction interval for post-COVID period

**Null hypothesis** (no change due to COVID-19): ≤5% of observations outside of prediction interval

Apply **one-sample proportion test** to confirm/reject null hypothesis
Time-Series Model

Prophet model\(^4\) created by Facebook

Additive regression model with three components:

\[ y(t) = g(t) + s(t) + h(t) + \epsilon_t \]

**trend** approximated with piecewise linear model

Time-Series Model

Prophet model\(^4\) created by Facebook

Additive regression model with three components:

\[ y(t) = g(t) + s(t) + h(t) + \epsilon_t \]

*seasonality* approximated with Fourier series

Time-Series Model

Prophet model⁴ created by Facebook

Additive regression model with three components:

\[ y(t) = g(t) + s(t) + h(t) + \epsilon_t \]

*holidays* captured with regression model

---

Time-Series Model

Prophet model\(^4\) created by Facebook

Additive regression model with three components:

\[ y(t) = g(t) + s(t) + h(t) + \epsilon_t \]

Results and Discussion
How often is COVID-19 discussed in mental health subreddits?

- Uptick in March, informing our choice of the post-COVID period
- COVID-19 is discussed earlier and more often on r/Anxiety

Percent of posts mentioning COVID-19 related words across mental health subreddits
Has COVID-19 changed the number of users posting in mental health subreddits?

- Results from prophet modeling
- Intervention = March 2020
- * next to subreddit = statistically significant number of outliers
Has COVID-19 changed the number of users posting in mental health subreddits?

• There is a **small increase** on r/Anxiety

![Graph showing daily active users over time](image)
Has COVID-19 changed the number of users posting in mental health subreddits?

• There is a **small increase** on r/Anxiety

• There is a **small decrease** on r/SuicideWatch in mid-March – April, but activity level eventually becomes normal
Has COVID-19 changed the number of users posting in mental health subreddits?

- There is a **small increase** on r/Anxiety
- There is a **small decrease** on r/SuicideWatch in mid-March – April, but activity level eventually becomes normal
- There is a **clear decrease** on r/depression that persists through the end of May
Has COVID-19 led to changes in the discussions users have surrounding mental health?

We use two types of metrics: LIWC categories and LDA topics.
The Pandemic and Daily Life

Motion

Transport and Daily Life

Family and Home
The Pandemic and Daily Life

Motion

Transport and Daily Life

Family and Home
The Pandemic and Daily Life

- Family and Home
- Transport and Daily Life
- Motion
Work and School

[Graphs showing trends in r/Anxiety, r/depression, and r/SuicideWatch for Work and School]

- Work
- School
Work and School

- Work
- School
Work and School

![Graphs showing trends in r/Anxiety, r/depression, and r/SuicideWatch for Work and School.](Image)
Work and School

Work

School
Anxiety and Health

Anxiety

Biological Processes

Medical Treatment
Anxiety and Health

**Anxiety**

**Biological Processes**

**Medical Treatment**
Anxiety and Health

Anxiety

Biological Processes

Medical Treatment
Anxiety and Health

Anxiety

Biological Processes

Medical Treatment
Collective Experience and Coping

We

I

Information Sharing
Collective Experience and Coping

We

I

Information Sharing
Collective Experience and Coping

We

Information Sharing
Conclusions

• COVID-19 has had a clear impact on mental health subreddits
• The virus is discussed most frequently on r/Anxiety, and the subreddit also has an increase in activity
• Content has shifted, including in some negative ways: increase in discussion of anxiety and decrease in medical treatment
• However, there is room for hope, with increased information sharing and third-person plural usage indicating collective coping