

The Impacts of the COVID-19 Pandemic on Mental Health across Different Genders and Sexualities

Abstract

Current studies report an increase in psychological distress as a result of the COVID-19 pandemic. This study is interested in examining mental health disparities and how the COVID-19 pandemic has disproportionately impacted marginalized groups—and more specifically, those identified by sex, gender, and sexuality—compared with the general population. This study also considers the effects and ramifications of different policy measures taken during the course of the pandemic. We perform exploratory data modeling and analysis on several important and publicly available datasets taken during the pandemic on mental health and COVID-19 infection data across various identity groups to look for significant disparities, correlations, and causations across different times and identities. This paper uses these analyses to suggest policy measures that could improve public wellness during future public health crises, and in particular across different identities.

Keywords: COVID-19, Mental Health, Gender Disparity, Public Health Policy, Vaccination, Data Modeling

1. Introduction

COVID-19 (coronavirus) is an infectious disease which arose in November 2019. As of June 2023, the COVID-19 infection has caused 6,945,714 deaths, along with 768,187,096 cases worldwide, of which the societal consequences have not been resolved (“WHO Coronavirus,” 2023). Aside from physical damage, psychological damage such as panic, anxiety, depression,

and PTSD are evident as well: Around 50% of the U.S. population reported anxiety and depression symptoms, largely caused by social isolation, certain policies regarding the regulation of COVID-19, economic stress, and fear of COVID-19 (Vahratian et al., 2021).

The pandemic also has impacted different demographic groups to disproportional degrees. To better understand and provide appropriate psychological support to these groups, this study looks into the differentiated mental health impacts of COVID-19 on female, male, and sexual and gender minority groups. The Gender Health Paradox reveals that male and female experienced different physical impacts from COVID-19 due to our social construct: Females have higher infection rates but males have higher death rates (Bambra et al., 2020). It would be expected that the mental health of different genders is disproportionately influenced by the COVID-19 pandemic due to similar societal factors and gender norms. As pointed out by a few studies, females are more negatively impacted psychologically than their male counterparts due to things such as restricted access to resources and assets, discrimination in the family, social inequalities, and the gender education gap, along with other intersectional factors that contribute to this phenomenon (Aleksanyan & Weinman, 2022; Lindau et al., 2021).

On the other hand, research has shown that mental health disparity among LGBTQ+ individuals during COVID-19 is significant as well. Due to different healthcare, employment, and social discrimination experiences, LGBTQ+ individuals are also impacted by the pandemic to a disproportionately negative extent, which is reflected by higher rates of mental distress as well as sleeping disorders (Dawson et al., 2021). In particular, the lack of gender-affirming treatment has caused transgender individuals to be more negatively impacted by COVID-19 than the general public (van der Miesen et al, 2020).

The purpose of this study is to address the lack of current literature connecting the intersection of mental health data, the pandemic, and issues of both gender and sexuality through statistical modeling and exploratory data analysis on several important and readily available datasets taken during the pandemic on mental health and COVID-19 infection data across different identity groups around identical time intervals. This study analyzes how and why males and females and those across different sexualities are disproportionately impacted mentally by the COVID-19 pandemic and uses the available data on mental health during the COVID-19 pandemic to suggest future healthcare policy adjustments that better support the mental health and wellbeing of marginalized groups. Factors such as pandemic-prevention-policy went through significant changes after 2020, and this study can provide a more up-to-date analysis of how these policy changes may have affected the general mental health of different groups in the United States.

The hypotheses proposed in this study are that, with the increase of COVID-19 severity, public mental health will worsen in proportion. Furthermore, the introduction of the COVID-19 vaccine and the loosening of pandemic policies afterwards alleviated mental health distress amongst the public. Finally, the mental distress of the female population is expected to be higher than that of the male population and the mental distress of LGBTQ+ individuals is expected to be higher than that of the general public.

2. Methods

2.1 Data Information

The mental health data used in this study were pulled from the Household Pulse Survey collected by the National Center for Health Statistics (NCHS) and the Census Bureau in the U.S.

starting on April 23, 2020. Responses were collected through a 20-minute questionnaire which measures symptoms of anxiety and depression (“Household Pulse Survey”, 2023). The data includes basic groupings of subjects from age, race, education, state, sex, gender identity, and sexual orientation.

The COVID-19 data used in this study were gathered from the Center for Disease Control and Prevention and provides measurements of COVID-19 cases, deaths since March 7, 2020 across groupings of sex, age, region, and race. The statistical analyses were done over a period of April 23, 2020 to March 13, 2023 and are listed below (“Covid Data Tracker”, 2023).

2.2 Methods

For all figures which display tests of statistical significance, the stars by the p-values indicate the level of significance using the same conventions found in R: one star (*) indicates a p-value from 0.01 (inclusive) to 0.05 (exclusive), two stars (**) indicate a p-value from 0.001 (inclusive) to 0.01 (exclusive), and three stars (***) indicate a p-value below 0.001 (R Core Team, 2023).

2.2.1 T-test. Student’s T-test can be used to compare the means of two sample populations by assuming that the samples are normally distributed but according to possibly different means and variances. To measure differentiated mental health experiences amongst varying identity groups, this study performs T-tests between U.S. male and female depression scores, U.S. male and female anxiety scores, U.S. male and female COVID-19 cases and COVID-19 death numbers, U.S. cisgender and transgender individuals’ anxiety scores, U.S. LGBTQIA+ and heterosexual individuals’ anxiety scores, and U.S. bisexual and homosexual individuals’ anxiety scores. In addition, T-tests on U.S. anxiety and depression scores before and after the first vaccine was released were performed to examine the impact of vaccination and the first release of a publicly-available COVID-19 vaccine on mental health.

2.2.2 Interpolation. Data interpolation is a process of computing new data points from existing values in a given interval. While COVID-19 infectious data used in this study is collected in a 7-day-interval, Household Pulse Survey data contains intervals varying from seven to fourteen days. In order to perform more complicated correlation tests and modeling techniques between the two datasets with different time intervals, interpolation was carried out to align data points in U.S. male and female anxiety and depression, and U.S. male and female covid cases and deaths. Interpolations were done at intervals of two weeks (14 days), for the purpose of maintaining the volume of data while minimizing error in timesteps. In this study, we use the `interp` function to perform interpolation (“Interpolation”, n.d.).

2.2.3 Linear Regression. Linear regression is a modeling technique implemented to predict and measure the strength of a linear relationship between two variables. Though not as sophisticated as nonlinear models, linear regression is still often an effective estimator of the strength of association between input and output variables. For this study, we constructed a linear model between U.S. COVID-19 cases and deaths to measure the correlation between those two variables. In addition, to determine whether a certain variable correlates with mental health more, the study performed and compared linear regressions between both depression and COVID-19 cases, and then between depression and COVID-19 deaths, each separately as functions of time. We are neglecting the effects of non-stationarity of each of the variables for this analysis, but we will try to mitigate these effects in other tests (Jung & Shah, 2015). Furthermore, in order to measure the effects of vaccination and the release of the first publicly-available vaccine on the strength of correlations between COVID-19 deaths and depression, the study builds two linear models between the two variables both before and after the first release of vaccination on April 19, 2021.

2.2.4 Granger Causality Test. Granger causality establishes how well one or multiple variables can be used to predict another variable, which in turn implies said variable causes the other variable, particularly useful when variables in question are time series (Rossi, 2013). To gauge the casual relationship between COVID-19 deaths and depression, this study performed a Granger causality test using grangertest function with COVID-19 deaths as a predictor of depression scores with intervals of years (i.e., 2020, 2021, 2022, 2023), as well as with intervals of before and after the release of first vaccination.

2.2.5 Spearman's Correlation. Spearman's correlation is a correlation test measuring the strength of a monotonic and potentially nonlinear relationship between two variables. This study performed Spearman's correlation test, again neglecting the effects of non-stationarity on the analysis, on COVID-19 deaths and U.S. depression scores, as well as COVID-19 cases and U.S. depression and anxiety to further examine the strength of correlation proceeding linear modeling by testing for a monotonic relationship that need not be linear.

2.2.6 Engle-Granger Test. The Engle-Granger test tests whether two underlying observed variables are cointegrated, or $I(0)$, against the null hypothesis that no such relationship exists. By $I(0)$, we mean that the two variables satisfy a linear relationship with an error that follows a stationary time series. This study performed Engle-Granger Tests between COVID-19 deaths and depression, deaths and anxiety, and depression and anxiety.

3. Results

The statistical analyses suggest several broad conclusions. First off, the general U.S. population has experienced mental health problems during COVID-19 which significantly differ depending on gender and sexuality. That is, it appears that the pandemic generally affects

females more than males, and affects the LGBTQ+ population more as well. Next, mental health dilemmas show a greater correlation with the number of deaths due to COVID-19 than merely COVID infection rates. Finally, the eligibility of vaccination and exposure to pandemic knowledge appeared to have had an alleviating effect on the US’s population’s depression and anxiety level.

To start, the analysis confirms a few claims about the Gender Health Paradox, as well as the correlation with COVID-19 cases and deaths, and anxiety and depression scores. Overall, U.S. males have died more from the pandemic, while U.S. females constitute a larger proportion of the infection cases in the states ($p < 0.005$, Figure 1). Moreover, as expected, there is a positive correlation between COVID-19 deaths and cases for both sex ($p < 0.005$, Figure 2). COVID-19 cases are causal to death due to COVID-19 infection in 2020 and 2021 ($p < 0.01$, Figure 3). For the correlation between anxiety and depression, the two mental distress scores are positively correlated with a regression coefficient close to 1, indicating that the two variables are roughly equivalent in terms of modeling and establishing relationships ($p < 0.005$, Figure 4).

Figure 1

Two-Sample t-tests (Depression and Anxiety Scores)

Variables	p-value	weighted t-value
U.S. male v. female depression score	<2.2e-16***	-25.128
U.S. male v. female anxiety score	<2.2e-16 ***	-49.132
U.S. LGBTQ+ v. straight depression score	<2.2e-16***	34.965
U.S. LGBTQ+ v. straight anxiety score	<2.2e-16***	35.579

U.S. gay v. bisexual depression score	7.381e-13***	-15.296
U.S. gay v. bisexual anxiety score	1.895e-13***	-16.403
U.S. transgender v. cisgender depression score	<2.2e-16***	31.633
U.S. transgender v. cisgender anxiety score	3.13e-16***	22.629

Note. This table shows the results of two sample t-tests between different sex, gender, and sexual orientation on their mental health.

Figure 2

Two-Sample t-tests (Pre- and Post-Vaccination)

Variables	p-value	weighted t-value
Female depression score before v. after eligibility	2.095e-12***	11.685
Female anxiety score before v. after eligibility	6.113e-11***	9.5024
Male depression score before v. after eligibility	1.483e-10***	8.8871
Male anxiety score before v. after eligibility	1.597e-11***	9.3073

Note. This table shows the result of two-sample t-tests between mental distress score before when vaccine was eligible and after when vaccine was eligible for both female and male.

Figure 3

Granger Causality Tests

Variables	p-value for F-test	Variables	p-value for F-test
Female deaths ~ cases in 2020	1.087679e-05***	Female depression ~ deaths in 2020	0.3914924

2021	0.4673115	2021	0.01647901*
2022	0.00540509**	2022	0.4200436
2023	0.1340348	2023	0.1003196
Male deaths ~ cases in 2020	1.087679e-05***	Male anxiety ~ deaths in 2020	0.7252502
2021	0.4673115	2021	0.01112981*
2022	0.00540509**	2022	0.3260936
2023	0.1340348	2023	0.3283473
Female anxiety ~ deaths in 2020	0.7528535	Male depression ~ deaths in 2020	0.2415244
2021	5.754688e-05***	2021	0.09539364
2022	0.5019003	2022	0.3463603
2023	0.3031425	2023	0.2838104

Note. This table shows the result of Granger causality test between COVID-19 deaths and cases, as well as between mental distress scores and COVID-19 deaths for all four years of the pandemic (from 2020 to 2023). In particular, this test examines if COVID-19 cases cause COVID-19 deaths and if COVID-19 deaths cause anxiety and depression.

Figure 4

Engle-Granger Tests

Variables	p-value	Regression coefficient
Female anxiety ~ deaths	3.16e-06***	7.217e-04
Female depression ~ deaths	3.02e-07***	5.937e-04
Male anxiety ~ deaths	0.00018***	5.092e-04
Male depression ~ deaths	0.00028***	3.901e-04
Female anxiety ~ depression	<2e-16***	1.25018
Male anxiety ~ depression	<2e-16***	1.23586

Note. This table shows the result of the Engle-Granger test between mental distress scores and COVID-19 deaths, as well as between anxiety scores and depression scores.

Sex, gender, and sexuality have a notable impact on anxiety and depression scores of the U.S. population. The study confirmed that females have a significantly higher mental distress score than males for both anxiety and depression ($p < 0.005$, Figure 1), with a greater disparity in anxiety level. In addition, for both sexes, depression scores are higher than anxiety scores ($p < 0.005$, Figure 1). Furthermore, it appears mental dilemmas, including anxiety and depression, are more significantly correlated with COVID-19 deaths for the female population than the male population (Figure 5).

Figure 5

Linear Regression and Spearman’s Correlation Tests

Variables	p-value for linear regression coefficient t-test	p-value for Spearman’s correlation test
Female anxiety ~ deaths	3.16e-06***	0.002928**
Female anxiety ~ cases	0.61	0.4513
Female depression ~ deaths	3.02e-07***	7.38e-05***
Female depression ~ cases	0.48	0.4416
Male anxiety ~ deaths	0.00018***	0.01139*
Male anxiety ~ cases	0.945	0.4661
Male depression ~ deaths	0.00028***	0.006142**
Male depression ~ cases	0.904	0.3915

Note. This table shows the result between COVID-19’s death and case, and mental distress scores. In these linear models, deaths and cases are used as explanatory variables for mental distress for both female and male. For all cases, the linear trend is positive.

When including the grouping of LGBTQ+ population, the study indicates that the LGBTQ+ community generally has greater mental distress during the pandemic than the rest of the population. In terms of gender, transgender groups experience far higher anxiety and depression scores than both cisgender males and females ($p < 0.005$, Figure 1). On the other hand, in terms of sexuality, the LGBTQ+ community, which, in this case, contains gay, queer, and bisexual individuals, have significantly higher anxiety and depression scores than heterosexual individuals ($p < 0.005$, Figure 1). In addition, when separating the LGBTQ+ community into gay/queer, and bisexual groups, bisexual individuals tend to experience greater mental distress than both homosexual and heterosexual individuals ($p < 0.005$, Figure 1).

In addition, as observed from the data analysis, COVID-19 deaths appear to be a better predictor of and are apparently more correlated with mental distress in the U.S. population than COVID-19 cases. While deaths related to COVID-19 appear to be causally correlated with COVID-19 cases (as one would expect), anxiety and depression scores appear to correlate with COVID-19 deaths but not as much with COVID-19 cases for both sexes ($p < 0.005$, Figure 2). The positive correlation between mental distress and deaths remains significant even until 2023. In terms of Granger causality, anxiety and depression level appears to be caused by COVID-19 deaths to a statistically significant extent during 2021, when the pandemic is considerably during its worst, though casualties aren't significant in 2020, or 2022 and 2023. COVID-19 deaths are causal to female anxiety level ($p < 0.005$, Figure 3) and female depression level ($p < 0.05$, Figure 3). On the other hand, COVID-19 deaths are roughly causal to male anxiety ($p < 0.05$, Figure 3), whereas COVID-19 deaths cause anxiety distress for both sexes with a stronger level of statistical significance, both in the sense of Granger causality.

The availability of the COVID-19 vaccine in April 2021 is correlated with a significant decrease in mental distress for both males and females ($p < 0.005$, Figure 5). When the vaccine was not available, COVID-19 deaths were positively correlated with anxiety and depression scores ($p < 0.005$, Figure 6). On the other hand, after the vaccine became eligible for the public, the correlations became no longer significant (Figure 6).

Figure 6

Linear Regression Test (Vaccination)

Variables	p-value for coefficient	Regression coefficient
Female anxiety ~ deaths before eligibility	8.58e-05***	7.012e-04
Female anxiety ~ deaths after eligibility	0.256	-0.0001378
Female depression ~ deaths before eligibility	0.000176***	4.730e-04
Female depression ~ deaths after eligibility	0.892	7.882e-06
Male anxiety ~ deaths before eligibility	0.00123**	4.808e-04
Male anxiety ~ deaths after eligibility	0.0971	-0.0002176
Male depression ~ deaths before eligibility	0.0173*	3.168e-04
Male depression ~ deaths after eligibility	0.188	-0.0001253

Note. This table shows the result of linear regression between mental distress scores and COVID-19 deaths. COVID-19 deaths are used as explanatory variables of mental distress for both female and male populations.

4. Discussion

In summary, the results suggest that COVID-19—or in particular, deaths due to COVID-19 infection—appeared to have caused a rise in the U.S. population’s mental distress (Figure 2). In addition, the results suggest that females have been more mentally impacted by the pandemic and that anxiety has been more causally related to COVID-19 deaths than depression. Several studies suggest a lack of attention to patients’ general care due to the large need for servicing COVID-19 patients in particular during the pandemic has also led to an increase in mental distress among the overall population (Blanchflower & Bryson, 2022; Cullen et al., 2020). Thus, preventive strategies for COVID-19 deaths as well as improvement for patient and public care through effective medical and policy strategies could effectively alleviate mental distress in the U.S.

COVID-19 appears to have negatively impacted the female population more than their male counterparts, at least as reported by the mental health survey data available (Figure 6). Social gender norms such as restricted access to resources and assets, discrimination in the family; lack of inclusion of women in familial finances; and gender education gap contribute to women having less decision-making power and therefore access to treatment resources (Aleksanyan & Weinman, 2022). As healthcare workers are largely female, the women population is associated with a greater risk of mental disorders as a result of frontier pandemic work and the stress involved with it (Thibaut & Wijngaarden-Cremers, 2020). However, relative to females, males are less likely to seek help from mental health services, which could be a notable reason for the lower reported mental distress score for men (Smith et al., 2018).

Our results also suggest that the LGBTQ+ community appears to experience greater mental distress than the rest of the population in the U.S. (Figure 1). For transgender individuals, the unexpected high mental risk is associated with historical discrimination as well as a lack of

gender-affirming treatments during the pandemic (van der Miesen et al, 2020). Similarly, gay and bisexual individuals experience higher mental distress scores than heterosexual individuals, which could be due to discrimination, loss of support system, and, more importantly, medical discrimination when receiving treatments (Pharr et al, 2022). Moreover, among different sexuality groups, the bisexual group is evidently more vulnerable to the mental health impact of COVID-19, as a result of weaker senses of belonging with the LGBTQ+ community (Chan et al., 2020).

More importantly, our results indicate a correlation between the eligibility of vaccination and decrease in mental distress among the U.S. population. Both anxiety and depression levels significantly decreased after the first vaccine was made eligible after April 19, 2021 (Figure 5, Figure 6). Before eligibility, increases in COVID-19 deaths were positively correlated with mental distress, but then the correlation became no longer significant after April 2021, indicating the public's mental distress was no longer significantly impacted by COVID-19 deaths. Notably, the U.S. female population experienced a greater decrease in anxiety and depression scores than the U.S. male population, consistent with the results found by (Chaudhuri & Howley, 2022). Other studies also indicate that an increase in vaccination rate was associated with a decrease in the negative effect that COVID-19 cases have had on the U.S. public's mental distress during 2021 and 2022 (Blanchflower & Bryson, 2022). People were less anxious about COVID-19 after knowing vaccines were available and pandemic restrictions were loosened, which have been observed by other studies (Coley et al., 2023). Although vaccination has a positive correlation with mental wellness, the trend observed in the study could also have been caused by more social interaction, less frequent lockdowns, and better socioeconomic status after vaccines were made available and things returned to a rough sense of normalcy.

Finally, when analyzing the evolution of mental health and COVID-19 deaths throughout the four years of the pandemic (2020 to 2023) using the Granger causality test, the causal relationship between COVID-19 deaths and mental distress appears to be only significant during 2021, when COVID-19 deaths sparked anxiety and depression for both biological sexes (Figure 3). However, other studies have suggested that mental distress spiked in 2020 but improved in later years as a result of the aforementioned factors such as exposure to knowledge and vaccination (Blanchflower & Bryson, 2022). The two observations could still be valid and tell two sides of a similar story. The causation could be explained as the public's response to the sudden exposure to information about the pandemic, together with frequent transitions between the COVID-19 pandemic lockdown and freedom of movement, caused a surge of anxiety among the public, whereas in 2020, constant quarantine and intransparent pandemic news and reported knowledge on the virus could have shielded the public from mental distress and exposure to COVID-19.

5. Conclusion

Overall, our study suggests that disparities in mental distress exist across sex, gender, and sexuality, and in particular that females and members of the LGBTQ+ community have been more impacted psychologically by the pandemic. But also, rather than COVID-19 cases, COVID-19 deaths appear to be the main cause of psychological distress for the U.S. population as a whole. However, the availability of the COVID-19 vaccine for the public proved to be evident in improving the general public's mental health, either due to psychological, social, or public health-related factors. More importantly, the aforementioned vulnerable groups appeared

to experience greater improvement in mental distress than the rest once the vaccine was made available.

In addition, this study revealed a few trends that are significant to policy decisions in the case of future pandemics and natural disasters. Firstly, we should expect a rise in pandemic impacts to spark a rise in public mental distress due to fear and anxiety, and the disparity in mental health across people of different identities is a long-term issue which the U.S. population continues to face. As a result, policy should aim to increase, or at the very least maintain, sufficient mental support providers for both patients with prescribed mental disorders and the general public even during the more serious stages of the pandemic. Secondly, it should be expected a priori that societally marginalized groups would receive more severe psychological impacts from the pandemic, and hence, future policies should focus on the needs of more vulnerable demographic groups at the beginning of the pandemic in order to minimize possible mental distress, including more inclusive healthcare policy and fostering a supportive social media environment that increases the visibility of minority groups to alleviate the impacts brought on by social isolation (Craig et al., 2021). Lastly, although exposure to pandemic knowledge would increase public mental distress at first, this study shows information transparency, death preventive strategies, and availability of vaccination could decrease the pandemic's impact on public mental health.

From our findings, we suggest a few directions of policymaking for COVID-19 and future global pandemics. The results of the data analyses suggest that the government should implement public care policies that focus on engaging with individuals' socioeconomic situations resulting from the COVID-19 pandemic and for future pandemics. These policies should also aim to address individual disparities in pandemic experiences, including a more

supportive healthcare system that is responsive to gender and sexuality-specific disparities with practices such as gender-affirming care.

One may also be interested in expanding the results of this study outside of the U.S. However, since most countries lack effective and complete metrics for mental health, COVID-19 data that covers the full length of the pandemic up to now, or data that incorporate information about multiple marginalized groups simultaneously, the framework of analysis introduced in this study currently cannot be used to come to effective conclusions on the global impacts of COVID-19 and how these differ across different countries. Thus, we suggest future research and data collection in other countries to focus on comparing mental health data across different cultures which involves data that feature a more diverse sampling of demographic groups.

In the end, the research has a broader purpose than just specific public health policy recommendations. As the world is going through breakthroughs and developments, it is important to adjust and improve social welfare and public health policies accordingly. As shown in this study, the trove of mental health data during the COVID-19 pandemic has been demonstrated to be an effective signal of the need for better mental health policies and interventions. We must build a more resilient health care and psychological system that is well-planned to withstand future pandemics like COVID-19. This data-driven study should stand as a call to action for further multidisciplinary studies that address the world's individual and group needs under uncertain times.

References

Aleksanyan, Y., & Weinman, J. P. (2022). Women, men and COVID-19. *Social science & medicine* (1982), 294, 114698. <https://doi.org/10.1016/j.socscimed.2022.114698>

- Bambra, C., Albani, V., & Franklin, P. (2020). COVID-19 and the gender health paradox. In *Scandinavian Journal of Public Health* (Vol. 49, Issue 1, pp. 17–26). SAGE Publications. <https://doi.org/10.1177/1403494820975604>
- Blanchflower, D. G., & Bryson, A. (2022). Covid and mental health in America. *PloS one*, 17(7), e0269855. <https://doi.org/10.1371/journal.pone.0269855>
- CDC. (2023a, August 16). Mental Health - Household Pulse Survey - COVID-19. Centers for Disease Control and Prevention. <https://www.cdc.gov/nchs/covid19/pulse/mental-health.htm>
- CDC. (2023b, September 9). CDC COVID Data Tracker. Centers for Disease Control and Prevention. <https://covid.cdc.gov/covid-data-tracker/#datatracker-home>
- Chan RCH, Operario D, Mak WWS. Bisexual individuals are at greater risk of poor mental health than lesbians and gay men: The mediating role of sexual identity stress at multiple levels. *J Affect Disord*. 2020 Jan 1;260:292-301. doi: 10.1016/j.jad.2019.09.020. Epub 2019 Sep 4. PMID: 31521866.
- Chaudhuri, K., & Howley, P. (2022). The impact of COVID-19 vaccination for mental well-being. *European Economic Review*, 150, 104293. <https://doi.org/10.1016/j.eurocorev.2022.104293>
- Coley, R. L., Carey, N., Baum, C. F., & Hawkins, S. S. (2023). COVID-19 vaccinations and mental health among U.S. adults: Individual and spillover effects. *Social science & medicine* (1982), 329, 116027. <https://doi.org/10.1016/j.socscimed.2023.116027>
- Craig, S. L., Eaton, A. D., McInroy, L. B., Leung, V. W., & Krishnan, S. (2021). Can Social Media Participation Enhance LGBTQ+ Youth Well-Being? Development of the Social Media Benefits Scale. *Social Media + Society*, 7(1), 205630512198893. <https://doi.org/10.1177/2056305121988931>
- Cullen, W., Gulati, G., & Kelly, B. D. (2020). Mental health in the COVID-19 pandemic. In *QJM: An International Journal of Medicine* (Vol. 113, Issue 5, pp. 311–312). Oxford University Press (OUP). <https://doi.org/10.1093/qjmed/hcaa110>
- Dawson, D., McGough, M., Kirzinger, A., Sparks, G., Rae, M., Young, G., & Kates, J. (2021, August 27). The impact of the COVID-19 pandemic on LGBT+ People's Mental Health. KFF. <https://www.kff.org/mental-health/issue-brief/the-impact-of-the-covid-19-pandemic-on-lgbt-peoples-mental-health/>

- Jung, K., Shah, N. H. (2015). Implications of non-stationarity on predictive modeling using EHRs. *Journal of Biomedical Informatics*, 58, 168–174. <https://doi.org/10.1016/j.jbi.2015.10.006>
- Lindau, S. T., Makelarski, J. A., Boyd, K., Doyle, K. E., Haider, S., Kumar, S., Lee, N. K., Pinkerton, E., Tobin, M., Vu, M., Wroblewski, K. E., & Lengyel, E. (2021). Change in Health-Related Socioeconomic Risk Factors and Mental Health During the Early Phase of the COVID-19 Pandemic: A National Survey of U.S. Women. *Journal of Women's Health*, 30(4), 502–513. <https://doi.org/10.1089/jwh.2020.8879>
- Pharr, J. R., Terry, E., Wade, A., Haboush-Deloye, A., Marquez, E., & Nevada Minority Health And Equity Coalition (2022). Impact of COVID-19 on Sexual and Gender Minority Communities: Focus Group Discussions. *International journal of environmental research and public health*, 20(1), 50. <https://doi.org/10.3390/ijerph20010050>
- R Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org>
- Rossi, B. (2013). Advances in Forecasting under Instability. *Handbook of Economic Forecasting*, 1203–1324. <https://doi.org/10.1016/b978-0-444-62731-5.00021-x>
- Smith, D. T., Mouzon, D. M., & Elliott, M. (2018). Reviewing the Assumptions About Men's Mental Health: An Exploration of the Gender Binary. *American journal of men's health*, 12(1), 78–89. <https://doi.org/10.1177/1557988316630953>
- Thibaut, F., & Wijngaarden-Cremers, P. J. (2020). Women's Mental Health in the Time of Covid-19 Pandemic. *Frontiers in Global Women's Health*, 1. <https://doi.org/10.3389/fgwh.2020.588372>
- UCLA. (n.d.). Interpolation Functions. R: Interpolation Functions. <https://www.math.ucla.edu/~anderson/rw1001/library/base/html/approxfun.html#:~:text=approx%20returns%20a%20list%20with,of%20the%20given%20data%20points>
- Vahratian, A., Blumberg, S., Terlizzi, E., & Schiller, J. (2021, April 1). Symptoms of anxiety or depressive disorder and use of mental health care among adults during the COVID-19 pandemic - United States, August 2020–February 2021. Centers for Disease Control and Prevention. <https://www.cdc.gov/mmwr/volumes/70/wr/mm7013e2.htm>
- van der Miesen, A. I., Raaijmakers, D., & van de Grift, T. C. (2020). “You Have to Wait a Little Longer”: Transgender (Mental) Health at Risk as a Consequence of Deferring Gender-Affirming Treatments During COVID-19. *Archives of Sexual Behavior*, 49(5), 1395–1399. <https://doi.org/10.1007/s10508-020-01754-3>

WHO. (n.d.). WHO Coronavirus (COVID-19) Dashboard. World Health Organization.
<https://covid19.who.int/>