

Original Article

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# Relationship between mental health diagnoses and COVID-19 test positivity, hospitalization, and mortality in Southeast Wisconsin

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**Abstract**

**Background.** There is a paucity of literature on the relationship between pre-existing mental health conditions and coronavirus disease-2019 (COVID-19) outcomes. The aim was to examine the association between pre-existing mental health diagnosis and COVID-19 outcomes (positive screen, hospitalization, mortality).

**Methods.** Electronic medical record data for 30 976 adults tested for COVID-19 between March 2020 and 10th July 2020 was analyzed. COVID-19 outcomes included positive screen, hospitalization among screened positive, and mortality among screened positive and hospitalized. Primary independent variable, mental health disorders, was based on ICD-10 codes categorized as bipolar, internalizing, externalizing, and psychoses. Descriptive statistics were calculated, unadjusted and adjusted logistic regression and Cox proportional hazard models were used to investigate the relationship between each mental health disorder and COVID-19 outcomes.

**Results.** Adults with externalizing (odds ratio (OR) 0.67, 95%CI 0.57–0.79) and internalizing disorders (OR 0.78, 95% CI 0.70–0.88) had lower odds of having a positive COVID-19 test in fully adjusted models. Adults with bipolar disorder had significantly higher odds of hospitalization in fully adjusted models (OR 4.27, 95% CI 2.06–8.86), and odds of hospitalization were significantly higher among those with externalizing disorders after adjusting for demographics (OR 1.71, 95% CI 1.23–2.38). Mortality was significantly higher in the fully adjusted model for patients with bipolar disorder (hazard ratio 2.67, 95% CI 1.07–6.67).

**Conclusions.** Adults with mental health disorders, while less likely to test positive for COVID-19, were more likely to be hospitalized and to die in the hospital. Study results suggest the importance of developing interventions that incorporate elements designed to address smoking cessation, nutrition and physical activity counseling and other needs specific to this population to improve COVID-19 outcomes.

**Introduction**

Since the emergence of severe acute respiratory syndrome-associated coronavirus (SARS-CoV-2), or coronavirus disease-2019 (COVID-19), in December 2019, understanding the etiology, symptomology, and spread of the virus has been the focus of attention to effectively mitigate global impact (Bulut & Kato, 2020; Ge et al., 2020; Madabhavi, Sarkar, & Kadakol, 2020; Rothan & Byrareddy, 2020; Sun, Lu, Xu, Sun, & Pan, 2020). Unfortunately, as of 13 November 2020 there have been more than 10.5 million cases of COVID-19, and more than 240 000 people have died as a result of the disease in the US (CDC, 2020a). Preliminary research has shown that severity and mortality of COVID-19 is associated with older age and chronic conditions such as hypertension, diabetes, cardiovascular disease, and chronic obstructive pulmonary disease (COPD) (Cevik, Bamford, & Ho, 2020). The virus attacks the respiratory system, resulting in a range of symptoms including common ones like cough, fever, fatigue and myalgia (Bulut & Kato, 2020; Tang, Comish, & Kang, 2020) as well as the more severe such as nausea, vomiting, diarrhea, acute respiratory distress syndrome (ARDS), and multi-organ dysfunction (Madabhavi et al., 2020). However, beyond the severe attack on the respiratory system, recent research suggests there is a neurological aspect to this disease as well (Ellul et al., 2020). As such, in addition to understanding the physical impacts, understanding of the impact of COVID-19 on mental health is also key (Xiang et al., 2020).

There were 46.6 million adults in the US with a mental illness in 2017 (NIMH, 2019), and serious mental illness results in \$193.2 billion in lost earnings each year in the US and \$1 trillion in lost productivity each year worldwide (NAMI, 2019). Mental health diagnoses can be



categorized as bipolar, internalizing, externalizing, and psychotic disorders. Specifically, bipolar I disorder is described as a condition resulting in changes in mood, ability to concentrate, and energy, and may be characterized by manic and depressive episodes possibly requiring hospitalization (NIMH, 2020). Internalizing disorders include conditions in which the individual impacted will keep problems to themselves and may manifest as depression, anxiety, or phobias. Externalizing disorders represent the development of maladaptive behaviors such as alcohol, drug dependence, or antisocial personality disorders (Krueger, 1999; Sbrana et al., 2005). Psychotic disorders include being schizoid, paranoid, having misperceptions, and interpersonal sensitivity (Sbrana et al., 2005).

Several studies report elevated levels of neuropsychiatric disorders such as anxiety, depression, panic attacks, post-traumatic stress disorder (PTSD), suicidal ideation, and psychosis as a result of the COVID-19 pandemic (de Burgos-Berdud, Jose Valdes-Florado, & Lopez-Diaz, 2020; Moghanibashi-Mansourieh, 2020; Pfefferbaum & North, 2020; Shuja, Aqeel, Jaffar, & Ahmed, 2020; Tsamakidis et al., 2020). For example, there has been an increase in the percentages of US adults reporting serious psychological distress (SPD) and feeling lonely, increasing from 3.9% and 11% in April 2018 to 13.6% and 13.8% in April 2020, respectively (McGinty, Presskreischer, Han, & Barry, 2020). Several researchers have identified vulnerable populations that are most at-risk for developing mental illness as a result of the COVID-19 pandemic including the elderly, homeless, migrant workers, pregnant women, students, individuals with pre-existing mental illness, and healthcare workers (Campion, Javed, Sartorius, & Marmot, 2020; Fiorillo & Gorwood, 2020; Rajkumar, 2020). Public health prevention recommendations in the US, while beneficial for reducing the spread of the virus, may have a negative impact on mental health outcomes (Fiorillo & Gorwood, 2020; Galea, Merchant, & Lurie, 2020; Hewson, Shepherd, Hard, & Shaw, 2020). Multiple studies suggest that these recommendations, such as stay-at-home orders, social distancing, and quarantine, increase feelings of isolation and loneliness (Galea et al., 2020; Poudel & Subedi, 2020).

Few studies, however, have examined the relationship between pre-existing mental health and COVID-19 outcomes. One such study found that patients with pre-existing dementia who tested positive for COVID-19 had a higher mortality rate compared to patients without dementia (Bianchetti et al., 2020). Other studies found patients with a mental health disorder were at increased risk of COVID infection and increased mortality (Maripuu, Bendix, Ohlund, Widerstrom, & Werneke, 2021; Nemani et al., 2021; Wang, Xu, & Volkow, 2020). COVID-19 has been associated with adverse effects on the brain including dizziness, headache, impaired consciousness, and cerebrovascular complications (Varatharaj et al., 2020; Yao, Chen, & Xu, 2020) with studies suggesting that patients with mental illness suffer additional symptoms such as delirium, altered consciousness, and encephalitis (Rogers et al., 2020). Emerging evidence suggests individuals with serious mental illness have an increased risk of infection due to impaired cognition and institutional barriers of healthcare (Rogers et al., 2020; Shinn & Viron, 2020), yet none of these studies discuss the effects of mental health diagnosis associated with COVID-19. Due to this gap in the literature, this study aimed to understand whether a mental health diagnosis (defined as bipolar I, internalizing, externalizing, or psychotic disorders) is associated with COVID-19 outcomes including the likelihood of testing positive, being hospitalized if tested positive, or dying if tested positive.

## Study data and methods

### Population

The Medical College of Wisconsin Institutional Review Board approved a HIPAA waiver for this study which used de-identified data collected from the electronic medical record. As such, obtaining informed consent was not required. In this cross-sectional analysis, data were obtained from the Froedtert & Medical College of Wisconsin (MCW) health network Epic medical record. The primary hospital for the Froedtert & MCW health network is located in Milwaukee County, other four additional hospitals within the health network are located in surrounding counties. The Froedtert & MCW health network operates nearly 40 health centers and clinics and is the only academic medical center in eastern Wisconsin.

The Froedtert & MCW health network has conducted approximately a quarter of all COVID-19 testing in the state of Wisconsin to date. Criteria for testing changed over time based on updated recommendations from the Center for Disease Control and Prevention (CDC, 2020b). During the initial phase of the pandemic, testing was provided only for symptomatic individuals, however in May 2020, testing guidelines changed and expanded to allow healthcare workers, students, and other asymptomatic individuals with suspected exposure to COVID-19. Additionally, patients being admitted or scheduled for a procedure were tested for COVID-19. Criteria for COVID-19 screening and treatment was consistent across hospitals and clinics within Froedtert & MCW network.

Data were extracted from the medical records on 20th July 2020, and included all adults tested for COVID-19 between March and 10th July 2020. There were 33 065 patients aged 18 and above with a COVID-19 medical lab test. Among them, 30 976 patients had medical diagnosis history prior to the COVID-19 test. This analysis included 30 976 adults with a definitive COVID-19 test result and prior medical diagnosis history.

### COVID-19 status

COVID-19 testing was conducted by collecting two swabs from each patient, a nasopharyngeal specimen and oropharyngeal specimen, respectively. Swabs were transported to the laboratory in viral transport media, and testing was performed using the CDC approved real-time polymerase chain reaction (RT-PCR) COVID-19 assay per the CDC protocol (CDC, 2020c).

All patients with completed COVID-19 tests were identified using the medical lab test record. Patients were considered to be confirmed cases if the initial test or follow-up test result was marked as 'Detected'.

### Variables

#### Outcome variables: COVID-19 status, hospitalization, mortality

Structured Query Language (SQL) was used to abstract data from the electronic medical record. Three outcome variables were abstracted: (1) *COVID-19 status*, COVID-19 status was based on test result and categorized as positive ('Detected') or negative ('Undetected'). (2) *Hospitalization*, Patients with confirmed COVID-19 were identified as being hospitalized or not hospitalized by an inpatient admission. (3) *All-cause mortality*. All-cause mortality was based on individuals indicated as

'deceased' in the medical record, with the last follow-up date of 20<sup>th</sup> July 2020.

### Primary independent variables: psychiatric disorders

Psychiatric disorders were classified into four dimensions including bipolar, internalizing, externalizing, and psychotic disorders (Prisciandaro et al., 2011). Krueger (1999) used confirmatory factors analysis to identify the diagnoses that should be used to create the internalizing and externalizing latent factors. Depression, dysthymia, anxiety, and phobias were found to load well on two latent variables, anxious-misery (0.93) and fear (0.78). When combined, the overall factor loading was 0.73 indicating valid measures were used to construct the internalizing dimension (Krueger, 1999). Alcohol (0.79) and drug dependence (0.84) along with antisocial personality disorder (0.74) all loaded well to the latent externalizing factor (Krueger, 1999). Schizophrenia and schizoaffective disorders were identified as the key diagnoses used to capture psychotic disorders (Sbrana et al., 2005). Psychiatric disorders were classified using the four aforementioned dimensions and (Krueger, 1999; Prisciandaro et al., 2011; Sbrana et al., 2005) were represented by four dichotomous variables:

- 1) **Bipolar I disorder** (Mania and bipolar affective disorder – ICD-9 codes 296.0, 296.4–296.7; ICD-10 codes F30.1–F30.4, F30.9, F31.1–F31.6, F31.73–F31.78, F31.9).
- 2) **Internalizing disorder** (Depression, mood disorder, phobia, anxiety, post-traumatic stress disorder – ICD-9 codes 300.02, 296.2–296.3, 300.4, 309.81, 300.01, 300.21, 300.22; ICD-10 codes F41.1, F32, F33, F34.1, F43.1, F41.0, F40.01, F40.02).
- 3) **Externalizing disorder** (alcohol and drug abuse – ICD-9 codes 305.0, 303.9, 305.1–305.9, 304.0–304.9; ICD-10 codes F10.10–F10.11, F10.20–F10.21, F11.10–F11.11, F12.10–F12.11, F12.90, F13.10–F13.11, F14.10–F14.11, F15.10–F15.11, F16.10–F16.11, F18.10–F18.11, F19.10–F19.11, F11.20–F11.21, F12.20–F12.21, F13.20–F13.21, F14.20–F14.21, F15.20–F15.21, F16.20–F16.21, F19.20–F19.21).
- 4) **Psychotic disorder** (schizophrenia, schizoaffective disorders – ICD9 codes 295.1–295.4, 295.6–295.7; ICD-10 codes F20.0–F20.2, F20.5, F20.81, F25.0–F25.1).

### Covariates

Demographic information included sex (categorized as male or female), age (at date of COVID-19 test, used as a continuous variable), race/ethnicity (based on self-report in the medical record, and categorized as non-Hispanic White, non-Hispanic Black, and Hispanic/Other), county of residence (based on zip code, and categorized into Milwaukee county, and other Wisconsin county/out of state), and primary payor (categorized as Insurer paid or Self-pay). Risk factors included tobacco use (categorized into never smoked, former smoker, and current smoker), and body mass index [calculated from most recent height and weight, categorized by obesity as yes (BMI  $\geq$  30) or no (BMI < 30)].

### Statistical analysis

Descriptive statistics were used to summarize sample characteristics for the sample of any individual tested, and the sample of individuals with a positive COVID-19 test result. ANOVA, Chi-square, and Fisher's exact tests were used to calculate

differences between demographic and clinical factors by four categories of psychiatric disorders (bipolar I disorder, internalizing disorder, externalizing disorder, psychotic disorder) separately for two samples.

Unadjusted and adjusted logistic regression and Cox proportional hazard models were used to investigate the independent relationship between each psychiatric disorder and COVID-19-related outcomes. The first set of models estimated the odds of having a confirmed COVID-19 case by each psychiatric disorder within all adults tested in the health system using logistic regression with the test result as the outcome. Four models were run with one of the psychiatric disorder types serving as the primary independent variable in each model. The second set of models estimated the odds of hospitalization by each psychiatric disorder within adults with a confirmed COVID-19 test using logistic regression with hospitalization as the outcome. Again, four models were run with one of the psychiatric disorder types serving as the primary independent variable in each model. The third set of models estimated the hazard ratio for mortality by each psychiatric disorder within adults with a confirmed COVID-19 test using a Cox proportional hazards model. Four models were run with one of the psychiatric disorder types serving as the primary independent variable in each model. After unadjusted analyses, each model was adjusted for sex, age, race/ethnicity, geographic location, primary payor, tobacco use, and obesity. All analyses were performed using SAS version 9.4 (SAS Institute, Cary NC) with  $p < 0.05$  was considered statistically significant.

### Results

Table 1 shows sample characteristics for adults tested for COVID-19 in the hospital system overall and stratified by mental health disorder. Overall, the majority were female (60%), non-Hispanic White (74%), and non-smokers (53.8%), and 6.8% had a COVID positive test. Similar results were found for bipolar, internalizing, and externalizing disorders, with the majority being female (70.3, 70.9, 51.9%, respectively), and non-Hispanic White (67.6, 74.6, 65.3%, respectively). However, among individuals with a psychotic disorder, the majority were male (50.5%), non-Hispanic Black (52%), and current smokers (43.8%). Patients with a psychotic disorder had the largest percentage of COVID positive tests (9.3%) compared to those with bipolar (4.9%), internalizing (5.1%), and externalizing disorders (4.3%). COVID positive tests were significantly lower among patients with bipolar disorder compared to those who did not have bipolar disorder (4.9% *v.* 6.8%;  $p = 0.031$ ), lower among patients with internalizing disorder compared to those who did not have internalizing disorder (5.1% *v.* 7.5%;  $p < 0.001$ ), and lower among patients with externalizing disorder compared to those who did not have externalizing disorder (4.3% *v.* 7.3%;  $p < 0.001$ ). There was no statistical difference between the percentage of COVID positive tests among patients with and without psychotic disorder (9.3% *v.* 6.8%;  $p = 0.150$ ).

Table 2 shows sample characteristics for adults who tested positive for COVID-19 overall and stratified by mental health disorder. Overall, the majority were female (57.7%), non-Hispanic White (44.9%), and non-smokers (63.5%). About 24% were hospitalized, and 5.2% died. The percentage of patients hospitalized was statistically significantly different ( $p = 0.0086$ ) across mental health disorders, with 55.3% of those with bipolar disorder, 23.0% of those with internalizing disorder, 33.2% of those with externalizing disorder, and 47.4% of those with a psychotic

**Table 1.** Characteristics of adults tested for COVID-19 in Milwaukee and Southeast Wisconsin by mental health disorder

	Total ( <i>n</i> = 30976)	Bipolar disorder ( <i>n</i> = 780)	Internalizing disorder ( <i>n</i> = 9344)	Externalizing disorder ( <i>n</i> = 5531)	Psychotic disorder ( <i>n</i> = 204)
Sex		***	***	***	**
Female	60.0%	<b>70.3%</b>	<b>70.9%</b>	<b>51.9%</b>	<b>49.5%</b>
Male	40.0%	<b>29.7%</b>	<b>29.1%</b>	<b>48.1%</b>	<b>50.5%</b>
Age, mean (s.d.)	52.8 (18.9)	<b>49.3 (15.0)***</b>	<b>53.2 (17.9)**</b>	53.0 (15.6)	54.5 (14.6)
Race/ethnicity		***	***	***	***
NH White	74.0%	<b>67.6%</b>	<b>74.6%</b>	<b>65.3%</b>	<b>45.6%</b>
NH Black	18.8%	<b>28.5%</b>	<b>19.6%</b>	<b>30.1%</b>	<b>52.0%</b>
Hispanic	4.4%	<b>3.3%</b>	<b>4.0%</b>	<b>3.1%</b>	<b>2.5%</b>
Other	2.8%	<b>0.6%</b>	<b>1.8%</b>	<b>1.5%</b>	<b>0%</b>
Location		***	***	***	***
Milwaukee county	44.4%	<b>57.1%</b>	<b>48.4%</b>	<b>54.5%</b>	<b>74.5%</b>
Waukesha county	19.5%	<b>14.4%</b>	<b>19.5%</b>	<b>13.9%</b>	<b>6.4%</b>
Washington/Ozaukee county	18.8%	<b>18.2%</b>	<b>20.9%</b>	<b>20.8%</b>	<b>13.7%</b>
Racine/Kenosha county	11.3%	<b>6.8%</b>	<b>6.7%</b>	<b>6.4%</b>	<b>2.9%</b>
Other county/out of state	5.9%	<b>3.6%</b>	<b>4.5%</b>	<b>4.4%</b>	<b>2.5%</b>
Primary payor		***	***	***	***
Managed care	44.6%	<b>18.1%</b>	<b>39.7%</b>	<b>29.7%</b>	<b>4.9%</b>
Medicare	35.9%	<b>48.1%</b>	<b>40.2%</b>	<b>40.0%</b>	<b>67.2%</b>
Medicaid	12.9%	<b>30.8%</b>	<b>15.7%</b>	<b>24.8%</b>	<b>26.5%</b>
Self-pay	4.3%	<b>1.7%</b>	<b>2.3%</b>	<b>3.3%</b>	<b>1.0%</b>
Other	2.4%	<b>1.4%</b>	<b>2.1%</b>	<b>2.3%</b>	<b>0.5%</b>
Tobacco use status		***	***	***	***
Non-smoker	53.8%	<b>28.6%</b>	<b>46.1%</b>	<b>13.2%</b>	<b>28.1%</b>
Current smoker	13.9%	<b>38.1%</b>	<b>17.4%</b>	<b>46.4%</b>	<b>43.8%</b>
Former smoker	32.3%	<b>33.2%</b>	<b>36.5%</b>	<b>40.4%</b>	<b>28.1%</b>
BMI, mean (s.d.)	30.4 (8.2)	<b>32.1 (8.9)***</b>	<b>31.3 (8.5)***</b>	30.3 (8.2)	31.2 (8.6)
COVID positive test	6.8%	<b>4.9%*</b>	<b>5.1%***</b>	<b>4.3%***</b>	9.3%

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$  – statistically significant difference for adults with the mental health disorder compared to those without the mental health disorder. Bolded values indicate statistical significance between groups.

disorder being hospitalized. Similar results were seen for mortality with 13.2% of those with bipolar disorder, 6.7% of those with internalizing disorder, 7.1% of those with externalizing disorder, and 0% of those with a psychotic disorder dying while in the hospital.

Table 3 shows results from the unadjusted and adjusted logistic regression models for odds of having a positive COVID-19 test by mental health disorder. In unadjusted models, individuals with bipolar disorder (OR 0.70, 95% CI 0.50–0.97), an externalizing disorder (OR 0.57, 95% CI 0.50–0.65) and individuals with an internalizing disorder (OR 0.66, 95% CI 0.60–0.74) had statistically significantly lower odds of having a positive COVID-19 test compared to those who did not have bipolar, an externalizing, or internalizing disorder. The results remained significant in the fully adjusted models with individuals with an externalizing disorder (OR 0.67, 95% CI 0.57–0.79) and individuals with an internalizing disorder (OR 0.78, 95% CI 0.70–0.88) having significantly lower odds of having a positive COVID-19 test compared

to those without externalizing or internalizing disorder. Patients with a mental health diagnosis of bipolar disorder had lower odds of having a COVID positive test compared to those without bipolar disorder. This result was statistically significant at the unadjusted level and after adjusting for gender, age, race/ethnicity, location, and primary payor. The results remained in the same direction, however lost statistical significance when lifestyle factors (tobacco use and obesity) were added to the model. Tobacco and obesity were added to the model because they are factors known to increase one's risk of COVID. We found that these two lifestyle factors explained the relationship between mental health diagnosis of bipolar disorder and positive COVID test. Once tobacco and obesity were taken into account, the original relationship that was seen at the unadjusted level and after demographics had been taken into account lost significance. Lifestyle factors of tobacco and obesity did not explain the relationships for externalizing or internalizing disorders.

**Table 2.** Characteristics for positive COVID-19 cases in Milwaukee and Southeast Wisconsin by mental health disorder

	Total ( <i>n</i> = 2103)	Bipolar disorder ( <i>n</i> = 38)	Internalizing disorder ( <i>n</i> = 478)	Externalizing disorder ( <i>n</i> = 238)	Psychotic disorder ( <i>n</i> = 19)
Sex			***		
Female	57.5%	68.4%	<b>72.8%</b>	52.5%	36.8%
Male	42.5%	31.6%	<b>27.2%</b>	47.5%	63.2%
Age, mean (s.d.)	48.5 (18.6)	52.3 (15.9)	<b>52.1 (17.9)***</b>	<b>52.8 (16.5)**</b>	<b>59.4 (14.6)*</b>
Race/ethnicity		**	***		
NH White	47.6%	<b>34.2%</b>	<b>51.7%</b>	41.4%	31.6%
NH Black	40.2%	<b>57.9%</b>	<b>40.4%</b>	53.2%	63.2%
Hispanic	9.0%	<b>7.9%</b>	<b>6.5%</b>	5.0%	5.3%
Other	3.1%	<b>0%</b>	<b>1.4%</b>	0.4%	0%
Location		**	***		
Milwaukee county	63.1%	<b>73.7%</b>	<b>67.6%</b>	73.1%	84.2%
Waukesha county	13.8%	<b>10.5%</b>	<b>13.0%</b>	8.8%	0.0%
Washington/Ozaukee county	10.0%	<b>7.9%</b>	<b>10.9%</b>	12.2%	5.3%
Racine/Kenosha county	10.6%	<b>5.3%</b>	<b>5.6%</b>	4.2%	5.3%
Other county/out of state	2.4%	<b>2.6%</b>	<b>2.9%</b>	1.7%	5.3%
Primary payor		***	***	***	***
Managed care	46.3%	<b>5.3%</b>	<b>37.9%</b>	<b>25.6%</b>	<b>0.0%</b>
Medicare	26.8%	<b>57.9%</b>	<b>37.2%</b>	<b>40.3%</b>	<b>78.9%</b>
Medicaid	16.7%	<b>31.6%</b>	<b>19.0%</b>	<b>28.2%</b>	<b>21.1%</b>
Self-pay	7.6%	<b>2.6%</b>	<b>3.8%</b>	<b>4.6%</b>	<b>0.0%</b>
Other	2.6%	<b>2.6%</b>	<b>2.1%</b>	<b>1.3%</b>	<b>0.0%</b>
Tobacco use status		***	***	***	***
Non-smoker	65.3%	<b>39.5%</b>	<b>56.7%</b>	<b>21.8%</b>	<b>47.4%</b>
Current smoker	7.5%	<b>26.3%</b>	<b>10.0%</b>	<b>30.3%</b>	<b>36.8%</b>
Former smoker	27.2%	<b>34.2%</b>	<b>33.3%</b>	<b>47.9%</b>	<b>15.8%</b>
BMI, mean (s.d.)	32.3 (8.7)	35.0 (10.8)	<b>33.3 (9.1)**</b>	32.9 (9.6)	32.0 (7.9)
Hospitalization	20.9%	<b>55.3%***</b>	23.0%	<b>33.2%***</b>	<b>47.4%**</b>
Mortality	4.8%	<b>13.2%*</b>	<b>6.7%*</b>	7.1%	0%

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$  – statistically significant difference for adults with the mental health disorder compared to those without the mental health disorder. Bolded values indicate statistical significance between groups.

Table 4 shows results from the unadjusted and adjusted logistic regression models for odds of being hospitalized among individuals who had a positive COVID-19 test. This table also shows results from the unadjusted and adjusted Cox proportional hazards models for the hazard of dying while in the hospital among this same group of patients. Individuals with bipolar disorder had significantly higher odds of being hospitalized compared to patients without bipolar disorder in both the unadjusted (OR 4.87, 95% CI 2.54–9.31) and fully adjusted models (OR 4.27, 95% CI 2.06–8.86). While the odds of being hospitalized were significantly higher among those with externalizing disorders in the unadjusted model (OR 2.08, 95% CI 1.55–2.79) and after adjusting for demographic factors (OR 1.71, 95% CI 1.23–2.38), the results lost significance in the fully adjusted model. Patients with a mental health diagnosis of externalizing disorders had increased odds of

hospitalization compared to those without externalizing disorders. This result was statistically significant at the unadjusted level and after adjusting for gender, age, race/ethnicity, location, and primary payor. The results remained in the same direction, however, lost statistical significance when lifestyle factors (tobacco use and obesity) were added to the model, meaning that these factors explained the relationship among this group of patients.

Individuals with psychotic disorders had significantly higher odds of being hospitalized compared to patients without psychotic disorders in the unadjusted model (OR 3.46, 95% CI 1.40–8.57), however, results lost significance after adjusting for gender, age, and race/ethnicity. Lastly, unadjusted models examining the relationship between mental health and mortality showed mortality was significantly higher for patients with bipolar (HR: 2.83, 95% CI 1.15–6.96) and internalizing disorders (HR: 1.60, 95%

**Table 3.** Unadjusted and adjusted association between psychiatric disorders and odds of positive screen for COVID-19 infection ( $n = 30\,976$ )

	Unadjusted odds ratio	Adjusted odds ratio (demographics)	Adjusted odds ratio (fully adjusted)
Bipolar disorder ( $n = 38$ )			
No	<b>Ref</b>	<b>Ref</b>	Ref
Yes	<b>0.70 (0.50–0.97), <math>p = 0.0324</math></b>	<b>0.62 (0.45–0.87), <math>p = 0.0051</math></b>	0.84 (0.60–1.19), $p = 0.3336$
Externalizing disorders ( $n = 238$ )			
No	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>
Yes	<b>0.57 (0.50–0.65), <math>pp &lt; 0.0001</math></b>	<b>0.45 (0.39–0.52), <math>p &lt; 0.0001</math></b>	<b>0.67 (0.57–0.79), <math>p &lt; 0.0001</math></b>
Internalizing disorders ( $n = 478$ )			
No	<b>Ref</b>	<b>Ref</b>	Ref
Yes	<b>0.66 (0.60–0.74), <math>p &lt; 0.0001</math></b>	<b>0.69 (0.62–0.77), <math>p &lt; 0.0001</math></b>	<b>0.78 (0.70–0.88), <math>p &lt; 0.0001</math></b>
Psychotic disorder ( $n = 19$ )			
No	Ref	Ref	Ref
Yes	1.42 (0.88–2.27), $p = 0.1508$	0.95 (0.59–1.55), $p = 0.8515$	1.34 (0.82–2.18), $p = 0.2487$
Any disorder ( $n = 12\,050$ )			
No	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>
Yes	<b>0.63 (0.57–0.69), <math>p &lt; 0.0001</math></b>	<b>0.59 (0.53–0.65), <math>p &lt; 0.0001</math></b>	<b>0.75 (0.67–0.84), <math>p &lt; 0.0001</math></b>

Model adjusted for demographics included gender, age, and race/ethnicity.

Fully adjusted model included gender, age, race/ethnicity, location, payor, tobacco use, and body mass index. Bolded values indicate statistical significance between groups.

CI 1.05–2.44). This relationship remained significant in the fully adjusted model for bipolar disorder (HR: 2.67, 95% CI 1.07–6.67), but lost significance after the model was adjusted for demographic factors among those with internalizing disorders.

## Discussion

The results from this study show that individuals with a mental health disorder (specifically bipolar, externalizing, and internalizing disorders) were less likely to have a positive COVID-19 test when screened. However, when tested positive for COVID-19, individuals with a mental health disorder were more likely to be hospitalized (for those with bipolar, externalizing, and psychosis disorders) and to die (for those with bipolar, internalizing disorders) in the hospital compared to individuals without a mental health disorder. Various factors explained the relationship between mental health disorders, testing positive, and hospitalization and mortality among those who tested positive depending on the type of mental illness. The relationship between mental health and COVID-19 positivity was explained by lifestyle factors including tobacco use and obesity among individuals with bipolar disorder. However, the relationship between mental health and COVID-19 positivity remained significant even after adjusting for all covariates among those with internalizing and externalizing disorders. The relationship between mental health disorder and hospitalization was significant for those with bipolar, externalizing, and psychoses being more likely to be hospitalized if positive for COVID-19. This relationship was explained by lifestyle factors for those with externalizing disorders and was explained by demographics for those with psychoses. Additionally, among COVID-19 positive individuals, the relationship between mental health and mortality was significant for those with bipolar and internalizing disorders being more likely to die. This relationship was explained by demographic factors for individuals with internalizing disorders.

This is one of the first studies to shed light on the relationship between mental health disorders and COVID-19 outcomes. These study findings of adults with mental health disorder being more likely to be hospitalized or to die in the hospital are consistent with recently published literature (Wang et al., 2020). Interestingly, the prevalence of mental health diagnoses in the general network where this study took place is 34.6%, which is much lower than the prevalence of mental health diagnoses among all adults tested for COVID-19 in the study (51.2%). However, only 36.8% of adults who tested positive for COVID had a mental health disorder, which is similar to the prevalence of mental health disorders in the general network. It is noteworthy that the relationship between COVID hospitalization and mental health was explained by demographic factors (sex, age, ethnicity/race, location, primary payor) for individuals with psychoses, and by lifestyle factors (tobacco use, BMI) for individuals with externalizing disorders. Patients diagnosed with severe mental health disorders such as depression, nervousness, anxiety, alcohol and drug abuse are more likely to be socioeconomically disadvantaged, less likely to have health insurance and access to health care, and many times are discriminated against and stigmatized; and as a result, often delay seeking medical attention even after symptoms of a more severe infection start to appear (Clement, Schauman, Graham, & Maggioni, 2015; Doherty et al., 2013; Luciano & Meara, 2014; Rowan, McAlpine, & Blewett, 2013; Temple et al., 2020). Delays in seeking care during the COVID pandemic increase the odds of presenting with advanced disease and complications among those who are COVID positive (Azar et al., 2020). However, contrary to the evidence presented, over half (51.2%) of the sample that was tested for COVID-19 in this study had a mental health diagnosis. Therefore, it appears that individuals with mental health diagnoses in this sample were able to access testing and does not support the notion that those with mental health disorders were not being tested.

**Table 4.** Unadjusted and adjusted association between psychiatric disorders and odds of hospitalization or death in patients with confirmed COVID-19 infection ( $n = 2103$ )

	Hospitalization (OR (95% CI))			Mortality (HR (95% CI))		
	Unadjusted	Adjusted (demographics)	Adjusted (fully adjusted)	Unadjusted	Adjusted (demographics)	Adjusted (fully adjusted)
Bipolar disorder ( $n = 38$ )						
No	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>	<b>Ref</b>
Yes	<b>4.87 (2.54–9.31), <math>p &lt; 0.0001</math></b>	<b>5.39 (2.63–11.02), <math>p &lt; 0.0001</math></b>	<b>4.27 (2.06–8.86), <math>p &lt; 0.0001</math></b>	<b>2.83 (1.15–6.96), <math>p = 0.0232</math></b>	<b>2.63 (1.07–6.49), <math>p = 0.0359</math></b>	<b>2.67 (1.07–6.67), <math>p = 0.0353</math></b>
Externalizing disorders ( $n = 238$ )						
No	<b>Ref</b>	Ref	Ref	Ref	Ref	Ref
Yes	<b>2.08 (1.55–2.79), <math>p &lt; 0.0001</math></b>	<b>1.76 (1.27–2.45), <math>p = 0.0007</math></b>	1.34 (0.93–1.94), $p = 0.1142$	1.57 (0.93–2.64), $p = 0.0916$	1.41 (0.83–2.39), $p = 0.2084$	1.36 (0.78–2.39), $p = 0.2832$
Internalizing disorders ( $n = 478$ )						
No	Ref	Ref	Ref	<b>Ref</b>	Ref	Ref
Yes	1.18 (0.92–1.50), $p = 0.1911$	1.04 (0.78–1.37), $p = 0.8086$	0.85 (0.64–1.13), $p = 0.2659$	<b>1.60 (1.05–2.44), <math>p = 0.0274</math></b>	1.27 (0.83–1.95), $p = 0.2728$	1.13 (0.73–1.76), $p = 0.5835$
Psychotic disorder ( $n = 19$ )						
No	<b>Ref</b>	Ref	Ref	–	–	–
Yes	<b>3.46 (1.40–8.57), <math>p = 0.0073</math></b>	1.98 (0.75–5.21), $p = 0.1655$	1.49 (0.55–4.04), $p = 0.4332$	–	–	–
Any disorder ( $n = 612$ )						
No	<b>Ref</b>	<b>Ref</b>	Ref	<b>Ref</b>	<b>Ref</b>	Ref
Yes	<b>1.60 (1.28–2.00), <math>p &lt; 0.0001</math></b>	<b>1.30 (1.01–1.68), <math>p = 0.0429</math></b>	1.03 (0.79–1.34), $p = 0.8359$	<b>1.68 (1.13–2.51), <math>p = 0.0106</math></b>	1.27 (0.85–1.90), $p = 0.2463$	1.17 (0.77–1.78), $p = 0.4747$

Model adjusted for demographics included gender, age, race/ethnicity, location, and payor.

Fully adjusted model included gender, age, race/ethnicity, location, payor, tobacco use, and body mass index.

No Cox models were run for psychotic disorder due to 0% of patients with the outcome of mortality. Bolded values indicate statistical significance between groups.

Based on these findings, interventions designed to reduce hospitalization rates among COVID positive patients with psychoses should be culturally tailored and include components to specifically address the needs of those who are eligible for public insurance. Whereas, interventions designed for those with externalizing disorders should incorporate lifestyle factors such as smoking cessation and activities designed to reduce BMI to impart benefits for improving outcomes among this group.

Findings also suggest that COVID-19 positive individuals with bipolar and internalizing disorder were more likely to die in the hospital compared to those without a mental health disorder. These findings are consistent with current literature examining the relationship between mental health and COVID-19 mortality (Wang et al., 2020). This relationship was explained by demographic factors (sex, age, ethnicity/race, location, primary payor) for those with internalizing disorders, again highlighting the importance of developing culturally appropriate interventions for adults with these disorders. Previous research suggests that people with severe mental illness are at an increased risk of mortality from infectious diseases (Doherty et al., 2013; Happell, Scott, & Platania-Phung, 2011; Young, Dosani, Whisler, & Hwang, 2015), which is consistent with findings from this study. Interestingly, Doherty et al., reported that individuals with mental health disorders are a vulnerable population at a higher risk of infection as a result of having less disease awareness, poor health-seeking behavior, crowded living, and higher rates of

smoking and homelessness (2013). However, findings from our study show individuals with the mental health disorders we included in the study (bipolar, internalizing, externalizing, and psychosis disorders) were less likely to test positive for COVID-19.

The research implications of this study highlight the need to focus on understanding why individuals with a diagnosed mental illness are less likely to test positive for COVID-19, yet more likely to be hospitalized or die when they do test positive. Particularly, additional studies should be conducted to understand which factors explain the relationship between mental health disorder and hospitalization among individuals with bipolar disorder. Additionally, culturally tailored interventions should be designed with considerations for those who are mentally ill and work to incorporate targets identified as explanatory factors for the relationships between mental health and hospitalization and mortality among those who test positive for COVID-19. Clinical implications suggest the importance of increased testing to quickly identify positive cases, and implementation of follow-up for patients who are mentally ill especially during the time of a pandemic. Policy changes allowing for an increase in the availability and delivery of testing for this vulnerable population will help to ensure positive cases are quickly identified and necessary follow-up procedures can be initiated.

While this study is strengthened by its use of the medical record in a diverse sample to understand the role of mental health

in COVID-19 outcomes, there are a number of limitations that should be considered. First, mental health was defined based on ICD9/10 codes, so individuals who were not diagnosed would not be captured in the sample with mental illness. Second, mental health conditions often go un- or under-diagnosed and individuals with undiagnosed mental health conditions may have been miscategorized. We did not have information on whether patients with mental health disorders were symptomatic and this analysis did not differentiate between whether diagnoses were current during the COVID pandemic. Analyses conducted using data for patients with a history of mental health disorders who are well-controlled may have different results compared to patients with a recent diagnosis of a mental health condition or those who are currently symptomatic. Third, the analysis includes the health system providing testing for staff and faculty when exposed during healthcare encounters, so there may be over-representation of healthcare professionals in the sample. Therefore, it is possible that the test-positivity rate might be different if testing were only conducted among the standard population that excluded healthcare professionals. We know healthcare professionals were at increased risk of exposure to COVID compared to the general population. Had testing only occurred in the general population (excluding health professionals), it is possible that individuals with mental health conditions may have had higher odds of testing positive. Fourth, sample sizes for bipolar disorder and psychotic disorders were relatively small, limiting our ability to adjust more additional relevant confounders in the regression models possibly resulting in an inability to determine which factors explain relationships seen among patients with mental health disorders and adverse COVID-19 outcomes. Finally, as a cross-sectional analysis, this study was not intended to comment on causality of relationship.

## Conclusions

This study found that while individuals with mental health disorders were less likely to test positive for COVID-19, those who did test positive were more likely to be hospitalized and more likely to die in the hospital compared to those without a mental health disorder. Factors explaining the relationship between mental health disorder and hospitalization differed across mental health conditions, with demographic factors explaining the relationship among those with psychoses, while lifestyle factors explained the relationship among those with externalizing disorders, and factors explaining the relationship among those with bipolar disorder remain unknown. COVID positive patients with bipolar and internalizing disorders were more likely to die in the hospital compared to patients without these conditions. These results are suggestive of the importance of developing interventions tailored to meet the needs of patients with mental health disorders, and adults who may qualify for public insurance, while incorporating smoking cessation, and BMI reduction strategies as a way to possibly improve outcomes among this vulnerable population.

### Author contributions.

LEE obtained funding for the study. LEE, EG, and RJW acquired, analyzed and interpreted the data. CE, AZD, RJW, EG, JAC, and LEE designed the study, drafted the article, and critically revised the manuscript for intellectual content. All authors approved the final manuscript.

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**Conflict of interest.** The authors declare no conflict of interest.

**Ethical standards.** This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Institutional Review Board of the Medical College of Wisconsin, Milwaukee, WI, USA.

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