Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Focus Article

Linking insomnia and OCD symptoms during the coronavirus pandemic: Examination of prospective associations

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ABSTRACT

There is considerable concern in the mental health community about the psychological consequences of the coronavirus pandemic and who may be most vulnerable. Obsessive-compulsive disorder (OCD) symptoms may be particularly sensitive to the context of the pandemic. Previous research suggests insomnia symptoms may contribute to increased OCD symptoms over time, particularly during times of stress, such as the pandemic. The present study examined pre-coronavirus outbreak insomnia symptoms as a predictor of post-coronavirus outbreak OCD symptoms in a sample of community adults who completed a 2016 survey study and were re-contacted on April 1, 2020 (N = 369). Results revealed a small significant increase in OCD symptoms following the coronavirus outbreak and a small significant decrease in insomnia symptoms. Pre-coronavirus outbreak insomnia symptoms significantly predicted increases in post-coronavirus outbreak OCD symptoms. Similar results were found for specific OCD symptom facets with the exception of washing and hoarding symptoms, which were unrelated to pre-coronavirus insomnia symptoms. There was no evidence for a reverse effect of prior OCD symptoms on insomnia symptoms during the pandemic. These findings suggest those with insomnia symptoms prior to the coronavirus pandemic may be vulnerable to increases in some OCD symptoms during the pandemic. The implications for preventing adverse psychological responses during the coronavirus pandemic are discussed.

1. Introduction

In December 2019, an outbreak of pneumonia in Wuhan, Hubei province, China began receiving international attention and concern (Wang, Horby, Hayden, & Gao, 2020). Research identified the source of the outbreak as a novel coronavirus and named its resulting condition coronavirus condition 2019 (COVID-19) (AJN, 2020; Wang, Horby et al., 2020). On March 11, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic (WHO, 2020). In addition to the devastating loss of human life, there has been speculation about the mental health impacts of the pandemic and who may be most vulnerable to psychological distress during this unprecedented challenge. Indeed, research conducted during the H1N1 "Swine Flu" pandemic from 2009 to 2010 found increased health anxiety, contamination fears, disgust sensitivity, and anxiety sensitivity were associated with increased swine flu fears (Brand, McKay, Wheaton, & Abramowitz, 2013; Wheaton, Abramowitz, Berman, Fabricant, & Olatunji, 2012). Likewise, increased perceptions of contamination severity were associated with Ebola and Zika virus fears during the respective viral outbreaks 2014 and 2015–2016 (Blakey & Abramowitz, 2017; Blakey, Reuman, Jacoby, & Abramowitz, 2015). Evidence for identifiable predictors of distress during previous viral outbreaks suggest the utility of similar research during the current coronavirus pandemic. Though preliminary, findings from China suggest women may be at an elevated risk for experiencing anxiety during the pandemic, while industrial service workers may be at an elevated risk for experiencing depression (Wang, Di, Ye, & Wei, 2020).

One aspect of mental health that may be particularly impacted by the coronavirus pandemic is symptoms of obsessive-compulsive disorder (OCD). OCD symptoms are characterized by intrusive, distressing thoughts (i.e., obsessions) and repetitive, uncontrollable behaviors intended to reduce the distress of the obsessions (i.e., compulsions) (American Psychiatric Association, 2013). A common theme of OCD symptoms is contamination concerns and washing/cleaning compulsions (Abramowitz, Schwartz, Franklin, & Furr, 2003). Indeed, there is considerable conceptual overlap between contamination/washing symptoms of OCD, public concern about contracting the coronavirus, and public health recommendations to prevent the spread of the

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coronavirus (i.e., increased hand washing, wearing face masks, increased cleaning of surfaces, etc.; Centers for Disease Control, 2020). Other OCD themes also bear conceptual similarity to coronavirus-related phenomenon, including obsessions (e.g., intrusive, distressing thoughts about increasing numbers of COVID-19 cases), hoarding (e.g., excessive procurement of food and household supplies), and checking (e.g., repetitive and excessive consumption of coronavirus-related news). The pandemic may then represent a context where OCD may develop or intensify. Thus, identification of factors that predict such an increase may facilitate focused intervention efforts during the pandemic.

Sleep disturbance is one such factor that may predict increased OCD symptoms during the coronavirus pandemic. Stressful events are known to interfere with sleep (Drake, Pillai, & Roth, 2014), and stressors specific to the coronavirus pandemic, such as sudden transitions to working from home and home-schooling children, rapidly changing public health recommendations, and uncertainty around access to care may impair sleep. Though few studies have examined sleep in the context of a pandemic, research conducted during the severe acute respiratory syndrome (SARS) outbreak offers initial evidence that viral outbreak events negatively impact sleep. Among healthcare workers in Hong Kong, those working with SARS patients reported increased insomnia and poor sleep compared to those in non-frontline positions (McAlonan et al., 2007; Su et al., 2007). Further, one study found that restless sleep was associated with elevated stress among middle-aged women in Hong Kong during the SARS outbreak (Yu, Ho, So, & Lo, 2005).

The available evidence suggests that sleep disturbance may contribute to increased psychological distress during the coronavirus pandemic, such as OCD symptoms. Indeed, accumulating evidence links sleep difficulties to OCD (Cox & Olatunji, 2020; Nota, Sharkey, & Coles, 2015), including insomnia symptoms (Cox & Olatunji, 2016). Insomnia symptoms include difficulties with sleep initiation and maintenance (American Psychiatric Association, 2013) and have been found to predict increased OCD symptoms over 2 months, controlling for baseline OCD and depression symptoms (Cox, Tuck, & Olatunji, 2018). Importantly, sleep difficulties are also known to influence responses to stress. Indeed, sleep loss is associated with a lower threshold for perceiving an event as stressful (Minkel et al., 2014), and a recent study found increased insomnia symptoms predicted increased subjective and physiological anxiety responses to a laboratory stressor (Short & Schmidt, 2018).

Together these findings suggest that elevated insomnia symptoms prior to the coronavirus pandemic may increase vulnerability for increased OCD symptoms following the pandemic onset (i.e., a stressor). The present study tested this hypothesis in a sample of adults who completed measures of insomnia and OCD symptoms in 2016 and were re-contacted to complete measures following the onset of the coronavirus pandemic. It was hypothesized that insomnia and OCD symptoms would increase following the coronavirus outbreak and increased pre-coronavirus outbreak insomnia symptoms would predict increased post-coronavirus outbreak OCD symptoms, including total symptoms and specific symptom subtypes. Pre-coronavirus outbreak OCD symptoms were included as a covariate to examine change in OCD symptoms following the pandemic onset, and pre-coronavirus outbreak depression symptoms were included to examine the specificity of insomnia over and above depression symptoms. Exploratory analyses testing the predictive effect of pre-coronavirus outbreak OCD symptoms on post-coronavirus outbreak insomnia symptoms were also conducted to examine bidirectional relations between insomnia and OCD symptoms before and after the pandemic onset.

2. Methods

2.1. Participants

The sample consisted of adults who completed a 2016 survey study on insomnia and anxiety-related symptoms who were re-contacted to participate in the present study ($N = 369$). The 2016 sample included adults aged 18–65 who were recruited for a survey study related to sleep and anxiety symptoms ($N = 1262$). Of the 2016 sample, 29 % participated when re-contacted. Participants who completed the 2016 survey but did not participate at re-contact did not significantly differ from those who participated in both surveys on age, race, gender, or baseline insomnia symptoms. Those who did not participate at re-contact had slightly higher baseline OCD symptoms ($M = 12.56$, $SD = 10.82$) than those who participated in both surveys ($M = 11.35$, $SD = 9.16$) $t(799.42) = 2.03$, $p = .04$, $d = 0.12$.

The present sample was 89.1 % female with a mean age of 46.98 ($SD = 13.50$) at follow-up, ranging from 22 to 69. The ethnicity composition was as follows: White ($n = 330$; 89.9 %), African American ($n = 10$; 2.7 %), Asian ($n = 8$; 2.2 %), Hispanic/Latino ($n = 12$; 3.3 %), Other ($n = 7$; 1.9 %). Occupation was classified according to the International Standard Classification of Occupations classification structure, with additional categories added for students, stay at home parents, disabled, retired, and unemployed. The most common reported occupation category was professional (43.7 %). 3.2 % reported being currently unemployed.

71.2 % reported living in a state with a shelter in place or stay at home order in place on or before 4/1/20. Information on state of residence and corresponding number of COVID-19 cases can be found in Table 1. 54.2 % reported working from home due to the pandemic (i.e., had not worked from home before the pandemic), 7.3 % reported experiencing symptoms of COVID-19, and 2.7 % reported having been

Table 1
State of residence of the study sample and number of COVID-19 cases in each state on 4/1/20 ($N = 369$).

State of residence	*n* (%)	Number of cases on 4/1/20
New York	37 (10.1 %)	83,948
Ohio	33 (9.0 %)	2,547
California	23 (6.3 %)	9,399
Tennessee	21 (5.7 %)	2,933
Florida	19 (5.2 %)	6,956
Maryland	18 (4.9 %)	1,986
North Carolina	15 (4.1 %)	1,675
Virginia	13 (3.5 %)	1,483
Georgia	12 (3.3 %)	4,638
Oregon	12 (3.3 %)	736
Kentucky	11 (3.0 %)	632
Maine	11 (3.0 %)	303
Minnesota	11 (3.0 %)	689
Utah	10 (2.7 %)	888
Washington	10 (2.7 %)	1,608
Colorado	9 (2.4 %)	2,982
Michigan	9 (2.4 %)	9,315
Illinois	8 (2.2 %)	6,980
Iowa	8 (2.2 %)	547
Pennsylvania	8 (2.2 %)	566
South Carolina	8 (2.2 %)	1,293
Texas	8 (2.2 %)	4,355
Indiana	7 (1.9 %)	2,564
Missouri	7 (1.9 %)	1,607
Alabama	5 (1.4 %)	1,060
Arkansas	5 (1.4 %)	590
New Jersey	5 (1.4 %)	22,255
Wisconsin	5 (1.4 %)	1,556
Arizona	4 (1.1 %)	1,530
Connecticut	3 (0.8 %)	3,557
Oklahoma	3 (0.8 %)	721
Kansas	2 (0.5 %)	485
Maine	2 (0.5 %)	303
Mississippi	1 (0.3 %)	1,073
Nevada	1 (0.3 %)	1,279
New Hampshire	1 (0.3 %)	367
New Mexico	1 (0.3 %)	340
West Virginia	1 (0.3 %)	191
Wyoming	1 (0.3 %)	130

tested. Of those who were tested, none reported testing positive for COVID-19.

2.2. Measures

2.2.1. Depression, Anxiety, and Stress Scales-Short Form (DASS; Lovibond and Lovibond, 1995)

The depression subscale of the is a 7-item self-report measure of depression symptoms over the past week. Items are rated on a Likert scale from 0 (*Did not apply to me at all)* to 3 (*Applied to me very much or most of the time*), and higher scores indicate higher depression symptoms. The DASS depression subscale was administered in the pre-pandemic study only, in which it demonstrated good internal consistency (α = 0.93).

2.2.2. Insomnia Severity Index (ISI; Bastien, Vallieres, & Morin, 2001)

The ISI is a 7-item self-report measure of insomnia symptoms. Items are rated on a Likert scale from 1 (*none*) to 4 (*very severe*), and higher scores indicate increased insomnia symptoms. A score of 15 or higher suggests clinically significant insomnia symptoms. The ISI demonstrated adequate internal consistency at time 1 (α = .89) and good internal consistency at time 2 (α = .90) in the present sample.

2.2.3. Obsessive-Compulsive Inventory-Revised (OCIR; Foa et al., 2002)

The OCIR is an 18-item self-report measure of OCD symptoms in the past month. The OCIR consists of 6 subscales measuring specific facets of OCD symptoms (hoarding, checking, ordering, neutralizing, washing, obsessing). Items on the OCIR are rated on a Likert scale from 0 (*not at all*) to 4 (*extremely*), and higher scores indicated increased OCD symptom severity. A score of 21 or higher suggests clinically significant OCD symptoms. The OCIR demonstrated adequate internal consistency at time 1 (α = 0.89) and at time 2 (α = .88).

2.3. Procedure

Participants for the 2016 study were recruited through ResearchMatch, a national health volunteer registry that was created by several academic institutions and supported by the U.S. National Institutes of Health as part of the Clinical Translational Science Award (CTSA) program. ResearchMatch has a large population of volunteers who have consented to be contacted by researchers about health studies for which they may be eligible. Participants were re-contacted with the option to enroll in the present study on April 1, 2020, and the survey remained open for 7 days. Participants were compensated with a $25 gift card drawing for both time points. Study data were collected and managed using REDCap (Research Electronic Data Capture) hosted at Vanderbilt University (Harris et al., 2009). REDCap is a secure, web-based application designed to support data capture for research studies and is supported by UL1 TR000445 from NCATS/NIH. Data on cumulative COVID-19 cases on April 1, 2020 in each state was collected from https://outbreak.info on April 3–5, 2020 (Hughes et al., 2020). Outbreak.info is a data aggregation and visualization website that combines COVID-19 data from Johns Hopkins University Center for Systems Science and Engineering, the New York Times, and the COVID Tracking Project. On April 1, 2020, there were 214,926 confirmed cases of COVID-19 in the United States and 4,841 confirmed deaths due to COVID-19 (https://outbreak.info). Review and approval for the 2016 study and the follow-up and all procedures was obtained from the Vanderbilt University Institutional Review Board.

2.4. Data analytic strategy

Data analysis was conducted in SPSS 26. Prior to data analysis, for scale totals with one item missing, mean imputation was used to replace the missing item. Measures with more than one missing item were considered missing and not included in analysis. Mean imputation was not utilized on OCIR subscales given each subscale is only 3 items. Within-subjects t-tests were conducted to examine change in insomnia and OCD symptoms before and after the coronavirus outbreak.

Given the nested structure of the data (i.e., individual observations nested within states), the intraclass correlation (ICC) was calculated to determine the degree to which variance in observations is due to clustering. Results indicated ICC = .01, suggesting a minimal effect of clustering by state. Thus, linear regression was utilized as the primary analyses (follow-up analyses utilizing multilevel modeling with state included as a Level 2 grouping variable yielded similar findings; see Supplemental Material). Seven hierarchical linear regression models were conducted to test the predictive effect of pre-coronavirus outbreak insomnia symptoms on post-coronavirus outbreak OCD symptoms globally and on hoarding, checking, ordering, neutralizing, washing, and obsessing specifically. Each model controlled for pre-coronavirus outbreak levels of the outcome and depression symptoms. Tests of model assumptions did not indicate heteroscedasticity or multicollinearity. Normality of residuals was confirmed for all dependent variables except checking, which achieved normality following square root transformation, and neutralizing[1] .

3. Results

3.1. Descriptive statistics and associations between study variables

Descriptive statistics and associations between study variables are shown in Table 2. Pre-coronavirus outbreak insomnia symptoms were significantly, positively correlated with post-coronavirus OCD symptoms globally and each subscale specifically. Results of independent samples t-tests found no significant differences in post-outbreak OCD symptoms between those living in states with or without a stay at home or shelter in place order ($p = .15$), those who had or had not experienced COVID-19 symptoms ($p = .91$), or those newly working from home or not newly working from home ($p = .74$). Likewise, results of independent samples t-tests found no significant differences in post-outbreak insomnia symptoms between those living in states with or without a stay at home or shelter in place order ($p = .42$) or those who had or had not experienced COVID-19 symptoms ($p = .54$). In contrast, there was a small significant difference in post-outbreak insomnia symptoms between those newly working from home ($M = 9.02$, $SD = 5.84$) and those not newly working from home ($M = 10.37$, $SD = 6.31$) $t(367) = 2.02$, $p = .04$, $d = 21$.

3.2. Change in insomnia and OCD symptoms before and after the coronavirus outbreak

There was a small, significant decrease in insomnia symptoms from before ($M = 11.08$, $SD = 6.14$) to after the coronavirus outbreak ($M = 9.71$, $SD = 6.09$) $t(379) = 4.43$, $p < .001$, $d = 0.23$. Given the unexpected direction of this effect, an exploratory analysis of covariance was conducted to examine whether there was a significant effect of gender or the presence of a shelter in place/stay at home order on post-outbreak insomnia symptoms, controlling for pre-outbreak insomnia symptoms. There was a small, significant effect of shelter in place/stay at home order on post-outbreak insomnia symptoms, $F(1,377) = 4.39$, $p = .04$, $\eta_p^2 = .01$, such that those in a state with a shelter in place/stay at home order reported decreased post-outbreak insomnia symptoms ($M = 8.36$, $SE = .53$) compared to those in a state without a shelter in place/stay at home order ($M = 10.24$, $SE = .73$), controlling for pre-outbreak insomnia symptoms. There was not a significant effect of gender, $F(1,377) = 2.77$, $p = .10$, $\eta_p^2 = .007$.

[1] Residuals for neutralizing were positively skewed, and skew was not amenable to square root transformation. Thus, neutralizing results should be interpreted with caution.

Table 2
Descriptive statistics and correlations for study measures ($N = 369$).

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Pre ISI	–																
2. Pre DASS	.45*	–															
3. Pre OCIR	.37*	.35*	–														
4. Pre hoard	.29*	.23*	.58*	–													
5. Pre check	.26*	.16*	.74*	.28*	–												
6. Pre order	.21*	.17*	.72*	.21*	.50*	–											
7. Pre neutr	.20*	.20*	.71*	.26*	.51*	.48*	–										
8. Pre wash	.19*	.14*	.64*	.19*	.46*	.41*	.43*	–									
9. Pre obsess	.33*	.41*	.67*	.32*	.36*	.28*	.34*	.26*	–								
10. Post ISI	.52*	.27*	.25*	.18*	.19*	.10*	.11*	.18*	.23*	–							
11. Post OCIR	.33*	.26*	.66*	.42*	.47*	.48*	.46*	.44*	.40*	.37*	–						
12. Post hoard	.28*	.26*	.41*	.69*	.18*	.14*	.21*	.14*	.24*	.26*	.62*	–					
13. Post check	.29*	.18*	.55*	.25*	.57*	.45*	.41*	.37*	.23*	.27*	.77*	.33*	–				
14. Post order	.24*	.18*	.53*	.21*	.40*	.65*	.30*	.33*	.21*	.21*	.76*	.34*	.59*	–			
15. Post neutr	.20*	.14*	.53*	.21*	.38*	.35*	.64*	.30*	.30*	.23*	.69*	.34*	.52*	.47*	–		
16. Post wash	.13*	.05	.33*	.10	.22*	.23*	.21*	.47*	.16*	.22*	.68*	.22*	.43*	.38*	.37*	–	
17. Post obsess	.26*	.24*	.44*	.23*	.28*	.19*	.24*	.22*	.56*	.40*	.71*	.36*	.46*	.36*	.44*	.44*	–
M	11.08		11.35	2.77	1.49	2.65	1.07	0.95	2.40	9.67	12.01	2.43	1.41	2.41	0.92	2.59	2.34
SD	6.13		9.16	2.58	1.86	2.68	1.90	1.86	2.71	6.08	10.02	2.72	1.97	2.64	1.80	2.80	2.50
Range	0–28		0–52	0–12	0–12	0–12	0–12	0–11	0–12	0–28	0–54	0–12	0–12	0–12	0–11	0–12	0–12

Note. Pre ISI = pre-outbreak Insomnia Severity Index; Pre DASS = pre-outbreak Depression, Anxiety, and Stress Scale, depression subscale; Pre OCIR = pre-outbreak Obsessive-Compulsive Inventory-Revised; Pre hoard = pre-outbreak OCIR hoarding subscale; Pre check = pre-outbreak OCIR checking subscale; Pre order = pre-outbreak OCIR ordering subscale; Pre neutr = pre-outbreak OCIR neutralizing subscale; Pre wash = pre-outbreak OCIR washing subscale; Pre obsess = pre-outbreak OCIR obsessions subscale; Post ISI = post-outbreak Insomnia Severity Index; Post OCIR = post-outbreak Obsessive-Compulsive Inventory-Revised; Post hoard = post-outbreak OCIR hoarding subscale; Post check = post-outbreak OCIR checking subscale; Post order = post-outbreak OCIR ordering subscale; Post neutr = post-outbreak OCIR neutralizing subscale; Post wash = post-outbreak OCIR washing subscale; Post obsess = post-outbreak OCIR obsessions subscale.
* $p < .05$.

There was a small, significant increase in OCD symptoms from before ($M = 11.18$, $SD = 9.18$) to after the coronavirus outbreak ($M = 12.00$, $SD = 10.06$) $t(385) = -2.07$, $p = .04$, $d = -0.11$. There was a small, significant decrease in hoarding symptoms from before ($M = 2.75$, $SD = 2.58$) to after the coronavirus outbreak ($M = 2.43$, $SD = 2.69$) $t(387) = 3.04$, $p = .003$, $d = 0.15$. There was a medium, significant increase in washing symptoms from before ($M = 0.94$, $SD = 1.83$) to after the coronavirus outbreak ($M = 2.57$, $SD = 2.79$) $t(381) = -12.69$, $p < .001$, $d = -0.65$. Checking, ordering, neutralizing, and obsession symptoms did not significantly change following the coronavirus outbreak (p's = .41, .06, .29, .77, respectively).

3.3. Effects of pre-coronavirus outbreak insomnia symptoms on post-coronavirus outbreak OCD symptoms

3.3.1. Total OCD symptoms

In the model predicting post-coronavirus outbreak OCD symptoms, pre-coronavirus outbreak OCD and depression symptoms significantly contributed to the model, $F(2,364) = 143.53$, $p < .001$ and accounted for 44 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 1% of the variance in post-coronavirus outbreak OCD symptoms, and the R^2 change was significant ($p = .02$). When added to the model, pre-coronavirus outbreak insomnia symptoms predicted a small increase in post-coronavirus outbreak OCD symptoms, B = .17, β = .10, $p = .02$, over and above the effect of pre-coronavirus outbreak OCD and depression symptoms. Pre-coronavirus outbreak depression symptoms did not significantly predict post-outbreak OCD symptoms. See Table 3 for the results of the regression model.

Table 3
Model coefficients for the hypothesized model predicting post-coronavirus outbreak OCD symptoms from pre-coronavirus outbreak insomnia symptoms, controlling for pre-coronavirus outbreak OCD and depression symptoms ($N = 366$).

	Post OCIR				
Predictor	B	SE	β	*t*	*p*
Step 1					
Pre OCIR	.71	.05	.65	15.57	<.001
Pre DASS	.09	.08	.04	1.07	.29
Step 2					
Pre OCIR	.69	.05	.62	14.53	<.001
Pre DASS	.02	.09	.01	.17	.87
Pre ISI	.17	.07	.10	2.27	.02

Note. OCD = obsessive-compulsive disorder; Pre OCIR = pre-outbreak Obsessive-Compulsive Inventory-Revised; Pre DASS = pre-outbreak Depression, Anxiety, and Stress Scale, depression subscale; Post OCIR = post-outbreak Obsessive-Compulsive Inventory-Revised; Pre ISI = pre-outbreak Insomnia Severity Index.

3.3.2. Hoarding

In the model predicting post-coronavirus outbreak hoarding, pre-coronavirus outbreak hoarding and depression symptoms significantly contributed to the model, $F(2,366) = 169.29$, $p < .001$ and accounted for 48 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 0.2 % of the variance in post-coronavirus outbreak hoarding, and the R^2 change was not significant ($p = .22$). When added to the model, pre-coronavirus outbreak insomnia symptoms did not predict post-coronavirus outbreak hoarding, over and above the effect of pre-coronavirus outbreak hoarding and depression symptoms. However, pre-coronavirus outbreak depression symptoms did significantly and uniquely predict a small increase in post-outbreak hoarding symptoms, B = .05, β = .09, $p = .04$. See Table 4 for the results of the regression model.

3.3.3. Checking

In the model predicting post-coronavirus outbreak checking, pre-coronavirus outbreak checking and depression symptoms significantly contributed to the model, $F(2,364) = 85.41$, $p < .001$ and accounted for 32 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 1.4 % of the variance in post-coronavirus outbreak checking, and the R^2 change was significant

Table 4
Model coefficients for the hypothesized models predicting post-coronavirus outbreak OCD symptom facets from pre-coronavirus outbreak insomnia symptoms, controlling for pre-coronavirus outbreak OCD symptom facets and depression symptoms ($N = 363$).

	Outcome									
	Post OCIR hoard					Post OCIR check				
Predictor	B	SE	β	*t*	*p*	B	SE	β	*t*	*p*
Step 1										
Pre outcome	.70	.04	.66	17.06	<.001	.57	.05	.55	12.52	<.001
Pre DASS	.06	.02	.11	2.78	.006	.03	.02	.08	1.79	.08
Step 2										
Pre outcome	.69	.04	.65	16.38	<.001	.54	.05	.52	11.82	<.001
Pre DASS	.05	.02	.09	2.04	.04	.01	.02	.02	.48	.63
Pre ISI	.02	.02	.05	1.24	.22	.04	.02	.14	2.78	.006
	Outcome									
	Post OCIR order					Post OCIR neutr				
Predictor	B	SE	β	*t*	*p*	B	SE	β	*t*	*p*
Step 1										
Pre outcome	.63	.04	.64	15.89	<.001	.62	.04	.64	15.44	<.001
Pre DASS	.04	.02	.07	1.79	.07	.009	.02	.02	.57	.57
Step 2										
Pre outcome	.62	.04	.63	15.46	<.001	.61	.04	.63	15.18	<.001
Pre DASS	.02	.02	.03	.68	.50	−.006	.02	−.02	−.40	.69
Pre ISI	.05	.02	.10	2.35	.02	.03	.01	.10	2.20	.03
	Outcome									
	Post OCIR wash					Post OCIR obsess				
Predictor	B	SE	β	*t*	*p*	B	SE	β	*t*	*p*
Step 1										
Pre outcome	.72	.07	.47	10.11	<.001	.52	.04	.56	11.77	<.001
Pre DASS	−.004	.03	−.008	−.17	.87	.003	.02	.006	.12	.91
Step 2										
Pre outcome	.70	.07	.46	9.83	<.001	.50	.05	.54	11.28	<.001
Pre DASS	−.02	.03	−.04	−.84	.40	−.02	.03	−.03	−.64	.52
Pre ISI	.04	.02	.08	1.58	.12	.04	.02	.10	2.03	.04

Note. OCD = obsessive-compulsive disorder; OCIR = Obsessive-Compulsive Inventory-Revised; Pre ISI = pre-outbreak Insomnia Severity Index; Pre DASS = pre-outbreak Depression, Anxiety, and Stress Scale, depression subscale; Post OCIR hoard = post-outbreak OCIR hoarding subscale; Post OCIR check = post-outbreak OCIR checking subscale; Post OCIR order = post-outbreak OCIR ordering subscale; Post OCIR neutr = post-outbreak OCIR neutralizing subscale; Post OCIR wash = post-outbreak OCIR washing subscale; Post OCIR obsess = post-outbreak OCIR obsessions subscale.

($p = .01$). When added to in the model, pre-coronavirus outbreak insomnia symptoms predicted a small increase in post-coronavirus outbreak checking, B = .04, β = .14, $p = .01$, over and above the effect of pre-coronavirus outbreak checking and depression symptoms. Pre-coronavirus outbreak depression symptoms did not significantly predict post-outbreak checking symptoms. See Table 4 for the results of the regression model.

3.3.4. Ordering

In the model predicting post-coronavirus outbreak ordering, pre-coronavirus outbreak ordering and depression symptoms significantly contributed to the model, $F(2,364) = 136.90$, $p < .001$ and accounted for 43 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 0.9 % of the variance in post-coronavirus outbreak ordering, and the R^2 change was significant ($p = .02$). When added to the model, pre-coronavirus outbreak insomnia symptoms predicted a small increase in post-coronavirus outbreak ordering, B = .05, β = .10, $p = .02$, over and above the effect of pre-coronavirus outbreak ordering and depression symptoms. Pre-coronavirus outbreak depression symptoms did not significantly predict post-outbreak ordering symptoms. See Table 4 for the results of the regression model.

3.3.5. Neutralizing

In the model predicting post-coronavirus outbreak neutralizing, pre-coronavirus outbreak neutralizing and depression symptoms significantly contributed to the model, $F(2,359) = 124.79$, $p < .001$ and accounted for 41 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 0.8 % of the variance in post-coronavirus outbreak neutralizing, and the R^2 change was significant ($p = .03$). When added to the model, pre-coronavirus outbreak insomnia symptoms predicted a small increase in post-coronavirus outbreak neutralizing, B = .03, β = .10, $p = .03$, over and above the effect of pre-coronavirus outbreak neutralizing and depression symptoms. Pre-coronavirus outbreak depression symptoms did not significantly predict post-outbreak neutralizing symptoms. See Table 4 for the results of the regression model.

3.3.6. Washing

In the model predicting post-coronavirus outbreak washing, pre-coronavirus outbreak washing and depression symptoms significantly contributed to the model, $F(2,361) = 51.64$, $p < .001$ and accounted for 22 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 0.5 % of the variance in post-coronavirus outbreak washing, and the R^2 change was not significant ($p = .12$). When added to the model, there was not a significant relation between pre-coronavirus outbreak insomnia symptoms and post-coronavirus outbreak washing, B = .04, β = .08, $p = .12$, over and above the effect of pre-coronavirus outbreak washing and depression symptoms. Likewise, pre-coronavirus outbreak depression symptoms

did not significantly predict post-outbreak washing symptoms, $p = .40$. See Table 4 for the results of the regression model.

3.3.7. Obsessions

In the model predicting post-coronavirus outbreak obsessions, pre-coronavirus outbreak obsessions and depression symptoms significantly contributed to the model, $F(2,368) = 85.18$, $p < .001$ and accounted for 32 % of the variance. Introducing pre-coronavirus outbreak insomnia symptoms to the model explained an additional 0.8 % of the variance in post-coronavirus outbreak obsessions, and the R^2 change was significant ($p = .04$). When added to the model, pre-coronavirus outbreak insomnia symptoms predicted a small, significant increase in post-coronavirus outbreak obsessions, $B = .04$, $\beta = .10$, $p = .04$, over and above the effect of pre-coronavirus outbreak obsessions and depression symptoms. Pre-coronavirus outbreak depression symptoms did not significantly predict post-outbreak obsession symptoms. See Table 4 for the results of the regression model.

3.4. Exploratory analyses: reverse effects of pre-coronavirus outbreak OCD symptoms on post-coronavirus outbreak insomnia symptoms

Models testing the reverse effect of pre-coronavirus outbreak OCD symptoms on post-coronavirus outbreak insomnia symptoms, controlling for pre-coronavirus outbreak insomnia and depression symptoms found no significant effect for total OCD symptoms or any subscale (see Table 5).

4. Discussion

The present study examined change in insomnia and OCD symptoms before and after the coronavirus outbreak. Interestingly, there was a small, significant decrease in insomnia symptoms from 2016 to following the pandemic onset. Exploratory follow-up analyses revealed that decreased insomnia symptoms were associated with shelter in place/stay at home orders. Though unexpected, this finding is consistent with accumulating research indicating small improvements in sleep during the pandemic, particularly among those who may benefit from decreased demands on time and increased schedule flexibility associated with working from home (e.g., Blume, Schmidt, & Cajochen, 2020; Gao & Scullin, 2020). Given that the majority of the present sample were classified as professionals, these findings add further support to the notion that those with access to more resources and the ability to work from home may actually experience improved sleep during the pandemic.

As expected, there was a small but significant increase in overall OCD symptoms following the onset of the pandemic. This effect is likely driven in large part by the large significant increase in washing symptoms, which is consistent with public health recommendations for preventing infection during the pandemic. Unexpectedly, there was a small, significant decrease in hoarding symptoms from 2016 to after the coronavirus outbreak. These findings are inconsistent with extant research indicating hoarding symptoms are associated with stressful life events (Tolin, Meunier, Frost, & Steketee, 2010). Further, there was no significant change in ordering, checking, neutralizing, or obsession

Table 5
Model coefficients for the exploratory models predicting post-coronavirus outbreak insomnia symptom from pre-coronavirus outbreak OCD symptoms, controlling for pre-coronavirus outbreak insomnia and depression symptoms ($N = 379$).

	Post ISI				
Predictor	B	SE	β	*t*	*p*
Step 1					
Pre ISI	.49	.05	.49	10.02	<.001
Pre DASS	.06	.06	.05	1.03	.30
Step 2					
Pre ISI	.48	.05	.48	9.42	<.001
Pre DASS	.05	.06	.04	.77	.44
Pre OCIR	.03	.03	.05	1.02	.32

	Post ISI						Post ISI				
Predictor	B	SE	β	*t*	*p*		Predictor	B	SE	β	*t*	*p*
Step 1							**Step 1**					
Pre ISI	.49	.05	.49	10.02	<.001		**Pre ISI**	.49	.05	.49	9.89	<.001
Pre DASS	.06	.06	.05	1.03	.30		**Pre DASS**	.06	.06	.05	.96	.34
Step 2							**Step 2**					
Pre ISI	.48	.05	.49	9.68	<.001		**Pre ISI**	.48	.05	.48	9.48	<.001
Pre DASS	.06	.06	.05	.96	.34		**Pre DASS**	.06	.06	.04	.90	.37
Pre OCIR hoard	.05	.11	.02	.47	.64		**Pre OCIR check**	.15	.15	.05	1.02	.31
Pre ISI	.49	.05	.50	10.07	<.001		**Pre ISI**	.49	.05	.49	9.89	<.001
Pre DASS	.06	.06	.05	1.02	.31		**Pre DASS**	.06	.06	.05	1.02	.31
Step 2							**Step 2**					
Pre ISI	.49	.05	.50	9.96	<.001		**Pre ISI**	.49	.05	.49	9.82	<.001
Pre DASS	.06	.06	.05	1.02	.31		**Pre DASS**	.06	.06	.05	1.02	.31
Pre OCIR order	−.007	.10	−.003	−.07	.95		**Pre OCIR neutr**	−.01	.15	−.004	−.08	.94
Pre ISI	.49	.05	.49	9.87	<.001		**Pre ISI**	.49	.05	.49	9.97	<.001
Pre DASS	.07	.06	.06	1.14	.26		**Pre DASS**	.06	.06	.05	1.01	.31
Step 2							**Step 2**					
Pre ISI	.48	.05	.48	9.56	<.001		**Pre ISI**	.48	.05	.48	9.64	<.001
Pre DASS	.06	.06	.05	1.04	.30		**Pre DASS**	.04	.06	.03	.64	.52
Pre OCIR wash	.23	.15	.07	1.54	.13		**Pre OCIR obsess**	.11	.11	.05	1.02	.31

Note. OCD = obsessive-compulsive disorder; Pre ISI = pre-outbreak Insomnia Severity Index; Pre DASS = pre-outbreak Depression, Anxiety, and Stress Scale, depression subscale; OCIR = Obsessive-Compulsive Inventory-Revised; Pre OCIR hoard = pre-outbreak OCIR hoarding subscale; Pre OCIR check = pre-outbreak OCIR checking subscale; Pre OCIR order = pre-outbreak OCIR ordering subscale; Pre OCIR neutr = pre-outbreak OCIR neutralizing subscale; Pre OCIR wash = pre-outbreak OCIR washing subscale; Pre OCIR obsess = pre-outbreak OCIR obsessions subscale.

symptoms. Evidence for consistency in these OCD symptom facets despite the pandemic is somewhat surprising. Although ordering, checking, neutralizing, or obsession symptoms share relatively less conceptual similarity to behaviors relevant to the coronavirus pandemic compared to washing symptoms, processes underlying these symptoms can be found in responses to the pandemic (e.g., excessively checking COVID-19 case numbers, intrusive thoughts about dying from COVID-19). The lack of change in most OCD symptom facets and decreased hoarding and insomnia symptoms may suggest these aspects of mental health are presently largely robust to the impact of the coronavirus pandemic at a main effect level. Still, tests of mean changes leave unanswered questions of individual differences. That is, are there factors that predict a worse response to the pandemic?

A major aim of the present study was to examine the predictive effects of pre-coronavirus outbreak insomnia symptoms on post-coronavirus outbreak OCD symptoms, controlling for baseline symptoms. The findings showed that increased pre-coronavirus outbreak insomnia symptoms significantly predicted small increases in total OCD symptoms, checking, ordering, neutralizing, and obsessions, over and above the effects of baseline OCD and depression symptoms. These findings are consistent with extant research linking sleep disturbance to OCD (see Cox, Jessup, & Olatunji, 2018; Cox & Olatunji, 2020 for reviews) and extend previous work on the predictive effect of insomnia symptoms on OCD symptoms (Cox, Tuck et al., 2018) across 4 years. Though the observed effects are small, the effect of pre-coronavirus insomnia symptoms is particularly notable given the amount of time elapsed between timepoints and the lack of significant predictive effect of depression symptoms. That is, these findings highlight a sustained impact of insomnia symptoms on OCD symptoms over several years, while a well-established correlate of OCD (Hong et al., 2004) was not predictive.

Importantly, exploratory analyses did not find evidence for the reverse effect of prior OCD on change in insomnia symptoms during the pandemic. Though the lack of experimental manipulation of sleep precludes causal interpretation, the unidirectional nature of the observed effect suggests a specific temporal impact of sleep disturbance on subsequent OCD. These findings also provide further refutation against the classical view of sleep disturbance as epiphenomena of psychopathology. Additionally, these findings highlight insomnia symptoms as one factor that may contribute to poorer mental health outcomes during the coronavirus pandemic. Consistent with a diathesis-stress model, sleep difficulties prior to the pandemic may confer vulnerability for experiencing increased intrusive thoughts and repetitive behaviors during the pandemic. That is, the detrimental effects of poor or insufficient sleep, such as decreased cognitive control (Drummond, Paulus, & Tapert, 2006; Khassawneh, Bathgate, Tsai, & Edinger, 2018) and increased emotional reactivity (Minkel et al., 2014; Yoo, Gujar, Hu, Jolesz, & Walker, 2007), may contribute to an increased risk for OCD symptoms that is then amplified by an acute stressor, such as the pandemic.

Findings largely did not indicate a differential impact of pre-coronavirus outbreak insomnia symptoms on specific OCD facets, suggesting sleep disturbance has a global impact across OCD symptom presentations. This finding further supports the notion that sleep disturbance is a transdiagnostic process within the context of psychopathology (Harvey, Murray, Chandler, & Soehner, 2011). However, the singular exception to the broad impact of pre-coronavirus insomnia symptoms on post-coronavirus OCD symptoms was washing symptoms. Interestingly, pre-coronavirus outbreak insomnia symptoms did not predict post-coronavirus washing symptoms. Examination of the zero-order correlations reveal a smaller correlation between insomnia symptoms and washing symptoms both before and after the coronavirus outbreak, relative to order OCD symptom facets. Thus, insomnia symptoms may simply be minimally related to washing, regardless of the coronavirus. This view is consistent with previous research which found no relation between concurrent insomnia symptoms and contamination symptoms (Raines et al., 2015).

Excessive washing symptoms in OCD better reflect compulsions than obsessions, and extant research suggests that sleep disturbance is more strongly related to obsessions (Timpano, Carbonella, Bernert, & Schmidt, 2014). Alternatively, given the increased relevance of washing to the coronavirus pandemic (i.e., fears of contamination by the virus, recommendations to increase hand washing and disinfect surfaces, etc.), it is likely that the washing subscale of the OCIR is capturing adaptive and expected increases in behaviors and cognitions related to prevention of coronavirus infection across the entire sample, which may mask a potential small predictive effect of prior insomnia symptoms. Thus, the divergent findings for washing symptoms may be unique to the current pandemic context.

The present study revealed significant predictive effects of pre-coronavirus outbreak insomnia symptoms on post-coronavirus OCD symptoms and suggest sleep disturbance may have a negative impact on subsequent mental health during the pandemic. Though the small effect sizes call for caution in interpretation, these findings may have implications for clinical intervention during the coronavirus pandemic. Specifically, these findings suggest that sleep interventions, such as cognitive behavior therapy for insomnia, may be beneficial adjunctive elements to intervention among those with new or worsening OCD symptoms during the pandemic, particularly in individuals with long-standing sleep complaints. However, considerably more research is needed to better elucidate the role of sleep in psychological response to the pandemic and identify other potential predictors of mental health outcomes as the pandemic progresses.

Although these findings offer preliminary evidence for the role of prior insomnia symptoms in increased OCD symptoms following the coronavirus outbreak, several important limitations must be considered. First, this study utilized a nonclinical community sample. Although 13.6 % and 15.7 % of the sample exceeded the clinical cutoff score on the OCIR (Foa et al., 2002) at time 1 and time 2, respectively, it is unclear whether these findings fully generalize to individuals with OCD. Second, the sample was predominantly white and female, limiting the ability to generalize these results to various demographic groups. This is an important limitation, as accumulating evidence indicates that racial minority communities are disproportionately impacted by the pandemic (Hooper, Napoles, & Perez-Stable, 2020; Price-Haywood, Burton, Fort, & Seoane, 2020). Relatedly, the majority of the sample reported occupations categorized as professional. Although this category includes healthcare workers, the present sample may be biased towards individuals with more resources who may be less vulnerable to the economic and health consequences of the pandemic. Third, the present study utilized self-report instruments that are imperfect measures of insomnia and OCD symptoms, and participants' subjective responses may differ from objective data and/or clinical interviews. Further, single-measure methods are vulnerable to estimate inflation due to shared method variance (Cole & Maxwell, 2003). Fourth, although the longitudinal design and measurement of OCD symptoms at both timepoints allows for prediction of change in OCD by insomnia symptoms, the lack of manipulation of sleep limits causal interpretations. Fifth, given the unprecedented nature of the coronavirus pandemic, there are likely unmodeled variables unique to the coronavirus experience, which may alter the present findings. Relatedly, although there was little evidence for clustering due to state (i.e., ICC = .01), there may be unmodeled sources of clustering. Future work utilizing multilevel modeling approaches to examine factors such as broader geographic region, political party, or COVID-19 status may offer additional insight. Finally, the two timepoint design precludes the ability to model mechanisms by which pre-coronavirus outbreak insomnia symptoms predict OCD symptoms. Thus, future research is needed to continue to measure sleep and OCD symptoms as the pandemic continues to more clearly delineate both the impact of sleep on OCD symptoms during the pandemic, as well as mechanisms that may account for this effect.

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Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Supplementary data

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