



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.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



# Contamination-related behaviors, obsessions, and compulsions during the COVID-19 pandemic in a United States population sample

Jack Samuels<sup>a,\*</sup>, Calliope Hologu<sup>b</sup>, Paul S. Nestadt<sup>a</sup>, O. Joseph Bienvenu<sup>a</sup>, Phillip Phan<sup>c,d</sup>, Gerald Nestadt<sup>a</sup>

<sup>a</sup> Department of Psychiatry and Behavioral Sciences, The Johns Hopkins University School of Medicine, Baltimore, MD, 21205, USA

<sup>b</sup> Department of Mental Health, The Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD, 21201, USA

<sup>c</sup> The Johns Hopkins University Carey Business School, Baltimore, MD, 21202, USA

<sup>d</sup> Department of Medicine, The Johns Hopkins University School of Medicine, Baltimore, MD, 21205, USA

## ARTICLE INFO

### Keywords:

Obsessive-compulsive disorder  
Phobia  
Contamination  
COVID-19  
General population

## ABSTRACT

**Background:** Contamination-prevention behaviors such as mask wearing and physical distancing are crucial to reduce coronavirus transmission during the COVID-19 pandemic. We hypothesized that engagement in these behaviors could provoke obsessions and phobias in vulnerable individuals in the community.

**Methods:** A total of 2117 participants, systematically selected to represent the age, gender, and race distributions of the US population, completed an online survey that assessed demographic characteristics, clinical features, COVID-19 risks, and COVID-19 contamination-prevention behaviors. Logistic regression was used to estimate the magnitude of the relationships between the COVID-19 behavior score and clinically significant contamination obsessions, contamination compulsions, and pre-COVID-19 to current change in obsessive-compulsive symptom scores.

**Results:** The COVID-19 behavior score was significantly associated with contamination obsessions (odds ratio (OR) = 1.15, 95% CI = 1.12–1.16;  $p < 0.001$ ) and contamination phobias (OR = 1.14, 95% CI = 1.12–1.16;  $p < 0.001$ ). The COVID-19 behavior score also was associated with pre-pandemic to current increase in the overall obsessive-compulsive symptom score (OR = 1.16, 95% CI = 1.09–1.23;  $p < 0.001$ ), as well as increase in obsessive-compulsive symptom score excluding washing items (OR = 1.13, 95% CI = 1.07–1.19;  $p < 0.001$ ). The magnitude of these relationships did not appreciably change, after adjustment for other variables associated with the outcomes. Moreover, the relationship was significant in those with or without OCD, and in individuals with different levels of doubt and COVID-19 risk.

**Conclusions:** Contamination safety measures are critical for reducing the spread of COVID-19 in the community. However, they may be related to the development of contamination-related symptoms and OCD in vulnerable individuals, complicating the diagnosis and treatment of mental disorders during this period.

## 1. Introduction

The immense impact of the COVID-19 pandemic is beyond question, with millions of cases and deaths, severe economic hardship, and social disruption in the United States and globally (Brenner, 2020; World Health Organization, 2021). There have been well-documented increases in depression and anxiety in many countries (Deng et al., 2021; Newby et al., 2020; Salari et al., 2020; Wang et al., 2020; Wu et al., 2021; Xiong et al., 2020). Population-based surveys in the U.S. also have found substantial adverse mental health outcomes, including symptoms

of depression, anxiety, post-traumatic stress, increased substance use, and suicide ideation (Czeisler et al., 2020; Ettman et al., 2020; Hologu et al., 2020).

In response to personal safety concerns and the urging of public health authorities, many individuals have made substantial efforts to reduce potential exposure to, and contamination with, the SARS-CoV-2 virus. These efforts include physical distancing, wearing of masks, and scrupulous hand washing. These behaviors reduce the risk of infection and must be encouraged during the pandemic. However, there is evidence that the unusual circumstances of the pandemic may increase the

\* Corresponding author.

E-mail address: [jacks@jhmi.edu](mailto:jacks@jhmi.edu) (J. Samuels).

<https://doi.org/10.1016/j.jpsychires.2021.03.064>

Received 1 February 2021; Received in revised form 19 March 2021; Accepted 29 March 2021

Available online 1 April 2021

0022-3956/© 2021 Elsevier Ltd. All rights reserved.

incidence of distressing and disabling obsessions, compulsions, and fears in the population (Ji et al., 2020; Abba-Aji et al., 2020). The stress and worry generated by the pandemic may be pathogenic for obsessions (Adams et al., 2018; Zvolensky et al., 2020). Furthermore, behaviors conducted repetitively to relieve anxiety may become habitual, leading to memory distrust, difficulty in focusing attention, and obsessive-compulsive symptoms (Van den Hout and Kindt, 2003; Hermans et al., 2008). The likelihood of these outcomes may be influenced by an individual's level of perceived risk, as well as the degree of subjective uncertainty about perceptions and memory (doubt) (Marton et al., 2019). Individuals with obsessive-compulsive disorder (OCD) may experience recurrence or exacerbation of their symptoms, especially those that are contamination-related (Davide, 2020; French and Lyne, 2020; Jelinek et al., 2021).

In the current study, we investigated the relationship between contamination-prevention behaviors (COVID-19 related behaviors), and contamination obsessions, contamination phobias, and OCD, in a sample of adult U.S. residents who were surveyed in mid-September 2020, about six months after the first official COVID-19 related death reported in the U.S. We hypothesized that engagement in COVID-19 related behaviors during this period would be associated with obsessions and phobias.

## 2. Materials and methods

### 2.1. Participants

Potential participants were identified by the survey research firm, Qualtrics, from market research panels ([www.qualtrics.com](http://www.qualtrics.com)). Census-matched quota sampling was used to identify a study sample of approximately 2000 adult residents of the United States, with approximately equal proportions of men and women; one-third in each of three age groups (ages 18–34; 35–55; and 55 and over); and a race/ethnicity distribution of 66% non-Hispanic White; 12% non-Hispanic Black; 12% Hispanic; and 10% other.

Informed consent of participants was obtained after the nature of study procedures had been explained. The online consent form indicated that Johns Hopkins University was conducting the study to identify COVID-19 related concerns and to determine if these concerns change over time; that participants would be asked about their feelings, thoughts, and behaviors now and in six months; and that they would be compensated for completing the baseline survey, as well as the follow-up survey. Study investigators were provided with de-identified responses. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki. The study design was reviewed and approved by the Institutional Review Board of the Johns Hopkins Medical Institutions.

All surveys underwent data quality screening procedures including algorithmic and keystroke analysis for attention patterns, click-through behavior, duplicate responses, machine responses, and inattentiveness. Respondents who failed an attention or speed check, along with any responses identified by the data-scrubbing algorithms, were excluded from the analysis.

### 2.2. Measures

As described in the Introduction, the goal of this study was to assess potential associations between COVID-19 related behaviors (i.e., behaviors initiated to reduce the risk of infection in response to the pandemic) and contamination obsessions, contamination phobias, and OCD symptoms.

#### 2.2.1. COVID-19 related behaviors

COVID-19 related behaviors were assessed with an 11-item questionnaire (Coronavirus Impact Scale; University of Miami. PhenXToolkit, 2020) that asked about the extent of changes the participant had

made changes in usual lifestyle or daily activities because of COVID-19. The behaviors included handwashing, use of hand sanitizer, cleaning of home, disinfecting household surfaces, disinfecting or wiping down groceries, disinfecting or wiping down mail or packages, stocking up food and supplies, avoiding domestic travel, avoiding international travel, not ordering restaurant take-out food, and wearing a mask while in public. The possible scores on this Likert-scaled instrument ranged from 0 to 33 (Appendix, Table A1).

#### 2.2.2. Contamination obsessions and contamination phobias

Current (i.e., past-month) contamination obsessions were assessed with five Likert-scaled questions from the contamination section of the Dimensional Yale-Brown Obsessive-Compulsive Scale (DY-BOCS) (Rosario-Campos et al., 2006). The questions asked about: time spent thinking about contamination and engaging in behaviors to reduce contamination; contamination-related avoidance; contamination-related distress; contamination-related disruption of daily routine; and ability to resist contamination-related thoughts and behaviors. The possible scores ranged from 0 to 20.

Current (i.e., past-month) contamination phobias were assessed with 10 items from the Severity Measure for Specific Phobia—Adult instrument (Craske et al., 2013). Each item was scored on a Likert-scale, with response options ranging from never to all of the time. The possible scores range from 0 to 40.

#### 2.2.3. Obsessive-compulsive symptoms

Obsessive-compulsive symptoms were assessed with the Obsessive-Compulsive Inventory – Revised (OCI-R), an 18-item screening instrument for obsessive-compulsive symptoms (Foa et al., 2002). The instrument includes three items each for washing, checking, obsessing, ordering, hoarding, and neutralizing symptoms. Each item is scored on a 5-point Likert-scale. The possible total score ranges from 0 to 72. We also derived an OCI-R score that excluded the three washing items that ranged from 0 to 60. Two separate time periods were assessed: before March 1, 2020 (i.e., before general public recognition of the severity of the COVID-19 pandemic in the U.S.; and current (i.e., within the past month).

#### 2.2.4. Other variables

The survey included several other variables that we considered might influence the relationship between COVID-19 related behaviors and contamination obsessions, contamination phobias, and other obsessive-compulsive symptoms. Demographic characteristics included age, sex, race/ethnicity, education, and residential area. Past-month anxiety and depression symptoms were assessed with the four-item PHQ-4, with two items assessing anxiety, and two items assessing depression (Kroenke et al., 2009). Participants also were asked if they had ever been diagnosed with depression, OCS, or any other anxiety disorder. The Doubt Questionnaire, a 17-item questionnaire, was used to assess doubt/uncertainty (range, 0–85) (Marton et al., 2019). COVID-19 related risks were assessed with 10 yes/no items that asked about current situations conferring increased risk of COVID-19 exposure (range, 0–10) (Appendix, Table A2).

### 2.3. Statistical analysis

Logistic regression models were used to estimate the magnitude of the relationships between the COVID-19 behaviors score (the independent variable) and clinically significant contamination obsessions, contamination compulsions, and pre-COVID-19 to current change in OCI-R scores (the dependent variables). Contamination obsession scores were dichotomized into scores of 0–10 and 11–20; using this threshold, 91% of the high scorers, compared to 9% of the low scorers, gave moderate to extreme severity ratings on at least four of the five obsession items. Contamination phobia scores were dichotomized into scores of 0–20 and 21–40; using this threshold, 86% of high scorers, compared to

2% of low scorers, reported experiencing eight or more of the ten phobias at least half of the time over the past month.

Among participants who reported a low pre-pandemic OCI-R score, we derived a dichotomous variable for change in the OCI-R score, from a low pre-pandemic score (0–9) to a high past-month score (21 or more). Similarly, among participants who reported a low pre-pandemic OCI-R score excluding washing items, we derived a dichotomous variable for change in the OCI-R score, excluding washing items, from a low pre-pandemic score (0–9) to a high past-month score (16 or more).

For each dependent variable, we fit unadjusted models, which included the COVID-19 behavior score as the only independent variable. We then fit a series of adjusted models which sequentially included, along with the COVID-19 behavior score, demographic characteristics (age and sex), PHQ depression and anxiety subscale score, lifetime history of OCD diagnosis, doubt score, and COVID-19 risk score. In addition, to explore potential effect modification, we estimated the associations between the COVID-19 related behavior score and the dependent variables, stratifying by history of OCD diagnosis, categorical doubt score, or categorical COVID-19 risk score.

### 3. Results

#### 3.1. Sample characteristics

A total of 2117 individuals completed the survey between September 17–30, 2021, about six months after the first reported COVID-19 related death in the US. The ages of participants ranged from 18 to 89 years (mean, 46 years), and 54% were women. Whites comprised 71% of the sample; African Americans, 12%, Asian-Americans 6%, and Hispanics, 5%. Most (64%) of the participants lived in a large city or suburb of a large city, 13% in a small city, and 23% in a town, village, or rural area (Table 1).

Nine per cent of participants reported having ever been diagnosed by a doctor or psychologist with OCD, 28% with another anxiety disorder, and 36% with depression.

#### 3.2. Distributions of scale scores

The distributions of study scale scores are shown in Appendix, Table A3.

Twenty-two per cent of participants had high contamination obsession scores (11–20), and 20% had high contamination phobia scores (21–40). Of the 634 participants with a pre-pandemic OCI-R score of 0–9, 20 (3%) had a past-month OCI-R score of 21 or more. Of the 771 participants with a pre-pandemic OCI-R score of 0–9, excluding washing items, 23 (3%) had a past-month score of 16 or more, excluding washing items (Table 2).

#### 3.3. Relationships between COVID-19 behavior and dichotomous outcomes

Several of the demographic characteristics and clinical features assessed in the study were associated with contamination obsessions, contamination phobias, and pre-pandemic to current change in OCI-R scores. Age was inversely related to all outcomes. Compared to women, men had greater odds for contamination obsessions and contamination phobias. The odds of all outcomes increased with depression, anxiety, doubt, and COVID-19 risk scores. Compared to those without a history of OCD, participants with OCD had much greater odds of each of the outcomes (Appendix Table A4).

As shown in Table 3, the COVID-19 behavior score was significantly associated with contamination obsessions (O.R. = 1.15 per unit increase in COVID-19 behavior score; 95% CI = 1.12–1.16;  $p < 0.001$ ) and contamination phobias (O.R. = 1.14, 95% CI = 1.12–1.16;  $p < 0.001$ ). The COVID-19 behavior score also was associated with increase in the overall obsessive-compulsive symptom score (OR = 1.16, 95% CI =

**Table 1**  
Demographic characteristics of the sample (N = 2117).

Characteristic	Number (%)
Sex	
Female	1137 (53.7)
Male	980 (46.3)
Age Group	
18–29	357 (16.9)
30–39	471 (22.2)
40–49	484 (22.9)
50–59	274 (12.9)
60–69	350 (16.5)
70–89	181 (8.5)
Age (mean, SD)	45.8 (16.0)
Race/ethnicity	
Asian-American	131 (6.2)
Black or African American	255 (12.0)
Hispanic or Latinx	109 (5.1)
White	1494 (70.6)
Native American or Alaska Native	20 (0.9)
Other or Multiple	108 (5.1)
Education, highest completed	
Not high school graduate	55 (2.6)
High school graduate or GED	466 (22.0)
Some college	535 (25.3)
College graduate	459 (21.7)
Some post-college	100 (4.7)
Graduate or professional degree	502 (23.7)
Marital status	
Never married	525 (24.8)
Separated or divorced	240 (11.3)
Widowed	77 (3.6)
Cohabiting as if married	152 (7.2)
Married	1123 (53.0)
Residential area	
Large city	617 (29.1)
Suburb of large city	744 (35.1)
Small city	268 (12.7)
Town or village	164 (7.7)
Rural area	324 (15.3)

**Table 2**  
Distributions of dichotomous scale scores.

Dichotomous score	Number (%)
Contamination obsessions	
0–10	1647 (77.8)
11–20	470 (22.2)
Contamination phobias	
0–20	1687 (79.7)
21–40	430 (20.3)
Obsessions score, current <sup>a</sup>	
0–9	614 (96.8)
21–72	20 (3.2)
Obsessions score, current, excluding washing items <sup>b</sup>	
0–9	748 (97.0)
16–60	23 (3.0)

<sup>a</sup> Among 634 participants with a pre-pandemic OCI-R score of 0–9.

<sup>b</sup> Among 771 participants with a pre-pandemic OCI-R score of 0–9, excluding washing items.

**Table 3**  
Association between COVID-19 behavior score and dichotomous outcomes. Logistic regression models.

Adjusting for:	Contamination obsessions (N = 2117)	Contamination phobias (N = 2117)	Change in OCI-R Score <sup>a</sup> (N = 634)	Change in OCI-R Score, excluding washing items <sup>b</sup> (N = 771)
Odds Ratio (95% CI)				
–	1.15 (1.12–1.16) <sup>e</sup>	1.14 (1.12–1.16) <sup>e</sup>	1.16 (1.09–1.23) <sup>e</sup>	1.13 (1.07–1.19) <sup>e</sup>
Age and Sex	1.14 (1.12–1.16) <sup>e</sup>	1.12 (1.11–1.14) <sup>e</sup>	1.15 (1.08–1.22) <sup>e</sup>	1.12 (1.06–1.18) <sup>e</sup>
Depression score and Anxiety score	1.13 (1.11–1.15) <sup>e</sup>	1.12 (1.10–1.15) <sup>e</sup>	1.13 (1.06–1.20) <sup>e</sup>	1.09 (1.04–1.16) <sup>d</sup>
OCD diagnosis	1.15 (1.13–1.17) <sup>e</sup>	1.14 (1.12–1.15) <sup>e</sup>	1.15 (1.09–1.22) <sup>e</sup>	1.12 (1.06–1.19) <sup>e</sup>
Doubt score	1.13 (1.12–1.15) <sup>e</sup>	1.12 (1.10–1.13) <sup>e</sup>	1.17 (1.10–1.24) <sup>e</sup>	1.13 (1.07–1.20) <sup>e</sup>
COVID risk score	1.14 (1.13–1.16) <sup>e</sup>	1.13 (1.12–1.15) <sup>e</sup>	1.15 (1.09–1.22) <sup>e</sup>	1.12 (1.06–1.18) <sup>e</sup>
Age, sex, depression score, anxiety score, OCD diagnosis, doubt score, and COVID-19 risk score	1.09 (1.07–1.11) <sup>e</sup>	1.07 (1.05–1.09) <sup>e</sup>	1.09 (1.01–1.17) <sup>c</sup>	1.10 (1.04–1.16) <sup>d</sup>

<sup>a</sup> Change from 0 to 9 to 21+, among 634 participants with a pre-pandemic OCI-R score of 0–9.

<sup>b</sup> Change from 0 to 9 to 16+, among 771 participants with a pre-pandemic OCI-R score of 0–9, excluding washing items.

<sup>c</sup> p < 0.05.

<sup>d</sup> p < 0.01.

<sup>e</sup> p < 0.001.

1.09–1.23; p < 0.001), as well as increase in obsessive-compulsive symptom score excluding washing items (OR = 1.13, 95% CI = 1.07–1.19; p < 0.001). The magnitude of these relationship did not appreciably change, after adjustment for other variables associated with the outcomes.

Given that hoarding disorder is considered distinct from OCD in DSM-5 (American Psychiatric Association, 2013), we repeated the analyses for the change in OCI-R score, excluding the hoarding items. There were 782 individuals whose pre-pandemic score on this scale was 0–9; of those, 740 (94.6%) had a current score of 0–9, and 42 (5.4%) had a score of 16+. The results were not appreciably different from those in Table 3 (data not shown).

The magnitude of the univariable association between COVID-19 behaviors and each of the dichotomous outcome variables was not appreciably different, in different categories of the doubt score, different strata of the COVID-19 risk score, or in those with or without a reported lifetime diagnosis of OCD (Table 4). Excluding participants who reported being diagnosed with OCD, the relationships (odds ratio, 95% CI; p-value) between COVID-19 behaviors and outcomes were: 1.13 (1.10–1.15; p < 0.001) for contamination obsessions; 1.11 (1.09–1.13; p < 0.001) for contamination phobias; 1.12 (1.05–1.19; p < 0.01) for change in OCI-R score; and 1.10 (1.03–1.16; p < 0.01) for change in the OCI-R without washing items, in multivariable models that included age, sex, depression score, anxiety score, doubt score, and COVID-19 risk score.

#### 4. Discussion

Several recent studies have investigated COVID-19 related behaviors and psychological symptoms in population surveys. Greater engagement in protective behaviors was associated with higher stress and anxiety levels in an Australian survey (Newby et al., 2020), and taking steps to avoid infecting others, as well as the perceived likelihood of infection, were significantly associated with anxiety and depression in a U.S. survey (Holingue et al., 2020). Furthermore, a survey in Wuhan, China found a high prevalence of presumptive OCD during the pandemic that was associated with comorbidity with, and family history of, psychiatric disorders (Zheng et al., 2020). Moreover, several studies have found that many OCD-affected individuals have experienced exacerbation of their symptoms during the pandemic, especially those with contamination

**Table 4**

Associations between COVID-19 behavior and dichotomized contamination obsessions, contamination phobias, and OCI-R change, stratified by OCD diagnoses, doubt score, and COVID-19 risk score Univariable logistic regression models.

	Contamination Obsessions (N = 2117)	Contamination Phobias (N = 2117)	OCI-R Change <sup>a</sup> (N = 634)	OCI-R Change, Excluding washing items <sup>b</sup> (N = 771)
Odds Ratio (95% CI)				
OCD Diagnosis				
No	1.15 (1.13–1.17) <sup>e</sup>	1.13 (1.12–1.15) <sup>e</sup>	1.16 (1.09–1.23) <sup>e</sup>	1.13 (1.07–1.20) <sup>e</sup>
Yes	1.13 (1.08–1.18) <sup>e</sup>	1.14 (1.09–1.19) <sup>e</sup>	1.13 (0.92–1.38)	1.08 (0.93–1.26)
Doubt Score				
17–39	1.19 (1.14–1.24) <sup>e</sup>	1.19 (1.12–1.26) <sup>e</sup>	1.22 (1.11–1.33) <sup>e</sup>	1.15 (1.07–1.24) <sup>e</sup>
40–59	1.13 (1.11–1.16) <sup>e</sup>	1.12 (1.07–1.13) <sup>e</sup>	1.10 (1.01–1.21) <sup>c</sup>	1.11 (1.01–1.22) <sup>c</sup>
60–81	1.12 (1.09–1.15) <sup>e</sup>	1.14 (1.11–1.17) <sup>e</sup>	1.11 (0.90–1.35)	1.05 (0.90–1.23)
COVID-19 Risk Score				
0–2	1.17 (1.13–1.20) <sup>e</sup>	1.13 (1.10–1.16) <sup>e</sup>	1.15 (1.04–1.28) <sup>d</sup>	1.12 (0.99–1.27)
3–5	1.14 (1.11–1.17) <sup>e</sup>	1.14 (1.12–1.17) <sup>e</sup>	1.24 (1.11–1.37) <sup>c</sup>	1.17 (1.09–1.27) <sup>e</sup>
6–10	1.12 (1.08–1.16) <sup>e</sup>	1.13 (1.09–1.17) <sup>e</sup>	1.04 (0.95–1.15)	1.03 (0.94–1.13)

<sup>a</sup> Change from 0 to 9 to 21+, among 634 participants with a pre-pandemic OCI-R score of 0–9.

<sup>b</sup> Change from 0 to 9 to 16+, among 771 participants with a pre-pandemic OCI-R score of 0–9, excluding washing items.

<sup>c</sup> p < 0.05.

<sup>d</sup> p < 0.01.

<sup>e</sup> p < 0.001.

obsessions and washing compulsions (Adam, 2020; French and Lyne, 2020; Davide et al., 2020; Jelinke et al., 2021), although with increases across multiple obsessive-compulsive symptom dimensions (Khosravani et al., 2021a). Abba-Aji et al. (2020) reported that 60% of respondents who subscribed to a supportive text messaging service reported new-onset OCD symptoms during the pandemic.

The current population-based survey of U.S. adult residents, conducted in mid-September 2020, is to our knowledge the first to investigate specific relationships between COVID-19 related behaviors, obsessions, and phobias. We found that the degree of compliance with recommended behaviors to reduce the risks of exposure to and transmission of infection during the COVID-19 pandemic was significantly associated with clinically significant contamination obsessions and phobias. Engaging in these behaviors also was significantly associated with pre-pandemic to current change in the severity of obsessive-compulsive symptoms, even when contamination-related obsessions and compulsions were excluded from the assessment. Furthermore, these findings were evident in participants who reported no lifetime history of OCD. These relationships were independent of other measured demographic characteristics (age, sex) and clinical features (anxiety, depression, doubt, and COVID-19 related risk), all of which were associated with contamination obsessions, contamination phobias, and change in the severity of obsessive-compulsive symptoms. These findings support our hypothesis that the repetition of behaviors, like mask wearing, hand washing, and physical distancing, while crucial for reducing the risk of contamination and illness, may contribute to the development and exacerbation of contamination obsessions, contamination phobias, and severity of obsessive-compulsive symptoms during the COVID-19 pandemic.

Although not a focus of this study, it is interesting that men had greater odds of contamination obsessions (OR = 1.70; 95% CI = 1.39–2.10;  $p < 0.001$ ) and contamination phobias (OR = 2.41; 95% CI = 1.94–3.00;  $p < 0.001$ ) in this sample (Appendix Table A4). This is mostly explained by participant sex differences in the distributions of age, education, and area of residence, variables which were strongly related to contamination obsessions and compulsions. A total of 69% of the men, vs. 56% of the women, were in the 18–49 year-old age group; 42% of the men, vs. 17% of the women, had a post-college education; and 40% of the men, vs. 19% of the women, lived in a large city. Adjusting for these demographic characteristics substantially reduced the magnitude of the relationships between sex and contamination obsessions (OR = 1.23; 95% CI = 0.98–1.54;  $p = 0.07$ ) and between sex and contamination phobias (OR = 1.48; 95% CI = 1.16–1.89;  $p < 0.01$ ).

The magnitude of the relationships between COVID-19 behaviors, contamination obsessions, and contamination phobias were similar in participants with or without a lifetime diagnosis of OCD. Moreover, we found that the relationship between COVID-19 behaviors and reported change in OCI-R score from before to during the pandemic was similar, albeit slightly lower, when washing items were removed from the scale. Over the natural course of OCD, there are transitions in which new, previously unexperienced, obsessions and compulsions emerge and even predominate the clinical presentation (Skoog and Skoog, 1999). It is possible that contamination concerns generalize into additional unrelated obsessions and compulsions. The process whereby this occurs is unknown, perhaps emerging from a learning process or behavioral sensitization (Post and Weiss, 1998), or activation of evolutionarily conserved neural circuits that were important for threat detection and harm avoidance in the distant past (Polimeni et al., 2005; Feigin et al., 2006).

The clinical management of OCD is aggravated by the reduced availability of care wrought by the pandemic itself. Moreover, exposure and response prevention treatments may be less effective during this period and may need to be modified or temporarily replaced by other cognitive-behavioral therapies until the pandemic is brought under control (Fineberg et al., 2020; Sheu et al., 2020; Quittkat et al., 2020; Storch et al., in press). Ironically, some patients with OCD may feel that

the general public's adoption of hygienic practices validates their compulsive behaviors, leading to complacency regarding their own psychopathology and retarding therapeutic progress (Adam, 2020; Ornell et al., 2021).

Epidemiologic studies of OCD have identified few consistent risk factors, apart from familiarity (Nestadt et al., 2000) and perinatal factors (Brander et al., 2016), though neither were evaluated in this study. There also is evidence that stressful events can provoke OCD symptoms (Adams et al., 2018; Murayama et al., 2020), and Zvolensky et al. (2020) have proposed a relationship between COVID-19 pandemic-related stress and psychopathology. In the current study, we found that COVID-19-related risk, as measured by potential exposure to the pathogen, was associated with obsessions and phobias. However, the relationship between safety behaviors and obsessions and phobias remained significant, even after adjusting for COVID-19 risk.

Several personal vulnerability factors for OCD should also be considered. In previous studies, we have found that pathological doubt is associated with increased impairment and poorer treatment response in OCD-affected individuals (Marton et al., 2019; Samuels et al., 2017). In the current study, we considered that doubt about properly performing infection prevention behaviors might have increased the risk of psychopathology during the pandemic. We found that the doubt score was significantly associated with the outcomes but, contrary to our expectation, the association between COVID-19 related behaviors and obsessions was independent of the score on the doubt scale. This may be related to the contamination nature of the obsessions, as doubt may be more strongly related to checking behaviors (Samuels et al., 2017).

Several potential limitations of the current study must be acknowledged. First, although the sample was selected to reflect the broad age, gender, and racial/ethnic distributions of U.S. adults, respondents to the survey may not be representative; indeed, the self-reported lifetime prevalences of depression, anxiety disorders, and OCD in the sample are considerably higher than found from epidemiologic studies (Kessler et al., 2012). Although the reported prevalences of depressive and anxiety symptoms are higher than expected, these are similar with those found by other studies during the COVID-19 pandemic (Czeisler et al., 2020; Ettman et al., 2020). Like several other online surveys, in order to limit the time required by participants to complete the survey, we used the PHQ-4, which assesses only two symptoms of depression and two symptoms of generalized anxiety disorder (Kroenke et al., 2009), and self-report instruments like the PHQ-9 and GAD-7 that assess a greater number of DSM-V symptoms for these disorders should be considered for future research (Kroenke et al., 2001; Spitzer et al., 2006). Second, only a limited number of factors could be assessed, to ensure participation and completion of the survey by the targeted number of individuals. Additional personal vulnerability factors for OCD, such as neuroticism, obsessive-compulsive personality traits (Samuels et al., 2000), anxiety sensitivity (Calamari et al., 2008; Brand et al., 2013), and intolerance of uncertainty (Buhr and Dugas, 2002) should be considered in future studies, as well as more specific COVID-19 related stress (Taylor et al., 2020; Khosravani et al., 2021b). Third, the COVID-19 behavior and risk scales used in this study were only recently developed and, to our knowledge, have not been extensively tested and validated in other samples; although they appear to have face validity, investigation of the psychometric features of these instruments is needed. Furthermore, the thresholds we used to dichotomize contamination obsession and phobias score need to be compared against clinical diagnoses. Moreover, all information was collected by self-report survey questionnaires and was cross-sectional or retrospective, and future prospective studies are needed to provide further insight into causal relationships between pandemic-related behaviors and psychopathology.

## 5. Conclusions

Behaviors to prevent SARS-CoV-2 virus exposure, infection, and transmission are crucial for reducing the severity of the pandemic. In

some individuals, these behaviors may lead to the development or exacerbation of psychopathology, including obsessions, compulsions, and phobias. Clinicians must be vigilant for the development of these symptoms in patients during the pandemic. A substantial increase in the number of individuals in the population with these symptoms will necessitate increased availability of treatment resources – limited at the

best of times – and exert an additional burden on mental health services (Campion et al., 2020).

**Declaration of competing interest**

The authors report no conflict of interest.

**APPENDIX**

**Table A1**

COVID-19 Behavior Scale To what extent have you made the following changes to your usual lifestyle or daily activities because of COVID-19?

	No more than usual (0)	A little more than usual (1)	Moderately more than usual (2)	A lot more than usual (3)
Handwashing				
Use of hand sanitizer				
Cleaning in your home				
Disinfecting surfaces in your household				
Disinfecting or wiping down groceries				
Disinfecting or wiping down mail or packages				
Stocking up on food and supplies				
Avoiding or cancelling domestic travel				
Avoiding or cancelling international travel				
Not ordering take-out from restaurants				
Wearing a mask while out in public				

**Table A2**

COVID Risk Scale. Please answer the following questions about your current situation

	Yes (1)	No (0)
Do you live with others who work or go to school outside the home?		
Do you work outside the home?		
Do you live with anyone who works or volunteers as a health care worker, first responder, or other position which may put them at greater risk of exposure to others?		
Do you work or volunteer as a health care worker, first responder, or other position which may put you at greater risk of exposure to others?		
Do you live with anyone who has been ill with COVID?		
Do you live with anyone who has been in close physical contact (less than 6 feet away) with someone with COVID?		
Have you been in close physical contact (less than 6 feet away) with someone with COVID?		
When outside your home, are you usually able to keep at least 6 feet away from others?		
When outside your home, do you usually wear a face mask?		
When outside your home, are other people around you wearing face masks?		
Do you go to other indoor places where there are other people around, such as grocery stores or other businesses?		
Do you have any chronic medical conditions, like chronic heart disease, lung disease, asthma, diabetes, or high blood pressure (hypertension)?		

**Table A3**  
Distributions of Scale Scores

Scale	Range	Mean (SD)
COVID-19 behaviors	0–33	17.5 (9.1)
COVID-19 risks	0–10	3.2 (2.0)
Doubt	17–81	48.8 (14.5)
Depression and Anxiety	0–12	3.9 (3.7)
Depression	0–6	1.9 (2.0)
Anxiety	0–6	1.9 (2.0)
Contamination obsessions	0–20	6.8 (4.7)
Contamination phobias	0–40	9.9 (11.1)
Obsessions, pre-pandemic	0–72	23.1 (19.2)
Obsessions, past-month	0–72	22.7 (20.0)
Obsessions, pre-pandemic, excluding washing items	0–60	19.4 (16.0)
Obsessions, past-month, excluding washing items	0–60	18.1 (16.9)

**Table A4**  
Univariable Association between risk correlates and dichotomous outcomes

	Contamination Obsessions (N = 2117)	Contamination Phobias (N = 2117)	Change in OCI-R Score <sup>a</sup> (N = 634)	Change in OCI-R Score excluding washing items <sup>b</sup> (N = 756)
Age	0.96 (0.96–0.97) <sup>e</sup>	0.96 (0.95–0.96) <sup>e</sup>	0.96 (0.94–0.99) <sup>e</sup>	0.96 (0.94–0.99) <sup>d</sup>
Sex (Male:Female)	1.70 (1.39–2.10) <sup>e</sup>	2.41 (1.94–3.00) <sup>e</sup>	1.79 (0.73–4.37)	1.64 (0.72–3.77)
PHQ Depression Score	1.62 (1.53–1.72) <sup>e</sup>	1.97 (1.84–2.10) <sup>e</sup>	1.82 (1.48–2.24) <sup>e</sup>	1.69 (1.39–2.05) <sup>e</sup>
PHQ Anxiety Score	1.68 (1.59–1.78) <sup>e</sup>	1.87 (1.76–2.00) <sup>e</sup>	1.84 (1.49–2.26) <sup>e</sup>	1.68 (1.38–2.04) <sup>e</sup>
OCD (Yes:No)	2.91 (2.14–3.96) <sup>e</sup>	3.86 (2.84–5.25) <sup>e</sup>	7.47 (1.51–3.71) <sup>d</sup>	10.05 (2.60–38.83) <sup>d</sup>
Doubt Score	1.05 (1.04–1.06) <sup>e</sup>	1.09 (1.08–1.11) <sup>e</sup>	1.04 (1.00–1.09) <sup>c</sup>	1.04 (0.99–1.08)
COVID Risk Score	1.27 (1.21–1.34) <sup>e</sup>	1.54 (1.46–1.63) <sup>e</sup>	1.49 (1.20–1.85) <sup>c</sup>	1.61 (1.32–1.97) <sup>e</sup>

<sup>a</sup> Change from 0 to 9 to 21+, among 634 participants with a pre-pandemic OCI-R score of 0–9.

<sup>b</sup> Change from 0 to 9 to 16+, among 756 participants with a pre-pandemic OCI-R score of 0–9, excluding washing items.

<sup>c</sup> p < 0.05.

<sup>d</sup> p < 0.01.

<sup>e</sup> p < 0.001.

**References**

Abba-Aji, A., Li, D., Hrabok, M., Shalaby, R., Gusnowski, A., Vuong, W., Surood, S., Nkire, N., Li, X.M., Greenshaw, A.J., Agyapong, V., 2020. COVID-19 pandemic and mental health: prevalence and correlates of new-onset obsessive-compulsive symptoms in a Canadian province. *Int. J. Environ. Res. Publ. Health* 17, 6986. <https://doi.org/10.3390/ijerph17196986>.

Adam, D., 2020. The hellish side of handwashing: how coronavirus is affecting people with OCD. *Guardian*. March 13. <https://www.theguardian.com/society/2020/mar/13/why-regular-handwashing-can-be-badadvice-for-patients>.

Adams, T.G., Kelmendi, B., Brake, C.A., Gruner, P., Badour, C.L., Pittenger, C., 2018. The role of stress in the pathogenesis and maintenance of obsessive-compulsive disorder. *Chronic Stress*. <https://doi.org/10.1177/2470547018758043>.

American Psychiatric Association, 2013. *Diagnostic and Statistical Manual of Mental Disorders*, fifth ed. APA, Washington, DC.

Brand, J., McKay, D., Wheaton, M.G., Abramowitz, J.S., 2013. The relationship between obsessive compulsive beliefs and symptoms, anxiety and disgust sensitivity, and Swine Flu fears. *J. Obsessive Compuls. Relat. Disord.* 2, 200–206.

Brander, G., Rydell, M., Kuja-Halkola, R., Fernández de la Cruz, L., Lichtenstein, P., Serlachius, E., Rück, C., Almqvist, C., D’Onofrio, B.M., Larsson, H., Mataix-Cols, D., 2016. Association of perinatal risk factors with obsessive-compulsive disorder: a population-based birth cohort, sibling control study. *JAMA Psychiatr.* 73, 1135–1144.

Brenner, M.H., 2020. Will there be an epidemic of corollary illnesses linked to a COVID-19-related recession? *Am. J. Public Health* 110, 974–975.

Buhr, K., Dugas, M.J., 2002. The Intolerance of Uncertainty Scale: psychometric properties of the English version. *Behav. Res. Ther.* 40, 931–945.

Calamari, J.E., Rector, N.A., Woodard, J.L., Cohen, R.J., Chik, H.M., 2008. Anxiety sensitivity and obsessive-compulsive disorder. *Assessment* 15, 351–363.

Campion, J., Javed, A., Sartorius, N., Marmot, M., 2020. Addressing the public mental health challenge of COVID-19. *Lancet Psychiatr.* 7, 657–659.

Craske, M., Wittchen, U., Bogels, S., Stein, M., Andrews, G., Lebeu, R., 2013. *APA DSM-5 Severity Measure for Specific Phobia – Adult*. American Psychiatric Association.

Czeisler, M.E., Lane, R.I., Petrosky, E., Wiley, J.F., Christensen, A., Njai, R., Weaver, M.D., Robbins, R., Facer-Child, s E.R., Barger, L.K., Czeisler, C.A., Howard, M.E., Rajaratnam, S.M.W., 2020. Mental health, substance use, and suicidal ideation



- during the COVID-19 pandemic - United States, June 24–30, 2020. In: MMWR. Morbidity and Mortality Weekly Report, vol. 32, p. 69 (August 14, 2020).
- Davide, P., Andrea, P., Martina, O., Andrea, E., Davide, D., Mario, A., 2020. The impact of the COVID-19 pandemic on patients with OCD: effects of contamination symptoms and remission state before the quarantine in a preliminary naturalistic study. *Psychiatr. Res.* 291, 113213. <https://doi.org/10.1016/j.psychres.2020.113213>.
- Deng, J., Zhou, F., Hou, W., Silver, Z., Wong, C.Y., Chang, O., Huang, E., Zuo, Q.K., 2021. The prevalence of depression, anxiety, and sleep disturbance in COVID-19 patients: a meta-analysis. *Ann. N. Y. Acad. Sci.* 1486, 90–111.
- Ettman, C.K., Abdalla, S.M., Cohen, G.H., Sampson, L., Vivier, P.M., Galea, S., 2020. Prevalence of depression symptoms in US adults before and during the COVID-19 pandemic. *JAMA Netw. Open* 3 (9), e2019686. <https://doi.org/10.1001/jamanetworkopen.2020.19686>.
- Feygin, D.L., Swain, J.E., Leckman, J.F., 2006. The normalcy of neurosis: evolutionary origins of obsessive-compulsive disorder and related behaviors. *Prog. Neuro-Psychopharmacol. Biol. Psychiatry* 30, 854–864.
- Fineberg, N.A., Van Ameringen, M., Drummond, L., Hollander, E., Stein, D.J., Geller, D., Walitza, S., Pallanti, S., Pellegrini, L., Zohar, J., Rodriguez, C.I., Menchont, J.M., Morgado, P., Mpavaenda, D., Fontenelle, L.F., Feusner, J.D., Grassi, G., Lochner, C., Veltmanab, D.J., Sireau, N., Carmi, L., Adamai, D., Nicolini, H., Dell'Ossoaf, B., 2020. How to manage obsessive-compulsive disorder (OCD) under COVID-19: a clinician's guide from the international college of obsessive compulsive spectrum disorders (ICOCs) and the obsessive-compulsive and related disorders research network (OCRN) of the European college of neuropsychopharmacology. *Compr. Psychiatr.* 100, 152174. <https://doi.org/10.1016/j.comppsy.2020.152174>.
- Foa, E.B., Huppert, J.K., Leiberg, S., Langner, R., Kichic, R., Hajcak, G., Salkovskis, P.M., 2002. The Obsessive-Compulsive Inventory: development and validation of a short version. *Psychol. Assess.* 14, 485–496.
- French, I., Lyne, J., 2020. Acute exacerbation of OCD symptoms precipitated by media reports of COVID-19. *Ir. J. Psychol. Med.* 37, 291–294.
- Hermans, D., Engelen, U., Grouwels, L., Joos, E., Lemmens, J., Pieters, G., 2008. Cognitive confidence in obsessive-compulsive disorder: distrusting perception, attention and memory. *Behav. Res. Ther.* 46, 98–113.
- Holingue, C., Kalb, L.G., Riehm, K.E., Bennett, D., Kapteyn, A., Velhuis, V., 2020. Mental distress in the United States at the beginning of the COVID-19 pandemic. *Am. J. Public Health* 110, 1628–1634.
- Jelinek, L., Moritz, S., Miegel, F., Voderholzer, U., 2021. Obsessive-compulsive disorder during COVID-19: turning a problem into an opportunity? *J. Anxiety Disord.* 77, 102329.
- Ji, G., Wei, W., Yue, K.C., Li, H., Shi, L.J., Ma, J.D., He, C.Y., Zhou, S.S., Zhao, Z., Lou, T., Cheng, J., Yang, S.C., Hu, X.Z., 2020. Effects of the COVID-19 pandemic on obsessive-compulsive symptoms among university students: prospective cohort survey study. *J. Med. Internet Res.* 22 (9), e21915. <https://doi.org/10.2196/21915>.
- Kessler, R.C., Petukhova, M., Sampson, N.A., Zaslavsky, A.M., Wittchen, H.-U., 2012. Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *Int. J. Methods Psychiatr. Res.* 21, 169–184.
- Khosravani, V., Aardema, F., Ardestani, S.M.S., Bastan, F.S., 2021a. The impact of the coronavirus pandemic on specific symptom dimensions and severity in OCD: a comparison before and during COVID-19 in the context of stress responses. *J. Obsessive Compuls. Relat. Disord.* 29, 100626. <https://doi.org/10.1016/j.jocrd.2021.100626>.
- Khosravani, V., Asmundson, G.J.G., Taylor, S., Bastan, F.S., Ardestani, S.M.S., 2021b. The Persian COVID-19 stress scales (Persian-CSS) and COVID-19-related stress reactions in patients with obsessive-compulsive and anxiety disorders. *J. Obsessive Compuls. Relat. Disord.* 28, 100615. <https://doi.org/10.1016/j.jocrd.2020.100615>.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. *J. Gen. Intern. Med.* 16, 606–613.
- Kroenke, K., Spitzer, R.L., Williams, J.B.W., Löwe, B., 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics* 50, 613–621.
- Marton, T., Samuels, J., Nestadt, P., Krasnow, J., Wang, J., Shuler, M., Kamath, V., Chib, V.S., Bakker, A., Nestadt, G., 2019. Validating a dimension of doubt in decision-making: a proposed endophenotypes for obsessive-compulsive disorder. *PLoS One* 14, e0218182.
- Murayama, K., Nakao, T., Ohno, A., Tsuruta, S., Tomiyama, H., Hasuzawa, S., Mizobe, T., Kato, K., Kanba, S., 2020. Impacts of stressful life events and traumatic experiences on onset of obsessive-compulsive disorder. *Front. Psychiatr.* 11, 1–6, 561266.
- Nestadt, G., Samuels, J., Riddle, M., Bienvenu 3rd, O.J., Liang, K.Y., LaBuda, M., Walkup, J., Grados, M., Hoehn-Saric, R., 2000. A family study of obsessive-compulsive disorder. *Arch. Gen. Psychiatr.* 57, 358–363.
- Newby, J.M., O'Moore, K., Tang, S., Christensen, H., Faasse, K., 2020. Acute mental health responses during the COVID-19 pandemic in Australia. *PLoS One* 15, e0236562.
- Ornell, F., Braga, D.T., Bavaresco, D.V., Francke, I.D., Nitcherwitz-Scherer, J., von Diemen, L., Kessler, F.H.P., 2021. Obsessive-compulsive disorder reinforcement during the COVID-19 pandemic. *Trends Psychiatr. Psychother.* <https://doi.org/10.47626/2237-6089-2020-0054>. Jan 22;S2237-60892021005001205.
- Polimeni, J., Reiss, J.P., Sareen, J., 2005. Could obsessive-compulsive disorder have originated as a group-selected adaptive trait in traditional societies? *Med. Hypotheses* 65, 55–664.
- Post, R.M., Weiss, S.R.B., 1998. Sensitization and kindling phenomena in mood, anxiety, and obsessive-compulsive disorders: the role of serotonergic mechanisms in illness progression. *Biol. Psychiatr.* 44, 193–206.
- Quittkat, H.L., Dising, R., Holtmann, F.-J., Buhlmann, U., Svaldi, J., Vocks, S., 2020. Perceived impact of COVID-19 across different mental disorders: a study on disorder-specific symptoms, psychosocial stress and behavior. *Front. Psychol.* 11, 586246.
- Rosario-Campos, M.C., Miguel, E.C., Quatrano, S., Chacon, P., Ferrao, Y., Findley, D., Katsovich, L., Scahill, L., King, R.A., Woody, S.R., Tolin, D., Hollander, E., Kano, Y., Leckman, J.F., 2006. The Dimensional Yale-Brown Obsessive-Compulsive Scale (DY-BOCS): an instrument for assessing obsessive-compulsive symptom dimensions. *Mol. Psychiatr.* 11, 495–504.
- Salari, N., Hosseini-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulopoor, S., Mohammadi, M., Rasoulopoor, S., Khaledi-Paveh, B., 2020. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Glob. Health* 16, 57.
- Samuels, J., Bienvenu, O.J., Krasnow, J., Wang, Y., Grados, M.A., Cullen, B., Goes, F.S., Maher, B., Greenberg, B.D., McLaughlin, N.C., Rasmussen, S.A., Fyer, A.J., Knowles, J.A., Nestadt, P., McCracken, J.T., Piacentini, J., Geller, D., Pauls, D.L., Stewart, S.E., Murphy, D.L., Shugart, Y.Y., Kamath, V., Bakker, A., Riddle, M.A., Nestadt, G., 2017. An investigation of doubt in obsessive-compulsive disorder. *Compr. Psychiatr.* 75, 117–124.
- Samuels, J., Nestadt, G., Bienvenu, O.J., Costa Jr., P.T., Riddle, M.A., Liang, K.Y., Hoehn-Saric, R., Grados, M.A., Cullen, B.A., 2000. Personality disorders and normal personality dimensions in obsessive-compulsive disorder. *Br. J. Psychiatry* 477, 457–462.
- Sheu, J.C., McKay, D., Storch, E.A., 2020. COVID-19 and OCD: potential impact of exposure and response prevention therapy. *J. Anxiety Disord.* 76, 102314.
- Skooog, G., Skoog, I., 1999. A 40-year follow-up of patients with obsessive-compulsive disorder. *Arch. Gen. Psychiatr.* 56, 121–127.
- Spitzer, R.L., Kroenke, K., Williams, J.B.W., Löwe, B., 2006. A brief measure for assessing generalized anxiety disorder—the GAD-7. *Arch. Intern. Med.* 166, 1092–1097.
- Storch, E.A., Sheu, J.C., Guzik, A.G., Schneider, S.C., Cepeda, S.L., Rombado, B.R., Gupta, R., Hoch, C.T., Goodman, W.K., 2021. Impact of the COVID-19 pandemic on exposure and response prevention outcomes in adults and youth with obsessive-compulsive disorder. *Psychiatr. Res.* 295, 113597. <https://doi.org/10.1016/j.psychres.2020.113597>.
- Taylor, S., Landry, C.A., Paluszek, M.M., Fergus, T.A., McKay, D., Asmundson, G.J.G., 2020. Development and initial validation of the stress scales. *J. Anxiety Disord.* 72, 102232. <https://doi.org/10.1016/j.janxdis.2020.102232>.
- Van den Hout, M.A., Kindt, M., 2003. Repeated checking causes memory distrust. *Behav. Res. Ther.* 41, 301–316.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R.S., Choo, F.N., Tran, B., Ho, R., Sharma, V.K., Ho, C., 2020. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav. Immun.* 87, 40–48.
- World Health Organization Coronavirus Disease (COVID-19) Dashboard. WHO, 2021. January 12. [covid19.who.int](https://covid19.who.int).
- Wu, T., Jia, X., Si, H., Niu, J., Yin, X., Xie, J., Wang, X.J., 2021. Prevalence of mental health problems during the COVID-19 pandemic: a systematic review and meta-analysis. *J. Affect. Disord.* 281, 91–98.
- Xiong, J., Lipsitz, O., Nasri, F., Lui, L.M.W., Gill, H., Phan, L., Chen-Li, D., Iacobucci, M., Ho, R., Majeed, A., McIntyre, R.S., 2020. Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J. Affect. Disord.* 277, 55–64.
- Zheng, Y., Xiao, L., Xie, Y., Wang, H., Wang, G., 2020. Prevalence and characteristics of obsessive-compulsive disorder among urban residents in Wuhan during the stage of regular control of coronavirus disease-19 epidemic. *Front. Psychiatr.* 16 (11), 594167. <https://doi.org/10.3389/fpsy.2020.594167>.
- Zvolensky, M.J., Garey, L., Rogers, A.H., Schmidt, N.B., Vujanovic, A., Storch, E.A., Buckner, J.D., Paulus, D.J., Alfano, C., Smits, J., O'Leary, C., 2020. Psychological, addictive, and health behavior implications of the COVID-19 pandemic. *Behav. Res. Ther.* 134, 103715. <https://doi.org/10.1016/j.brat.2020.103715>.