

# Associations Between COVID-19 Isolation, PCR Test Status, and Reported Symptoms and PHQ-2 Scores

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## Research note

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# Abstract

**Objective:** Increases in the incidence of mental illness is a concern during the COVID-19 pandemic. The fear of becoming ill may compound the stress of loneliness in isolation. Using a unique COVID-19 symptom reporting dataset, we examine whether quarantine status, test status, and reported symptoms are predictive of clinical depression, as measured by Patient Health Questionnaire-2 scores.

**Results:** We find that those who test positive for COVID-19 are at six-fold risk of clinical depression, and may require clinical intervention.

## Introduction

The psychological stress associated with large-scale disasters such as the COVID-19 pandemic is thought to increase the incidence of mental illness in a population (1). Loneliness is a stressor that is a major independent risk factor for mental illness (2). The COVID-19 pandemic continues to produce quarantines, typically as one person in isolation. One's fear of becoming seriously ill may compound the stress associated with loneliness while in isolation.

We used data from a symptom-reporting application to examine the effect of experiencing common COVID-19 symptoms, quarantine, or testing positive for COVID-19 on objectively-measured depression using the 2-question Patient Health Questionnaire (PHQ-2). The PHQ-2 is sometimes used by clinicians to screen patient panels for clinical depression, but its positive predictive value would be improved by targeting it to high-risk populations (3).

## Methods

We obtained data from Track Together, a company that collected COVID-19 symptom data using a public online and mobile phone application-based survey available worldwide (4). The Track Together data included self-reported COVID-19 symptoms (fever, cough, loss of taste or smell, etc.), self-isolation status (not leaving the house under any circumstances), SARS-CoV-2 polymerase chain reaction (PCR)-test status, PCR test results, age, and the PHQ 2. Our primary outcome was the risk of depressive symptoms assessed by the PHQ-2, a validated measure of depression with a sensitivity of 61%-91% and a specificity of roughly 78%. (3, 5) On the PHQ-2, scores range from 0 to 6 with scores of 3 and above suggesting a diagnosis of major depressive disorder (3, 5).

Age was categorized into three strata (0–24, 25–64, and 65+). Participants were dichotomized by self-reported: symptoms (any/none), isolation status (yes/no), and whether they had laboratory-confirmed COVID-19. Multivariable logistic regression models were built using SAS version 9.4 (SAS® OnDemand for Academics) to determine the association between the likelihood of major depressive disorder. All p-values were 2-tailed, and the level of significance was set 0.05. The Columbia University Institutional Review Board determined this study did not include human subjects research.

## Results

There were 378 respondents with complete PHQ-2 questionnaires. Among all respondents (irrespective of self-isolation status) the odds of having a PHQ-2 score of 3 or higher were lower for respondents that were 65 and older (odds ratio [OR] = 0.05 [95% CI, 0.001–0.426]) compared to those 24 and younger. Those aged 25–64 were not significantly different from those aged 24 and under. They were also lower for respondents reporting any symptoms (OR = 0.17 [95% CI, 0.080–0.366]) compared to respondents reporting no COVID-19 symptoms.

The odds of having a PHQ-2 score of 3 or higher for respondents that reported self-isolating were 3.58 (95% CI, 1.82–7.05) compared to those not isolating. For respondents who reported testing positive for COVID-19, the odds were 6.30 (95% CI, 1.82–21.86) compared to those that tested negative (Table 1).

Table 1

Age, isolation status, test status, and reported symptoms associated with PHQ-2 Scores, Track Together Symptom Reporting Dataset, 2020.

		Sample Size (n = 378)	Odds Ratio	95% Confidence Interval	
<b>Age</b>	<=24	40	1	Reference	
	25–64	274	0.85	0.343	2.097
	>=65	64	0.05*	0.005	0.426
<b>Reported isolation</b>	No	264	1	Reference	
	Yes	114	3.58**	1.821	7.049
<b>PCR test status</b>	Tested negative	72	1	Reference	
	Not tested	289	1.23	0.550	2.741
	Tested positive	17	6.30*	1.816	21.862
<b>Reported symptoms</b>	None	43	1	Reference	
	Any symptoms <sup>a</sup>	335	0.17***	0.080	0.366
* $p < 0.01$ , ** $p < 0.001$ , *** $p < 0.0001$					
<sup>a</sup> Symptoms: fever, dry cough, chest pain or pressure, shortness of breath, confusion, sore throat, muscle or joint pain, loss of taste or smell, diarrhea, tiredness or exhaustion, and a runny nose.					

## Discussion

When quarantines occur across a large population, policy options for public health departments or clinical providers are limited. However, when they occur in smaller outbreaks, it is theoretically possible to provide emotional support during isolation or mental health intervention on clinical follow-up following isolation. Our findings suggest that it would be prudent to add contact with a caseworker who can provide emotional support as an adjunct to routine contact tracing and quarantine verification activities.

Specifically, we find that a positive test result and self-isolation, particularly among those who believe that they are infected with COVID-19, is associated with a large increase in risk of clinical depression. Mental health assessment—which is typically conducted using a PHQ-2 screen—is therefore important on clinical follow-up. When resources are limited, clinical follow-up might be targeted to the highest risk group—those with a positive test result.

A number of behavioral techniques exist to manage quarantine in isolation. These range from medication or relaxation practices to providing more human interaction through video conferencing. Something as simple providing those in quarantine with a list of online resources for emotional support, human connection, and relaxation practices could plausibly help those facing quarantine (6). Another option would be to allow people to quarantine with pets if they are in countries that utilize quarantine centers (7).

Previous studies have found high rates of depression associated with experiences of quarantine and critical illness (8, 9). To the extent possible, those who test positive for COVID-19 should receive clinical follow up for mental health assessment, ideally while under self-isolation. Healthcare workers providing mental health assessment is a public health priority, especially during the COVID-19 pandemic. Our study identifies a unique population, those that test positive for COVID-19 and report being in isolation, that may benefit from critical mental healthcare.

## Limitations

Our study is associational and limited to those who were using an app or website for self-reporting symptoms of COVID-19. It is possible that those who are depressed are more likely to self-report symptoms using an app or, conversely, that those who have COVID-19 symptoms are more likely to become depressed as a result of their illness.

It is also likely that those who are more outgoing and social may be more likely to contract influenza-like illnesses, including COVID-19. This hypothesis is supported by our finding that those with symptoms of COVID-19 (irrespective of diagnosis or isolation status) are less likely to have depression as measured by the PHQ-2. However, those with depression may be less likely to engage in symptom reporting. Therefore, our study may underestimate effect sizes associated with self-isolation or having a positive test for COVID-19.

Another limitation of our study is that the PHQ-2 may have a lower specificity for depression than the PHQ-9, the 9-question version of the survey. However, the PHQ-2 is commonly used as a screening tool in

clinical practice. Therefore, our findings may better inform clinical practice policies than a study that used the longer instrument.

## Abbreviations

PHQ-2

2-question Patient Health Questionnaire; PCR:polymerase chain reaction; OR:odds ratio

## Declarations

**Ethics approval and consent to participate:** The Columbia University Institutional Review Board determined this study did not include human subjects research.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The datasets generated and analysed during the current study are available in the Track Together Open Data repository, <https://github.com/tracktogether/opendata>.

**Competing Interests:** The authors declare that they have no competing interests.

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**Authors' Contributions:** CS and YX conducted formal analysis for the paper. GN and RW generated and managed the Track Together data. CS, YX, and PM drafted the manuscript. All authors read and approved the final manuscript.

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