Long COVID in the United States

David G. Blanchflower
Alex Bryson

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David G. Blanchflower
*Dartmouth College, Adam Smith Business School,
University of Glasgow, Bloomberg and NBER*

Alex Bryson
University College London, NIESR and IZA

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ABSTRACT

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Although yet to be clearly identified as a clinical condition, there is immense concern at the health and wellbeing consequences of long COVID. Using data collected from nearly half a million Americans in the period June 2022-December 2022 in the US Census Bureau's Household Pulse Survey (HPS), we find 14 percent reported suffering long COVID at some point, half of whom reported it at the time of the survey. Its incidence varies markedly across the United States – from 11 percent in Hawaii to 18 percent in West Virginia – and is higher for women than men, among Whites compared with Blacks and Asians, and declines with rising education and income. It peaks in midlife in the same way as negative affect. Ever having had long COVID is strongly associated with negative affect (anxiety, depression, worry and a lack of interest in things). The effect is larger among those who currently report long COVID, especially if they report severe symptoms. In contrast, those who report having had short COVID report higher wellbeing than those who report never having had COVID. Long COVID is also strongly associated with physical mobility problems, and with problems dressing and bathing. It is also associated with mental problems as indicated by recall and understanding difficulties. Again, the associations are strongest among those who currently report long COVID, while those who said they had had short COVID have fewer physical and mental problems than those who report never having had COVID. Vaccination is associated with lower negative affect, including among those who reported having had long COVID.

Corresponding author:
Alex Bryson
Social Research Institute
University College London
27 Woburn Square
London WC1H 0AA
Great Britain

E-mail: a.bryson@ucl.ac.uk

1. Introduction

The SARS-CoV-2 (or COVID-19) pandemic has resulted in an estimated 6.8 million deaths around the world since the beginning of the outbreak in December 2019 and severely impacted the lives of many others who suffered temporary illness.[1] Chart 1 plots the weekly estimates of COVID cases and deaths in the United States reported by the Centers for Disease Control and Prevention (CDC). These show three major spikes in cases, peaking at 5.6 million at the start of 2022. The number of deaths has four major peaks with the highest, 23,387, again at the start of 2021. The latest estimate for the start of 2023, was 415,000 cases and 3,900 deaths.

However, it has become increasingly apparent that a significant proportion of the population continue to report COVID symptoms long after initial infection. This condition, which has come to be known as 'long COVID', has yet to be clearly identified as a clinical condition, but is defined by the World Health Organization (WHO) as the continuation or development of new symptoms three months after the initial infection, with these symptoms lasting for at least 2 months with no other explanation.[2]

The recency of long COVID, together with difficulties in precisely defining it (Rando et al., 2021), mean uncertainty persists regarding its incidence and consequences. Notwithstanding these issues, a consensus is emerging regarding its incidence, factors associated with it, and its health consequences. We review this literature below in Section Two. We contribute to this body of work by exploiting new survey data on the incidence and consequences of long COVID in the US Census Bureau's Household Pulse Survey (HPS). In doing so we build on an earlier paper (Blanchflower and Bryson, 2022a) that examined the incidence of COVID and changes in mental health over the period April 2020-April 2022. That paper used data from HPS sweeps #1-#44.[3] This paper extends that work from June through December 2022 with new data on long COVID from sweeps #46-#53 that was not available in earlier sweeps.

We find 14 percent of respondents reported suffering long COVID at some point, half of whom reported it at the time of the survey. Its incidence varies markedly across the United States – from 11 percent in Hawaii to 18 percent in West Virginia – and is higher for women than men, among Whites compared with Blacks and Asians, and declines with rising education and income. It peaks in midlife in the same way as negative affect. Ever having had long COVID is strongly associated with negative affect (anxiety, depression, worry and a lack of interest in things). The effect is larger among those who currently report long COVID, especially if they report severe symptoms. In contrast, those who report having had short COVID report *higher* wellbeing than those who report never having had COVID. Long COVID is also strongly associated with physical mobility problems, and with problems dressing and bathing. It is also associated with mental problems as indicated by recall and understanding difficulties. Again, the associations are strongest among those who currently report long COVID, while those who said they had had short COVID have fewer physical and mental problems than those who report never having had COVID. Vaccination is associated with lower negative affect, including among those who reported having had long COVID.

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[1] https://covid19.who.int/
[2] https://www.who.int/europe/news-room/fact-sheets/item/post-COVID-19-condition
[3] https://www.census.gov/programs-surveys/household-pulse-survey/data.html

2. Previous Literature on the Incidence and Health Effects of Long COVID

In their systematic review article Davis et al. (2023) define long COVID as "*a multisystemic condition comprising often severe symptoms that follow a sever acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection*" (p. 134). They say that more than 200 symptoms have been identified, with impacts on multiple organ systems. They estimate that "*at least 10%*" of *those with severe COVID infections go on to develop long COVID. This is roughly 65 million individuals worldwide. They say many long COVID sufferers experience "dozens of symptoms across multiple organ systems*" (p. 134). Among them are cognitive and physical impairments we focus on in this study.

In their systematic review of 194 studies – most of them in Europe - O'Mahoney et al (2022) showed that at an average follow-up time of 126 days, 45% of COVID-19 survivors, regardless of hospitalization status, go on to experience at least one unresolved symptom. In addition, the prevalence of ongoing symptoms appears to be higher in post-hospitalized cohorts compared to non-hospitalized populations.

Taquet et al (2021) conducted a retrospective cohort study based on linked electronic health records (EHRs) data from 81 million patients including 273,618 COVID-19 survivors and found 57% of patients having at least one long-COVID feature recorded in the 180 days after infection and 37% having them in the 90 to 180 days after diagnosis.

Correlates of long COVID emerging from this literature include variance by age, and a potential role for vaccination which, at least in some studies, reduced the probability of long COVID (Davis et al., 2023: 140). Taquet et al. (2021) find a higher incidence of long COVID among the elderly, in more severely affected patients, and in women, patterns also found by Subramanian et al. (2022) among non-hospitalized adults. Qasmieh et al (2022) also found long COVID was higher among females, but also among Blacks and the unemployed. Price (2022), who uses the HPS as we do, finds long-term COVID symptoms are much more prevalent among women, adults under 65, Hispanics and Latinos, and non–college graduates than among other demographic groups. Using a non-probability internet survey and a slightly different definition of long COVID (symptomatic two months after initial infection) Perlis et al. (2022) also find a higher incidence among women. They also point to a lower incidence among the more highly educated and among those who had been vaccinated. Symptoms included cognitive and respiratory problems, anxiety and sleep disruption.

For the UK the Office of National Statistics (ONS, 2023) calculated the incidence of long COVID from their Coronavirus (COVID-19) Infection Survey. They estimated that 2.1 million people living in private households in the UK (3.3% of the population) were experiencing self-reported long COVID (which they defined as symptoms continuing for more than four weeks after the first confirmed or suspected COVID-19 infection that were not explained by something else) as of 4 December 2022. They adversely impacted the day-to-day activities of 1.6 million. The prevalence was greatest in midlife ages 35-69.

Using the same ONS survey Ayoubkhani et al. (2022a) found the odds of long COVID symptoms decreased after COVID vaccination by around 13 percent, while a second dose reduced the odds by around 9%. In a related study with the same survey Ayoubkhani et al. (2022b) find long COVID

symptoms were significantly lower among those receiving 2 doses of the vaccine after 12 weeks relative to being unvaccinated when infected.

Also, for the UK, Bagues and Dimitrova (2022) report psychological gains from COVID-19 vaccination. Although their paper is not focused on long COVID, it is notable in using exogenous variance in the timing of vaccination roll-out to make causal inferences about the positive impact of COVID vaccination in increasing psychological wellbeing as captured by a reduction in the General Health Questionnaire short form (GHQ-12) scale capturing mental distress.

Notwithstanding differences in the precise definition of long COVID, survey design and populations, taken together, these previous studies indicate that long COVID is a common condition among those infected with the virus, although its incidence varies across demographic groups. It often comes with multiple symptoms which can be severe and affect both cognitive and physical function.

In the next section of the paper, we describe the incidence of long COVID in the US population, and its incidence across sub-populations. In Section Four we estimate the probability of long COVID, thus identifying the independent correlations with a number of individual traits, as well as location and vaccination status. In Section Five we establish the association between long COVID and cognitive and physical impairment as well as ill-being.

3. Incidence of Long COVID and Long COVID symptoms in the US Census HPS

Our data are the United States Census Bureau's Household Pulse Survey (HPS) for the period June through December 2022. These sweeps of the data include new data on long COVID from sweeps #46-#53 that was not available in earlier sweeps.[4][5] They form part of an extended battery of 14 questions on COVID infection (see Appendix 1). The sample size is 461,550.

Almost half (46.7%) of respondents say they have had COVID at some point ('yes' to Q2 in Appendix 1). 14.4% had ever had long COVID, as indicated by a 'yes' response to the question "Have you ever had COVID-19 or coronavirus symptoms lasting 3 months or longer?" (Q3).[6] This suggests that around three-in-ten of those who get COVID go on to develop long COVID.

Similarly, 14.4% of respondents answered 'yes' to the following question about having COVID symptoms lasting 3 months or more:[7]

Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19? Long term symptoms may include - tiredness or fatigue, difficulty thinking, concentrating, forgetfulness, or memory problems (sometimes referred to as "brain fog", difficulty breathing or shortness of breath, joint or muscle pain, fast-beating or pounding heart

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[4] https://www.cdc.gov/nchs/COVID19/pulse/long-COVID.htm

[5] Data we examine here on long COVID is from sweeps #46 (Jun 1-Jun 13, 2022);, #47 (June 29-July 11, 2022);; #48 (July 27-Aug 8, 2022);; #49 (Sept 14-Sept 26, 2022);; #50 (Oct 5-Oct 17, 2022);; #51 (Nov 2-Nov 14, 2022);, #52 (Dec 9-Dec 19, 2022); and #53 (Jan 4-16, 2023);.

[6] When we report mean estimates we use the person weight variable *pweight* but run the regressions unweighted.

[7] There were 6,844 unclassified, unweighted cases due to missing values and 59,505 (unweighted); cases with long COVID of whom 29,839 had symptoms now.

(also known as heart palpitations), chest pain, dizziness on standing, menstrual changes, changes to taste/smell, or inability to exercise? (Q1)

Those who had had COVID were asked about the severity of their symptoms. 13.3% said they had suffered "severe symptoms" (Appendix 1, Question 5). Table 1 shows how severe the symptoms of COVID were for those who had had short COVID, and those who reported long COVID now and in the past. Of those with short COVID only 7% had severe symptoms compared with 24% for those who had had long COVID in the past and 31% who currently had long COVID. Even so, this means two-thirds of those with long COVID now were not suffering severe symptoms.

In sweeps #49-#53 a further question was asked of those with long COVID – *Q6. Do these long-term symptoms reduce your ability to carry out day-to-day activities compared with the time before you had COVID-19?* The sample size across these five sweeps is 288,951. 6.9% of weighted respondents currently reporting long COVID also reported such symptoms (*Longnow).* We decided to classify as *Longlot* those who said they had long COVID now and their symptoms reduced their ability to carry out day-to-day activities 'a lot'. Overall, 1.6% of the sample from weeks 49-53 or a quarter of those who say they have COVID, now have major debilitating issues.

Our finding that 6.9% had long COVID with current symptoms is consistent with results from a recent paper by McKaylee et al (2022) who estimated the prevalence of long COVID from June 30-July 2, 2022, in a random sample of 3,042 adults. They found 7.3% reporting long COVID.

Table 2 presents means for ever having had long COVID (*LongCOVID)* and currently having long COVID with current symptoms (*Longnow)* in parentheses.[8] The patterns are similar for both. Long COVID peaks in midlife, it is higher for women (as found by Chen et al, 2022 and others) and declines with education and income. Long COVID is also more prevalent among whites than blacks or Asians. Hawaii has lowest incidence and West Virginia highest.

4. The probability of having long COVID

To establish independent associations between long COVID and individuals' characteristics we run a set of probit estimates in Table 3. All estimates include controls for age, race, gender, education, whether the respondent was working, state of residence and week of interview.

In column 1 of Table 3 we estimate a probit equation for the probability that an individual has ever had long COVID (*LongCOVID).* The second estimates the probability of having long COVID now with symptoms (*Longnow).* The final column reports estimates, for the probability of long COVID now with symptoms reducing one's ability to carry out day-to-day activities 'a lot' (*Longlot).*

Consistent with the existing studies, women are more likely to suffer long COVID. They are also more likely than men to report currently having long COVID with symptoms, and to have

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[8] The CDC has reported the incidence of long COVID using these data for each of the seven surveys we examine. They found the incidence higher among women, the prime age, Hispanics and high school dropouts and highest in West Virginia, Wyoming; Mississippi and Kentucky and lowest in Vermont and Rhode Island. https://www.cdc.gov/nchs/COVID19/pulse/long-COVID.htm

symptoms that affect them a lot. Whites are more likely to suffer long COVID than non-white ethnic groups. They are also more likely to have long COVID with symptoms and symptoms that affect their day-to-day activities 'a lot'.

The incidence of long COVID is highest in Alabama, Mississippi and West Virginia – which are also among the states with the lowest subjective wellbeing rankings in the United States (Blanchflower and Bryson, 2022b) whilst Hawaii - the highest ranked state on subjective wellbeing (Blanchflower and Bryson, 2022b) – has the lowest incidence of long COVID.

The probability of long COVID falls among graduates, as does the probability of long COVID with symptoms, and with severe symptoms.

In their earlier study, Blanchflower and Bryson (2022a) found workers were more likely to have had COVID than non-workers. The simple descriptive means in Table 2 indicate that workers were more likely than non-workers to have had long COVID and to have long COVID with symptoms at the time of interview. However, there is no statistically significant association between working and having had long COVID in Table 3 (the coefficient in column 1 is 0.002 with a t-statistic of 0.35). Furthermore, working was negatively associated with currently having long COVID with symptoms (column 2) and currently having long COVID with symptoms that affected their day-to-day activity a lot (column 3). This may be because individuals with long COVID with symptoms felt obliged to stay away from work for fear of spreading the virus, or because they were physically unable to perform work tasks and thus forced onto temporary or long-term sickness absence.

The age structure of long COVID tracks that of the unhappiness literature peaking in midlife between the ages of 45 and 49 (Blanchflower, 2023, 2021, 2020, 2016, Blanchflower and Graham, 2021, 2022 and Blanchflower, Graham and Piper, 2023). This contrasts with the findings in our earlier paper regarding the incidence of COVID (Blanchflower and Bryson, 2022a) which peaked between the ages of 20-24. Long COVID incidence ever and at the time of interview peaked in mid-life. The evidence is also that the taking of anti-depressants also peaks in midlife (Blanchflower and Oswald, 2016).

Overall, in the sample 83.2% of respondents had received a vaccine. Of those who had not had covid 84.2% had received a vaccine, compared with 82.0% who had had short covid and 82.1% of those who reported they at some time suffered from long covid.

5. The Impact of Long COVID on wellbeing and physical and mental health

In this section we examine the impact of long COVID and symptoms on four negative affect measures – anxiety, worry, being down and depressed, and showing a lack of interest or pleasure in doing things. These metrics are based on the following questions:

Over the last 2 weeks, how often have you been bothered by:
a) feeling nervous, anxious, or on edge?
b) not being able to stop or control worrying?
c) by feeling down, depressed, or hopeless?
d) bothered by having little interest or pleasure in doing things?

Answers were coded as Not at all =1, Several days =2, More than half the days=3 and Nearly every day=4.

These are Questions 7 to 10 in Appendix 1 which also provides the weighted percentages for each response category.

The four variables follow similar time series paths. Following Blanchflower and Bryson (2022a) in Chart 2 we plot a composite score which sums these four variables and runs from four to sixteen. It has a weighted mean of 7.54. It shows a sharp pick up in weeks #49 (September 14-26, 2022) and #50 (October 5-17, 2022) and then a subsequent decline. Referring back to Chart 1 this seems to be associated with the peak in deaths at the end of August 2022.

Table 4 reports mean scores for the four separate affect variables, together with the composite index, for those with who have never had long COVID (column 1), those who have had long COVID at some point (column 2), and those who were experiencing long COVID at the time of the survey. It is apparent that those who had ever experienced long COVID also experienced greater negative affect, particularly if they are currently experiencing long COVID.

In the bottom half of Table 4 we report mean scores for mobility difficulties ('difficulty walking or climbing stairs' (Q11), difficulties with self-care such as washing or dressing (Q12), understanding or being understood (Q13) and difficulties remembering or concentrating (Q14). In all cases the same pattern is apparent: physical and mental difficulties are greater for those who had experienced long COVID, particularly those currently experiencing it.

In Table 5 we run ordered logit regressions to estimate the association between COVID status and the four negative affect ordered outcomes, controlling for other factors. The last column reports OLS estimates from the (4,16) continuous outcome based on the summed total of the four negative affect variables.[9] The focus is the four-way COVID status variable at the top of the table. The base reference category is the half of individuals who have never had COVID. The three states in the table are having had short COVID only, having had long COVID but not currently suffering symptoms and finally those with long COVID and current symptoms. The table below shows their incidence in the data:

	Weighted %
Never had COVID	52.4
Short COVID: COVID but not long COVID	33.2
Had long COVID no symptoms now	7.5
Had long COVID with current symptoms	6.9

In Table 5, because of the way the data is coded, a higher number implies worse mental health. In all five cases the pattern is the same: short COVID has a negative coefficient versus the excluded category of no COVID. Having long COVID is worse especially with current symptoms. The male coefficient is interesting in its own right, confirming that males are less likely suffer from

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[9] The distribution of this variable is as follows weighted percent - 4=31.0%; 5=8.5; 6=9.4; 7=8.3; 8=12.4; 9=5.4; 10=4.6; 11=3.3; 12=4.1; 13=2.6; 14=2.5; 15=2.0 and 16=5.9.

negative affect that females, confirming our earlier work (Blanchflower and Bryson, 2023a). Working is negatively correlated with negative affect.

In Section Two we reviewed evidence indicating vaccination reduced the likelihood of long COVID. But does it affect individuals' wellbeing? Bagues and Dimitrova (2022) found that having been vaccinated raised well-being using UK data.

In our data we found little difference in vaccine rates across our four COVID states. 84.2% of those who have never had COVID had been vaccinated, although we don't know how many shots they have had. This compares with 82.0% of those with short COVID; 81.2% for those with long COVID but not presently with symptoms and 83.1% of those with long COVID now and 83.2% overall. As regards the link between vaccination and wellbeing we find similar results to Bagues and Dimitrova (2022) although the extent of the wellbeing improvement varies across our four COVID type categories.

Below we show using the weeks #46-#53 data, that anxiety- the other three variables have similar distributions - is higher if the respondent had not been vaccinated. The biggest differences are for those reporting anxiety nearly every day. The distributions for the other four variables are similar. Overall, even those who have had a vaccine 15% are anxious nearly every day versus 22% who had not been vaccinated.

Anxious	No vaccine	Vaccinated
Non COVID		
Not at all	39	42
Several days	27	32
More than half the days	12	11
Nearly every day	22	14
Short COVID		
Not at all	39	43
Several days	32	35
More than half the days	12	11
Nearly every day	17	12
Long COVID not now		
Not at all	26	26
Several days	33	38
More than half the days	16	15
Nearly every day	24	22
Long COVID now		
Not at all	17	17
Several days	30	35
More than half the days	16	17
Nearly every day	37	31

Table 6 re-estimates the equations for the five negative affect variables, but this time includes each of the four COVID types interacted with vaccination status. There are seven categories reported as compared to the excluded category which is no COVID and no vaccine. For each COVID status

those who were vaccinated had lower negative affect than the unvaccinated. Across all five negative affect models, those who had experienced short COVID had lower negative affect than those who had not been vaccinated and had not had COVID. This was the case whether the short COVID cases had been vaccinated or not. For each of the three COVID categories having a vaccine was linked to lower negative affect. The four long COVID categories each have positive signs but with higher wellbeing for those who had the vaccine.

Table 7 estimates equivalent equations to those in Table 5 but this time for four other potential outcomes of long COVID. The first two are difficulty walking or climbing stairs (column 1), and difficulties with self-care such as washing or dressing (column 2) while the other two relate to cognition - difficulties remembering or concentrating (column 3) and difficulties understanding or being understood (column 4). The pattern of results is identical to those presented in Table 5: compared to those who had never had COVID, short COVID is better than no COVID, whereas long COVID especially with current symptoms generates a significantly higher probability of facing the two physical and two mental health difficulties.

The possibility exists that some of the impact of long COVID on mobility and cognition could arise due to poor mental health. Indeed, there is evidence from Wang et al. (2022) that prior psychological distress before SARS-CoV-2 infection is associated with risk of COVID-19–related symptoms lasting 4 weeks or longer, known as post–COVID-19 conditions? Hence Table 8 uses the same four outcomes as in Table 7 but now also includes the mental health score as a control variable which is the sum of the negative affect variables. Unsurprisingly, scoring high on negative affect is strongly and positively associated with physical and mental health problems. However, even though its incorporation results in a decline in the size of the coefficients attached to COVID when comp and takes values from four to sixteen in Table 7 they are of the same sign and remain highly statistically significant.

4. Conclusions.
We have exploited new data for nearly half a million Americans on the prevalence of long COVID to explore its incidence and correlates, and the relationship between long COVID and physical and mental health problems. Long COVID is widespread. It has affected 14 percent of Americans at some point.

Its incidence varies markedly across sub-groups in the population. It is much higher among women than it is among men; it varies by ethnicity, being highest among whites; and it is hump-shaped in age, mimicking the age profile of negative affect which is highest in middle age. It also varies greatly by location. It is highest in states in the south such as West Virginia and Mississippi – states where negative affect is high – and is lowest in Hawaii, notable for being the 'happiest' state in the United States.

Long COVID is independently associated with negative affect, however one measures it, and with physical mobility and mental health problems. These associations are strongest among those who report current symptoms of long COVID. Vaccinations help: regardless of COVID status, those who have been vaccinated experience better wellbeing, and fewer physical and mental health difficulties, underscoring the importance of this public health program.

Table 1. The distribution of symptoms (n= unweighted; figures are weighted column percentages)

	No COVID	Short COVID	Long COVID not now	Long COVID now	All	N
No COVID					53	244,414
No symptoms		8	3	2	3	10,382
Mild symptoms		47	26	21	19	85,826
Moderate symptoms		38	48	46	19	88,652
Severe symptoms		7	24	31	6	24,189
All row %	53	33	8	7		
N	244,414	149,732	29,510	29,807		453,463

Table 2. Weighted mean proportion with long COVID and long COVID now with symptoms

USA	14.4 (6.9)	Michigan	13.8 (6.7)
Men	11.1 (5.0)	Minnesota	13.3 (6.5)
Women	17.6 (8.7)	Mississippi	17.6 (8.3)
Age <30	15.8 (6.4)	Missouri	14.7 (7.4)
Age 30-39	16.4 (7.4)	Montana	15.8 (8.7)
Age 40-49	17.6 (8.3)	Nebraska	14.3 (6.6)
Age 50-59	15.9 (8.1)	Nevada	15.3 (6.9)
Age 60-69	11.2 (6.1)	New Hampshire	12.6 (6.5)
Age 70-79	7.9 (4.5)	New Jersey	13.1 (6.3)
Age 80+	6.4 (3.5)	New Mexico	15.8 (7.5)
Hispanic	18.6 (7.6)	New York	14.5 (6.8)
Asian	9.8 (4.0)	North Carolina	14.6 (6.8)
Black	12.8 (5.7)	North Dakota	15.9 (7.7)
Non-Hispanic white	13.8 (7.0)	Ohio	13.7 (7.1)
Non-Hispanic other	18.0 (9.0)	Oklahoma	17.1 (8.1)
Less than high school	16.5 (9.6)	Oregon	13.1 (6.5)
High school diploma	14.3 (6.4)	Pennsylvania	12.8 (5.5)
Some college	16.9 (8.4)	Rhode Island	13.8 (7.0)
Bachelor's degree	12.5 (6.1)	South Carolina	15.0 (7.8)
Graduate degree	10.4 (5.1)	South Dakota	15.8 (7.7)
Working	15.2 (7.1)	Tennessee	16.8 (8.3)
Not working	13.5 (6.6)	Texas	15.3 (7.1)
Alabama	17.5 (8.8)	Utah	16.4 (8.0)
Alaska	16.8 (7.7)	Vermont	10.8 (5.9)
Arizona	16.6 (7.9)	Virginia	12.1 (5.7)
Arkansas	17.4 (8.6)	Washington	12.5 (6.7)
California	14.0 (6.7)	West Virginia	18.2 (9.3)
Colorado	15.8 (7.3)	Wisconsin	13.8 (6.9)
Connecticut	13.2 (6.7)	Wyoming	18.0 (8.3)
Delaware	11.5 (6.2)	Vaccinated	14.2 (6.9)
District of Columbia	9.8 (5.1)	Less than $25,000	16.5 (8.0)
Florida	13.7 (6.2)	$25,000 - $34,999	16.9 (8.6)
Georgia	14.6 (6.9)	$35,000 - $49,999	16.2 (8.2)
Hawaii	11.0 (4.0)	$50,000 - $74,999	15.2 (7.5)
Idaho	16.2 (8.3)	$75,000 - $99,999	14.5 (7.2)
Illinois	14.2 (6.5)	$100,000 - $149,999	13.4 (6.6)
Indiana	15.8 (7.6)	$150,000 - $199,999	11.8 (5.9)
Iowa	14.6 (7.7)	$200,000 and above	9.3 (4.3)
Kansas	14.8 (7.0)		
Kentucky	15.9 (8.4)	Figures in parentheses % long COVID now.	
Louisiana	16.1 (7.3)		
Maine	12.0 (6.4)		
Maryland	12.2 (5.6)		
Massachusetts	12.7 (6.1)		
Michigan	13.8 (6.7)		

Table 3. Probit estimates of long COVID, long COVID with symptoms now and ever had COVID. 2022

	Long COVID	Longnow	Longlot
20-24	.2133 (5.54)	.2489 (4.72)	.3988 (3.19)
25-29	.2190 (5.88)	.2557 (4.99)	.3496 (2.84)
30-34	.2331 (6.31)	.2887 (5.68)	.4032 (3.31)
35-39	.2534 (6.89)	.3447 (6.81)	.4858 (4.00)
40-44	.2853 (7.76)	.3871 (7.66)	.5428 (4.48)
45-49	.2886 (7.84)	.4269 (8.44)	.6134 (5.07)
50-54	.2565 (6.97)	.4039 (7.99)	.5815 (4.80)
55-59	.1904 (5.17)	.3591 (7.10)	.5808 (4.80)
60-64	.0671 (1.82)	.2735 (5.41)	.4725 (3.91)
65-69	-.0766 (2.08)	.1350 (2.66)	.2559 (2.11)
70-74	-.1707 (4.57)	.0538 (1.05)	.1493 (1.22)
75-79	-.2412 (6.27)	-.0074 (0.14)	.1347 (1.08)
80-84	-.2469 (5.91)	-.0010 (0.02)	.2040 (1.57)
85-89	-.2605 (5.30)	-.0195 (0.31)	.3022 (2.16)
Male	-.2883 (56.70)	-.2833 (15.14)	-.1744 (12.96)
Some high school	-.0277 (0.80)	-.1429 (3.37)	-.2329 (3.26)
High school graduate	-.0351 (1.20)	-.0875 (2.50)	-.2987 (5.16)
Some college	.0290 (1.01)	.0145 (0.42)	-.2119 (3.74)
Associate degree	.0290 (0.99)	.0136 (0.39)	-.2220 (3.83)
Bachelor degree	-.1692 (5.86)	-.1480 (4.28)	-.4124 (7.24)
Graduate degree	-.2462 (8.49)	-.2108 (6.07)	-.4390 (7.63)
Black	-.2305 (18.34)	-.1728 (11.02)	-.0875 (2.65)
Asian	-.3396 (22.09)	-.2961 (14.89)	-.2541 (5.43)
Other	-.0007 (0.06)	.0918 (5.69)	.1986 (6.14)
White non-Hispanic	-.1665 (17.75)	-.0652 (5.60)	-.0542 (2.17)
Work	.0020 (0.35)	-.0199 (2.84)	-.2848 (19.76)
Alaska	-.1358 (4.81)	-.1229 (3.62)	-.2285 (3.17)
Arizona	-.1627 (6.62)	-.1638 (5.52)	-.1929 (3.11)
Arkansas	-.0309 (1.13)	-.0453 (1.38)	.0152 (0.24)
California	-.2602 (11.91)	-.2157 (8.22)	-.2009 (3.71)
Colorado	-.1497 (6.04)	-.1411 (4.72)	-.1823 (2.87)
Connecticut	-.2067 (7.51)	-.1433 (4.36)	-.1299 (1.88)
Delaware	-.2364 (7.36)	-.1866 (4.84)	-.1352 (1.71)
DC	-.4132 (13.34)	-.3234 (8.59)	-.2843 (3.45)
Florida	-.2101 (8.72)	-.1997 (6.86)	-.1502 (2.51)
Georgia	-.1545 (6.18)	-.1407 (4.66)	-.2096 (3.24)
Hawaii	-.3372 (10.40)	-.3504 (8.66)	-.3582 (4.07)
Idaho	-.0872 (3.35)	-.0748 (2.40)	-.0773 (1.24)
Illinois	-.1821 (7.11)	-.1715 (5.53)	-.1839 (2.80)
Indiana	-.0962 (3.67)	-.1138 (3.59)	-.0907 (1.39)
Iowa	-.1504 (5.64)	-.1214 (3.79)	-.1294 (1.95)
Kansas	-.1251 (4.81)	-.1351 (4.30)	-.1645 (2.47)
Kentucky	-.0972 (3.60)	-.0797 (2.46)	-.2369 (3.35)

Louisiana	-.0708 (2.53)	-.1118 (3.27)	-.0350 (0.52)
Maine	-.2503 (7.95)	-.1986 (5.26)	-.2161 (2.68)
Maryland	-.2683 (10.25)	-.2537 (7.95)	-.2746 (3.97)
Massachusetts	-.2397 (9.54)	-.2122 (6.99)	-.1798 (2.79)
Michigan	-.1538 (6.30)	-.1401 (4.77)	-.0911 (1.53)
Minnesota	-.2179 (8.50)	-.1799 (5.84)	-.1657 (2.56)
Mississippi	.0051 (0.18)	-.0118 (0.34)	-.0971 (1.36)
Missouri	-.1454 (5.54)	-.1158 (3.68)	-.0827 (1.29)
Montana	-.0546 (1.90)	-.0664 (1.92)	.0177 (0.27)
Nebraska	-.1372 (5.13)	-.1588 (4.88)	-.2596 (3.68)
Nevada	-.1435 (5.17)	-.1341 (4.01)	-.2307 (3.16)
New Hampshire	-.2063 (7.30)	-.1670 (4.93)	-.1448 (2.02)
New Jersey	-.1733 (6.45)	-.1438 (4.44)	-.1626 (2.36)
New Mexico	-.1668 (6.26)	-.1310 (4.10)	-.1694 (2.57)
New York	-.1521 (5.70)	-.1443 (4.47)	-.1726 (2.50)
North Carolina	-.1723 (6.44)	-.1327 (4.14)	-.0952 (1.44)
North Dakota	-.0823 (2.71)	-.1144 (3.09)	-.1780 (2.27)
Ohio	-.1619 (6.01)	-.1374 (4.24)	-.1246 (1.85)
Oklahoma	-.0426 (1.63)	-.0584 (1.86)	-.0884 (1.38)
Oregon	-.2712 (10.90)	-.2282 (7.63)	-.1550 (2.53)
Pennsylvania	-.2189 (8.73)	-.2097 (6.90)	-.1845 (2.89)
Rhode Island	-.1624 (4.98)	-.1346 (3.43)	-.1726 (2.08)
South Carolina	-.1059 (3.92)	-.1013 (3.12)	-.1131 (1.68)
South Dakota	-.0945 (3.23)	-.0945 (2.68)	-.1020 (1.41)
Tennessee	-.0434 (1.68)	-.0308 (1.00)	-.0776 (1.21)
Texas	-.1824 (8.13)	-.1643 (6.08)	-.1361 (2.47)
Utah	-.1028 (4.22)	-.0950 (3.24)	-.0813 (1.35)
Vermont	-.3122 (9.63)	-.2118 (5.53)	-.2112 (2.51)
Virginia	-.2902 (11.57)	-.2484 (8.19)	-.2105 (3.32)
Washington	-.2943 (12.62)	-.2113 (7.58)	-.1239 (2.19)
West Virginia	.0232 (0.80)	.0280 (0.81)	.0097 (0.14)
Wisconsin	-.1885 (7.08)	-.1737 (5.39)	-.2187 (3.16)
Wyoming	-.0352 (1.21)	-.0463 (1.33)	-.0968 (1.34)
_cons	-.7674	-1.3302	-1.8703
Pseudo R^2	.0406	.0309	.0419
N	448,227	448,119	285,954

Notes: Excluded Alabama; less than high school; age<20 and white Hispanic. T-statistics in parentheses. Controls also include week of interview.

Longlot only available in weeks #49-#53

Table 4. Negative affect variables and mobility and cognizance variables by having long or short COVID

	No covid	Short COVID	Had long COVID	Long COVID now
Anxious	1.94	1.87	2.28	2.53
Down & depressed	1.76	1.66	1.99	2.25
Worry	1.86	1.78	2.14	2.42
Interest	1.79	1.68	2.02	2.30
Combined	7.43	7.06	8.48	9.61
Mobility	1.37	1.23	1.36	1.60
Self-care	1.12	1.07	1.12	1.21
Understand	1.11	1.07	1.12	1.20
Remember	1.49	1.44	1.68	1.96

Table 5. Ordered logit estimates 5 negative affect measures

	Anxious	Down	Worry	Interest	Combination (OLS)
Short COVID	-.2677 (39.47)	-.3095 (42.94)	-.2587 (36.82)	-.3051 (42.54)	-.5609 (48.09)
Long COVID not now	.3168 (25.91)	.2557 (20.23)	.3236 (26.10)	.2884 (22.98)	.5691 (26.13)
Long COVID now	.7943 (66.29)	.7417 (60.92)	.7525 (62.43)	.7924 (65.52)	1.6261 (76.76)
Male	-.4073 (66.51)	-.1775 (27.56)	-.4539 (71.50)	-.0815 (12.74)	-.4515 (42.89)
Working	-.2119 (28.62)	-.3268 (42.23)	-.2436 (32.12)	-.3187 (41.44)	-.6001 (47.42)
/cut1	-1.5064	-1.0877	-1.2179	-1.0989	9.7357
/cut2	.1401	.5004	.3513	.4309	
/cut3	.9109	1.2902	1.1253	1.3203	
Pseudo/Adjusted R^2	.0513	.0414	.0490	.0416	.1227
N	400,360	399,790	399,738	399,589	398,246
Mean dependent variable	2.05	1.78	1.90	1.81	7.15

Notes: Controls are age dummies, education, race, state, and week of interview.

Table 6. Ordered logit estimates 5 negative affect measures and vaccines

	Anxious	Down	Worry	Interest	Combination (OLS)
No COVID – vaccine	-.0868 (6.23)	-.1556 (10.95)	-.1941 (13.84)	-.2328 (16.54)	-.4694 (19.67
Short COVID – no vaccine	-.2510 (12.62)	-.3331 (16.22)	-.2660 (13.24)	-.3398 (16.74)	-.6650 (19.41)
Short COVID- vaccine	-.3519 (24.56)	-.4801 (32.67)	-.4695 (32.45	-.5504 (37.80)	-1.0532 (42.88)
LC not now - no vaccine	.3131 (9.79)	.2064 (6.34)	.2494 (7.77)	.2252 (6.95)	.4345 (7.66)
LC not now – vaccine	.2713 (15.06)	.1573 (8.52)	.1938 (19.68)	.1279 (6.96)	.2232 (7.04)
LC now – no vaccine	.8089 (23.70)	.7068 (20.51)	.7083 (20.74)	.7505 (21.98)	1.5675 (25.96)
LC now – vaccine	.7545 (42.53)	.6375 (35.42)	.6143 (34.52)	.6166 (34.58)	1.2734 (40.95)
Male	-.4072 (66.68)	-.1851 (28.93)	-.4582 (72.63)	-.0915 (14.43)	-.4741 (44.74)
Working	-.2466 (33.72)	-.4000 (52.26)	-.3180 (42.47)	-.4026 (53.00)	-.7335 (58.05)
/cut1	-1.7051	-1.1982	-1.3724	-1.3483	10.1209
/cut2	-.0738	.3733	.1782	.1593	
/cut3	.6905	1.1563	.9449	1.0394	
Pseudo/Adjusted R^2	.0463	.0350	.0422	.0327	.1056
N	399600	399,040	398,983	398838	397503

Notes: Controls are age dummies, education, race, state, and week of interview.

Table 7. Ordered logit estimates, physical mobility, remembering and understanding

	Mobility.	Dressing & bathing	Remember	Understand
Short COVID	-.3135 (33.00)	-.4509 (28.00)	-.1560 (20.76)	-.3970 (23.81)
Long COVID not now	.3115 (19.39)	.1003 (4.01)	.5660 (42.66)	.2302 (9.28)
Long COVID now	.9845 (70.39)	.7193 (35.61)	1.3400 (102.45)	.9142 (45.57)
Male	-.2706 (33.23)	.0638 (4.84)	-.2657 (39.51)	+.3006 (22.42)
Working	-.7121 (78.13)	-1.1444 (76.55)	-.2871 (35.60)	-.5967 (38.79)
/cut1	1.1459	.6125	-.9711	.3511
/cut2	3.1538	2.6589	1.6389	2.7177
/cut3	5.6540	4.5017	5.1847	4.4657
Pseudo R^2	.1210	.0698	.1420	.0544
N	390,904	390,999	388,552	391,058
Mean dependent variable	1.34	1.11	1.52	1.10

Notes: Controls are age dummies, education, race, state, and week of interview.

Table 8. Ordered logit estimates, physical mobility, remembering and understanding and mental health

	Mobility.	Dressing & bathing	Remember	Understand
Short COVID	-.2163 (22.17)	-.3048 (18.01)	-.0163 (2.04)	-.2534 (14.76)
Long COVID not now	.2423 (14.68)	-.0007 (0.03)	.4894 (35.22)	.1348 (5.25)
Long COVID now	.7609 (52.92)	.4072 (19.23)	1.0651 (79.15)	.6299 (30.13)
Male	-.2114 (25.31)	.1467 (10.72)	-.1747 (24.55)	+.4036 (29.11)
Working	-.6366 (68.18)	-1.0206 (66.12)	-.1675 (19.72)	-.4458 (28.17)
Combination mental health score	.1757 (146.72)	.2235 (128.91)	.2700 (239.22)	.2099 (119.09)
/cut1	3.0046	3.0017	1.4758	2.5060
/cut2	5.1281	5.1375	4.4989	4.9476
/cut3	7.6937	7.0153	8.1891	6.7211
Pseudo R^2	.1604	.1442	.1420	.1221
N	388,586	388,597	388,552	388,729

Notes: Controls are age dummies, education, race, state, and week of interview.

Chart 1. Cases and death numbers per week
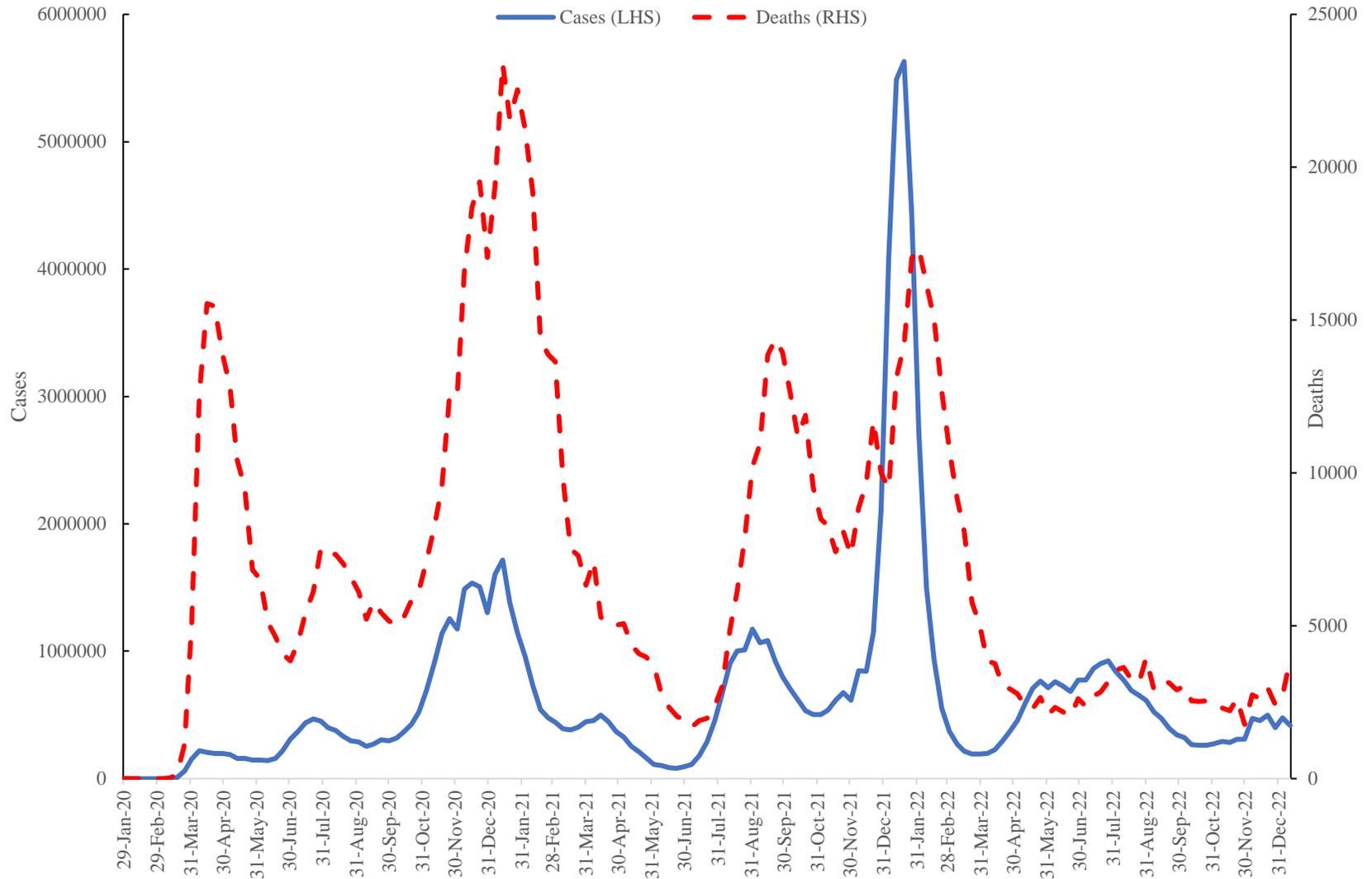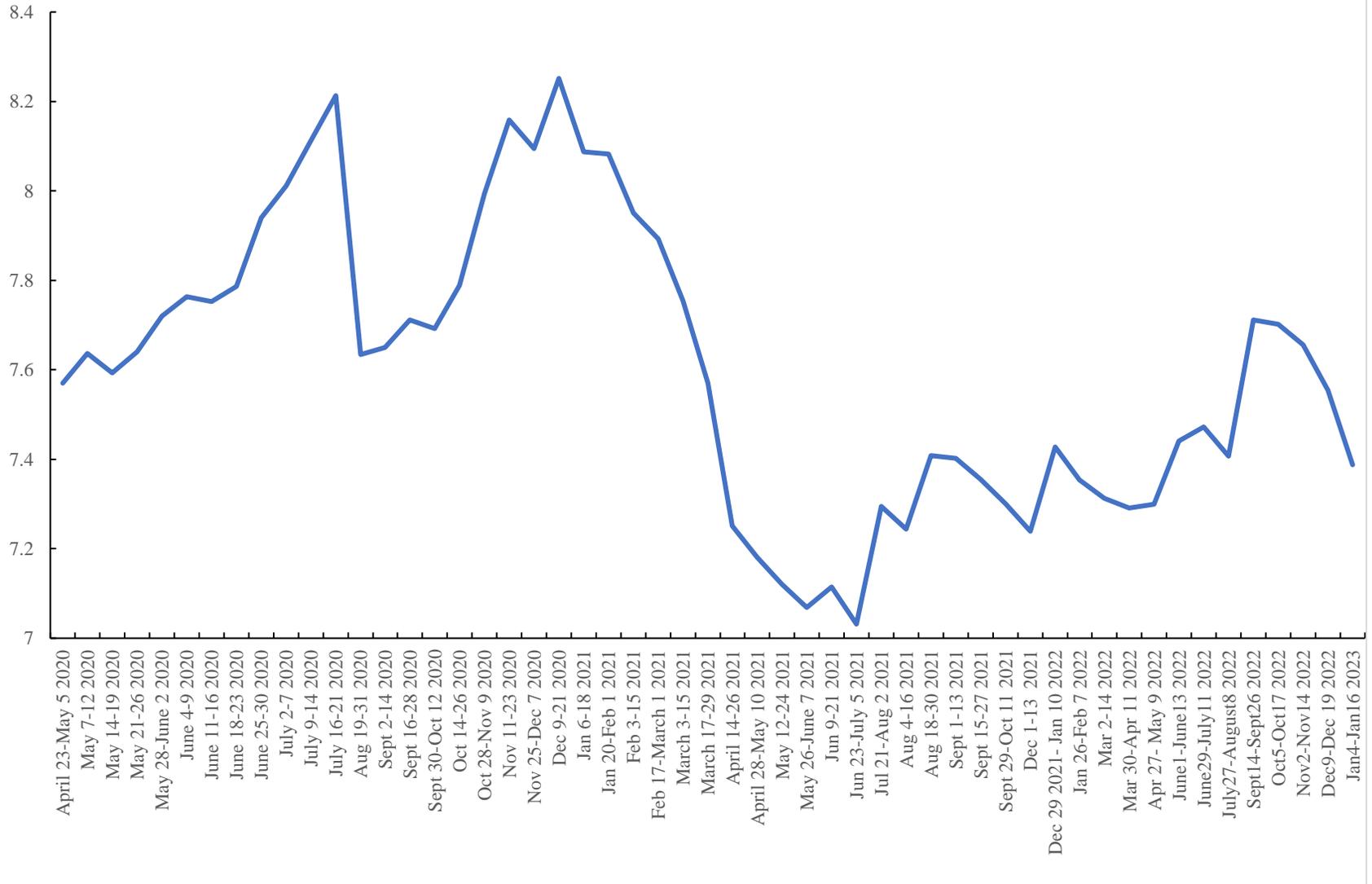https://COVID.cdc.gov/COVID-data-tracker/#trends_weeklycases_select_00

Chart 2. Composite Negative Affect Index, April 2020-January 2023

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Appendix 1. Questions used to identify Long COVID – with weighted percentages in square parentheses.

Q1. *Did you have any symptoms lasting 3 months or longer that you did not have prior to having coronavirus or COVID-19? Long term symptoms may include - tiredness or fatigue, difficulty thinking, concentrating, forgetfulness, or memory problems (sometimes referred to as "brain fog", difficulty breathing or shortness of breath, joint or muscle pain, fast-beating or pounding heart (also known as heart palpitations), chest pain, dizziness on standing, menstrual changes, changes to taste/smell, or inability to exercise? [14.4%]*

Q2. *Have you ever tested (using a rapid point-of-care test, self-test, or laboratory test) positive for COVID-19 or been told by a doctor or other health care provider that you have or had COVID-19? [46.7%]*

Q3. *Have you ever had COVID-19 or coronavirus symptoms lasting 3 months or longer?[14.4%]*

Q4. *Do you currently have COVID-19 or coronavirus symptoms? [8.6%]*

Q5. *How would you describe the COVID-19 symptoms when they were at their worst – (of those who had COVID);*
i) I had no symptoms [6.4%]
ii) I had mild symptoms [39.9%]
iii) I had moderate symptoms [40.4%]
iv) I had severe symptoms [13.3%].

Q6. *Do these long-term symptoms reduce your ability to carry out day-to-day activities compared with the time before you had COVID-19?*
0) No long COVID [93.7%]
1) Yes, a lot [1.4%]
2) Yes, a little [3.6%]
3) Not at all [1.3%]

Q7. *Over the last 2 weeks, how often have you been bothered by feeling nervous, anxious, or on edge? Select only one answer.*
1) Not at all [39.0%]
2) Several days [33.0%]
3) More than half the days [11.8%]
4) Nearly every day [16.3%]

Q8. *Over the last 2 weeks, how often have you been bothered by the not being able to stop or control worrying? Select only one answer.*
1) Not at all [46.1%]
2) Several days [30.9%]
3) More than half the days [10.1%]
4) Nearly every day [12.9%]

Q9. Over the last 2 weeks, how often have you been bothered by feeling down, depressed, or hopeless? Select only one answer.
1) Not at all [51.5%]
2) Several days [29.3%]
3) More than half the days [8.8%]
4) Nearly every day [10.4%]

Q10. Over the last 2 weeks, how often have you been bothered by having little interest or pleasure in doing things? Select only one answer.
1) Not at all [50.2%]
2) Several days [29.1%]
3) More than half the days [10.4%]
4) Nearly every day [10.3%]

Q11. Do you have difficulty walking or climbing stairs? Select one.
1) No - no difficulty [73.0%]
2) Yes - some difficulty [20.7%]
3) Yes - a lot of difficulty [5.6%]
4) Cannot do at all [0.7%]

Q12. Do you have difficulty with self-care, such as washing all over or dressing? Select one.
1) No - no difficulty [91.1%]
2) Yes - some difficulty [7.4%]
3) Yes - a lot of difficulty [1.2%]
4) Cannot do at all [0.4%]

Q13.   Using your usual language, do you have difficulty communicating, for example understanding or being understood? Select one.
1) No - no difficulty [91.2%]
2) Yes - some difficulty [7.5%]
3) Yes - a lot of difficulty [1.0%]
4) Cannot do at all [0.3%]

Q14. Do you have difficulty remembering or concentrating? Select one.
1) No - no difficulty [55.5%]
2) Yes - some difficulty [37.2%]
3) Yes - a lot of difficulty [6.9%]
4) Cannot do at all [0.4%]