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TRAJECTORIES OF PSYCHOLOGICAL DISTRESS OVER MULTIPLE COVID-19 LOCKDOWNS IN AUSTRALIA

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NON-TECHNICAL SUMMARY

The COVID-19 pandemic and its aftermath has stimulated substantial research in many different fields. One of these areas includes research that considers the impact of the COVID-19 pandemic, including the indirect effect of policy responses, on psychological distress and mental health. Most existing work has reported that mental health tended to be worse during the pandemic when compared to pre-COVID periods. Studies have also found that government-mandated lockdowns were detrimental to mental health, as compared to mental health in periods with no lockdowns. However, despite this burgeoning research, there has been little consideration of how levels of population distress rise and fall with the duration and repetition of lockdowns, or whether distress returns to initial levels once lockdowns ended.

This study describes the trajectories of psychological distress over multiple lockdowns during the first two years of the pandemic across five Australian states for the period May 2020 to December 2021 and examined whether these distress trajectories varied as a function of time spent in lockdown, or time since lockdown ended. A total of *N* = 574,306 Australian adults completed Facebook surveys over 611 days (on average 940 participants per day). Trajectories of psychological distress (depression and anxiety) were assumed to be a function of lockdown duration, time since lockdown ended, fear of infection, and perceived financial concerns.

The prevalence of distress was higher during periods of lockdown, more so for longer lockdowns relative to shorter lockdowns. Distress increased rapidly over the first weeks of lockdown, though less rapidly for short lockdowns. Distress levels tended to stabilise, or even decrease, after ten consecutive weeks of lockdown. After lockdown restrictions were lifted, distress rapidly declined again but did not return to pre-lockdown levels within four weeks, although continued to decline afterwards.

In Australia short pre-signaled duration lockdowns were associated with slower rises in distress. Lockdowns may have left some temporary residual population effect, but we cannot discern whether this reflects longer term trends in increasing distress. Overall, our results suggest that the negative mental health effects of the lockdowns themselves may not have been permanent, as there is evidence that levels of psychological distress declined significantly, even after very long lockdown periods.

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ABSTRACT

The impact of the global COVID-19 pandemic, including the indirect effect of policy responses, on psychological distress has been the subject of much research. However, there has been little consideration of how levels of population distress rise and fall with the duration and repetition of lockdowns, or the rate of resolution of distress once lockdowns ended. This study describes the trajectories of psychological distress over multiple lockdowns during the first two years of the pandemic across five Australian states for the period May 2020 to December 2021 and examined whether distress trajectories varied as a function of time spent in lockdown, or time since lockdown ended.

A total of N = 574,306 Australian adults completed Facebook surveys over 611 days (on average 940 participants per day). Trajectories of psychological distress (depression and anxiety) were regressed on lockdown duration and time since lockdown ended. Random effects reflecting the duration of each lockdown were included to account for varying effects on distress associated with lockdown length.

The prevalence of distress was higher during periods of lockdown, more so for longer lockdowns relative to shorter lockdowns. Distress increased rapidly over the first weeks of lockdown, though less rapidly for short lockdowns. Distress levels tended to stabilise, or even decrease, after ten consecutive weeks of lockdown. After lockdown restrictions were lifted, distress rapidly subsided but did not return to pre-lockdown levels within four weeks, although continued to decline afterwards.

In Australia short pre-signaled duration lockdowns were associated with slower rises in distress. Lockdowns may have left some temporary residual population effect, but we cannot discern whether this reflects longer term trends in increasing distress.

Keywords: depression, anxiety, mental health

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1. Introduction

Both the COVID-19 pandemic itself and the government policy responses introduced to limit the spread of the virus (such as 'lockdowns') were associated with significant life stressors including illness and bereavement, isolation and loneliness, loss of employment, and economic uncertainty (Hertz-Palmor et al., 2021; Wu et al., 2021). Many studies examined population mental health during the initial phase of the pandemic, drawing upon data from representative cohorts that surveyed the same individuals prior to, and then at multiple time points during the pandemic. These studies showed that, after an initial deterioration in population mental health at the onset of the pandemic, there was evidence of recovery (Pierce et al., 2021; Daly & Robinson, 2021). A subsequent meta-analysis of longitudinal studies conducted in Europe and North America in the first year of the pandemic, 2020, confirmed that lockdown had a negative impact on population levels psychological distress, although the effect size was small (Robinson et al., 2022).

Research examining the effect of lockdowns on population mental health face several challenges. Worsening mental health over time may reflect the effect of COVID-19 lockdowns or may be the continuation of longer-term population trends (e.g., Butterworth et al., 2020; Twenge et al., 2019). Studies drawing on longitudinal cohort studies with multiple pre-COVID measurement occasions have adjusted for underlying trends, and still found small but significant worsening of mental health during the pandemic (Pierce et al., 2020). Another challenge is to disentangle the mental health consequences of lockdowns from the direct effects of the pandemic (such as fear of catching the virus; Chandola et al., 2020). Studies using quasi-experimental designs (e.g., difference-in-difference) to contrast the mental health of people in areas that were and were not exposed to lockdowns (e.g., Butterworth et al., 2022; Serrano-Alarcón et al., 2022) have demonstrated that lockdowns had a modest negative effect on overall mental health.

Although the existing research provides important insights into the average effects of lockdown restrictions on mental health, it usually only includes a limited number of observations during COVID-19. As a result of this limited temporal resolution, such studies provide no information about two key issues, namely (i) how mental health changes over the course of lockdown, and (ii) how quickly mental health recovers after lockdowns are lifted. Lockdowns may have cumulative effects on psychological distress; depression and anxiety may continue to rise with longer lockdowns, or there may be patterns of stabilisation or improvement that cannot be detected from a single COVID measurement occasion. Even surveys that have included multiple measures during the pandemic still may not include adequate measurement occasions to capture the variability in lockdown duration for individuals in different

locations. As a result, estimates relying on such comparisons will fail to detect acute or transient changes in distress and so may underestimate the total, or maximal, effect of lockdown.

Another body of research conducted during the COVID-19 pandemic has adopted a surveillance or monitoring approach (e.g., Botha et al., 2022; Fancourt et al., 2021). These studies have recruited representative cross-sectional samples at regular occasions throughout the pandemic (as regularly as weekly), using consistent measures over time. This approach provides an opportunity to examine how population mental health has changed over time, and in relation to changes in lockdown status. For example, the COVID-19 Behaviour Tracker Global Survey drew fortnightly representative surveys from existing online panels in 15 different countries for more than 12 months. Linking this data to details of the stringency of local policy responses (Oxford COVID-19 Government Response Tracker) showed how population mental health was associated with policy stringency: mental health was worse at the times policies were strictest (Aknin et al., 2022).

This impact of the pandemic and lockdowns is unsurprising as negative life events are well known to be associated with adverse impacts on mental wellbeing and increased psychological distress (Frijters et al., 2011; Jeong et al., 2016). However, the impact of significant life stressors is often transient, with mental health and subjective wellbeing recovering to baseline levels for most individuals (Kettlewell et al., 2020). Similar transient effects have also been found in pre-COVID research of the mental health effects of quarantine (Jeong et al., 2016). Understanding whether any lockdown mental health impact is transient and the trajectory of this may help determine policy and service responses to future pandemics.

Over the course of the pandemic, different Australian states had very different lockdown experiences. All states experienced multiple lockdowns, although the duration of lockdowns varied considerably: sometimes lasting for as little as a week or, as in the case of Melbourne in the state of Victoria (VIC) extending for up to 4 months. VIC experienced the most severe and extended lockdown restrictions of any region in the world in 2020 of 112 consecutive days, while New South Wales (NSW) experienced a 106-day lockdown in the second half of 2021. Given Australia aggressive suppression strategy, there were also many shorter lockdowns (introduced at the first sign of community transmission) with the duration of these lockdowns often pre-determined and announced by policy makers. Studies with high frequency data collection (e.g., daily or weekly) are required to evaluate how psychological distress is affected by different lockdown durations.

The current study investigates the mental health effects of COVID-19 policy responses by considering trajectories of change and recovery during and after lockdowns, and examining the effect on mental health of lockdown duration and the number of lockdowns experienced. We describe for the first time how mental health varied as a function of time in lockdown, as well as time-to-recovery in the post-lockdown period immediately after restrictions were lifted. We draw on daily data from respondents in five Australian states to examine the association of mental health with timing and duration of lockdowns. The main source of data used in this paper was the Global COVID-19 Trends and Impact Survey (UMD Global CTIS), which recruited a new random sample of Facebook users each day, stratified by country and region, and assessed COVID symptoms, depression, anxiety, and financial stress among other items (Kreuter et al., 2020; Astley et al., 2021). As such, it provides the type of high frequency dataset needed to estimate the changes in psychological distress that occurred within lockdown, as well as after the restrictions lifted, for each Australian state throughout the pandemic.

2. Data and Methods

2.1 Sampling Method

The UMD Global CTIS was a partnership between the University of Maryland and Facebook. Facebook users were invited to take off-platform surveys of COVID-19-related symptoms beginning April 23rd, 2020. The survey and sampling strategy was designed by the University of Maryland Joint Program in Survey Methodology, and full details of the methods of the stratified survey collection are described in Kreuter et al. (2020). Briefly, every day a unique random sample of Facebook users over 18 years old (stratified by region) was invited to consent and participate via an invitation at the top of their Facebook News Feed (i.e., a repeated cross-sectional survey design).

Participants reported on their COVID-19 symptoms, psychological distress, and financial concerns (the complete list of survey variables is available at **https://gisumd.github.io/COVID-19-API-Documentation/docs/indicators/indicators**. Survey weights were developed from the United Nations Population Division 2019 World Population Projections for age and gender, and used to minimize errors of representation, including coverage, sampling, and non-response bias in each geographic region. The resulting weighted estimates aim to represent the general population of adults in each state rather than Facebook users per se. More details on the sampling frame, non-response modelling to reduce nonresponse and coverage bias, and post-stratification to represent the general adult population are available at **https://covidmap.umd.edu/document/css_methods_brief.pdf**.

2.2 Psychological distress

Psychological distress was measured by two questions on depression and anxiety taken from the Kessler-10 (K10) (Kessler et al. 2003):

"During the last 7 days, how often did you feel so depressed that nothing could cheer you up?" (*All of the time, most of the time, some of the time, a little of the time, none of the time*).

"During the last 7 days, how often did you feel so nervous that nothing could calm you down?" (*All of the time, most of the time, some of the time, a little of the time, none of the time*).

We report the population weighted proportions of adults responding "most" or "all of the time" to each question as the population prevalence of depression and anxiety, respectively.

2.3 Lockdown dates

After an initial national lockdown from the end of March 2020 to mid-May 2020, Australia successfully reduced COVID-19 cases to negligible levels (as few as 3 new cases a day according to the 7-day trailing average, www.covidlive.com.au). Australian data in the UMD Global CTIS is only available from early May 2020, towards the end of the first national lockdown. Subsequently, different states in Australia underwent distinct episodes of lockdowns of varying length over 2020 and 2021 (see Table 1). By the end of 2021, Melbourne (VIC) and Sydney (NSW) had experienced 272 and 150 days of lockdown respectively, while QLD (and the rest of Australia) had remained relatively free of restrictions. This makes NSW and VIC a good case-study to examine the impact of extended lockdowns on the prevalence of depression and anxiety in the population, relative to its temporal trend as well as by comparisons with the rest of Australia.

Note we excluded the initial national lockdown in the analyses below, as data collection only commenced towards the end of the first lockdown period. Furthermore, the second lockdown listed for NSW was restricted to a single local government area (LGA), representing fewer than 65,000 people (less than 0.8 percentage points of the NSW population), so was excluded from the analyses.

Table 1. Lockdown Characteristics, by State

State	Lockdown	Start	End	Duration
Victoria (VIC)	1	2020-03-31	2020-05-12	42 days
	2	2020-07-09	2020-10-28	111 days
	3	2021-02-12	2021-02-17	5 days
	4	2021-05-27	2021-06-10	14 days
	5	2021-07-15	2021-07-27	12 days
	6	2021-08-05	2021-10-22	78 days
New South Wales (NSW)	1	2020-03-31	2020-05-15	45 days
	2	2020-12-17	2021-01-09	23 days
	3	2021-06-26	2021-10-10	106 days
Queensland (QLD)	1	2020-03-31	2020-05-02	32 days
	2	2021-01-08	2021-01-11	3 days
	3	2021-03-29	2021-04-01	3 days
	4	2021-06-29	2021-07-03	4 days
	5	2021-07-31	2021-08-08	8 days
South Australia (SA)	1	2020-03-31	2020-05-11	41 days
	2	2020-11-19	2020-11-22	3 days
	3	2021-07-21	2021-07-28	7 days
Western Australia (WA)	1	2020-03-23	2020-04-27	35 days
	2	2021-01-31	2021-02-05	5 days
	3	2021-04-24	2021-04-27	3 days
	4	2021-06-29	2021-07-03	4 days

Note: Lockdown dates were sourced from State Premier announcements and news reports, and curated by Anthony Macali.

2.4 Modelling

The outcome variables were the daily prevalence of depression and anxiety. For duration of lockdown the main explanatory variable was the cumulative number of weeks spent to date in the current lockdown ("week"). To estimate the post-lockdown trajectory, we used the number of weeks in the post-lockdown period since the most recent lockdown ended, top-coded as a maximum of 5 weeks ("postweek"). To capture the non-linear trajectory of weekly changes in depression and anxiety with lockdown duration, the cumulative lockdown week (or post lockdown week) was modelled with a cubic regression spline (Wood, 2006). We included varying coefficients (i.e., random effects) for the total duration of each lockdown to correctly account for variations in trajectory due to the total length of each lockdown ("duration"). We present the predicted population-level estimates of prevalence as a function of time in lockdown. The marginal effects of each lockdown duration were calculated to allow comparison between lockdown trajectories with different durations.

The linear effect of time since the start of the pandemic ("month") was entered into each model to control for trends in levels of distress over the pandemic (Butterworth et al., 2022). State fixed effects were included to capture average differences between regions in Australia ("State") and the potential cumulative effect of new lockdowns ("number") in each state.

Formally, the daily prevalence of each outcome (pr) was modelled for each $i=1...I$ days of the pandemic for each $j=1...J$ State (NSW, VIC, QLD, SA, WA) as:

$$
\begin{aligned}
pr_{ij} \quad &= \beta_0 + \beta_1(month_i) + \beta_{2[j]}(State_j) + \beta_{3[j]}(number_i \times State_j) + \\
&\quad f_1(week_i) + f_{1[k]}(week_i, duration_k) + \epsilon_i \\
f_{1[k]} \quad &\sim f_1 b_{1[k]}(duration_k) \\
b_{1[k]} \quad &\sim N(0, \sigma^2_{duration}) \\
\epsilon_i \quad &\sim N(0, \sigma^2_{\epsilon})
\end{aligned}
$$

Where pr_{ij} is the population estimate of daily prevalence of distress in each State, β_1 is the underlying trend in levels of distress in Australia, β_2 is the fixed estimate for average differences in distress in each State over the pandemic, β_3 is the trend in distress over different lockdown numbers in each State, f_1 is

a smooth function(s) for the non-linear trend in distress over lockdown weeks, and b_1 is the random effect (slope) of lockdown duration for each $k=1...K$ durations.

f_1 is a penalised cubic regression spline of the form:

$$f(x) = \beta_0 + \beta_1(x) + \beta_2(x)^2 + \beta_3(x)^3 + \beta_p(x - \tau_p)^3$$

With equally spaced knots $\tau\_1<...<\tau_P$ for $p=1...P$ over the range of x.

In sensitivity analyses we also included the number of daily new infections and daily financial concerns as confounding variables (see Appendix Section 2). Appropriate model diagnostic information is available in Appendix Section 3.

3. Results

The demographic features of Facebook users in our sample of 574,306 who responded to either the depression or anxiety item between April 2020 and December 2021 are shown in Table 2.

Most responses were from females (61%) and/or adults aged 25-64 (74%), living in a city or town (84%), and over half came from VIC or NSW (53%). The survey weights provided by UMD Global CTIS were included in all models to adjust for disproportionate sampling over age groups and gender. Fear of infection ("Infection") was highest in VIC (48%) and lowest in WA (37%), X^2 (4 , N = 57,4306) = 3773.6, p < .001. Financial worry ("Finance") was similar in VIC, NSW, and QLD (26%) but lower in SA and WA, X^2 (4 , N = 57,4306) = 684.75, p < .001. The proportion of people feeling depressed was highest in VIC (7.5%), followed by NSW (6.6%), X^2 (4 , N = 57,4306) = 706.3, p < .001. Anxiety prevalence was also highest in VIC (4.8%) relative to other states, X^2 (4 , N = 57,4306) = 374.03, p < .001

Table 2. Summary Statistics, Overall and by State

Characteristic	Australia N = 574306	VIC N = 159465	NSW N = 144605	QLD N = 128028	SA N = 63283	WA N = 78925
Gender						
Female	348,842 (61%)	95,083 (60%)	86,968 (60%)	79,591 (62%)	39,602 (63%)	47,598 (60%)
Male	225,464 (39%)	64,382 (40%)	57,637 (40%)	48,437 (38%)	23,681 (37%)	31,327 (40%)
Age						
18-24	60,800 (11%)	17,927 (11%)	15,878 (11%)	13,989 (11%)	5,949 (9.4%)	7,057 (8.9%)
25-44	217,775 (38%)	64,480 (40%)	57,974 (40%)	48,544 (38%)	19,394 (31%)	27,383 (35%)
45-64	203,992 (36%)	54,320 (34%)	49,133 (34%)	45,348 (35%)	25,260 (40%)	29,931 (38%)
65+	91,739 (16%)	22,738 (14%)	21,620 (15%)	20,147 (16%)	12,680 (20%)	14,554 (18%)
Region						
City	287,802 (51%)	77,990 (50%)	66,058 (47%)	63,066 (50%)	34,149 (55%)	46,539 (60%)
Town	182,543 (33%)	52,848 (34%)	50,782 (36%)	41,921 (34%)	16,624 (27%)	20,368 (26%)
Rural	89,470 (16%)	24,432 (16%)	24,094 (17%)	19,976 (16%)	10,889 (18%)	10,079 (13%)
Fear of infection	191,607 (43%)	60,749 (48%)	49,565 (46%)	39,668 (40%)	18,857 (38%)	22,768 (37%)
Financial concerns (yes)	144,856 (25%)	42,148 (26%)	37,656 (26%)	32,724 (26%)	14,867 (23%)	17,461 (22%)
Depressed	36,795 (6.4%)	12,019 (7.5%)	9,494 (6.6%)	7,669 (6.0%)	3,744 (5.9%)	3,869 (4.9%)
Anxious	24,057 (4.2%)	7,683 (4.8%)	6,101 (4.2%)	5,268 (4.1%)	2,508 (4.0%)	2,497 (3.2%)

3.1 Depression

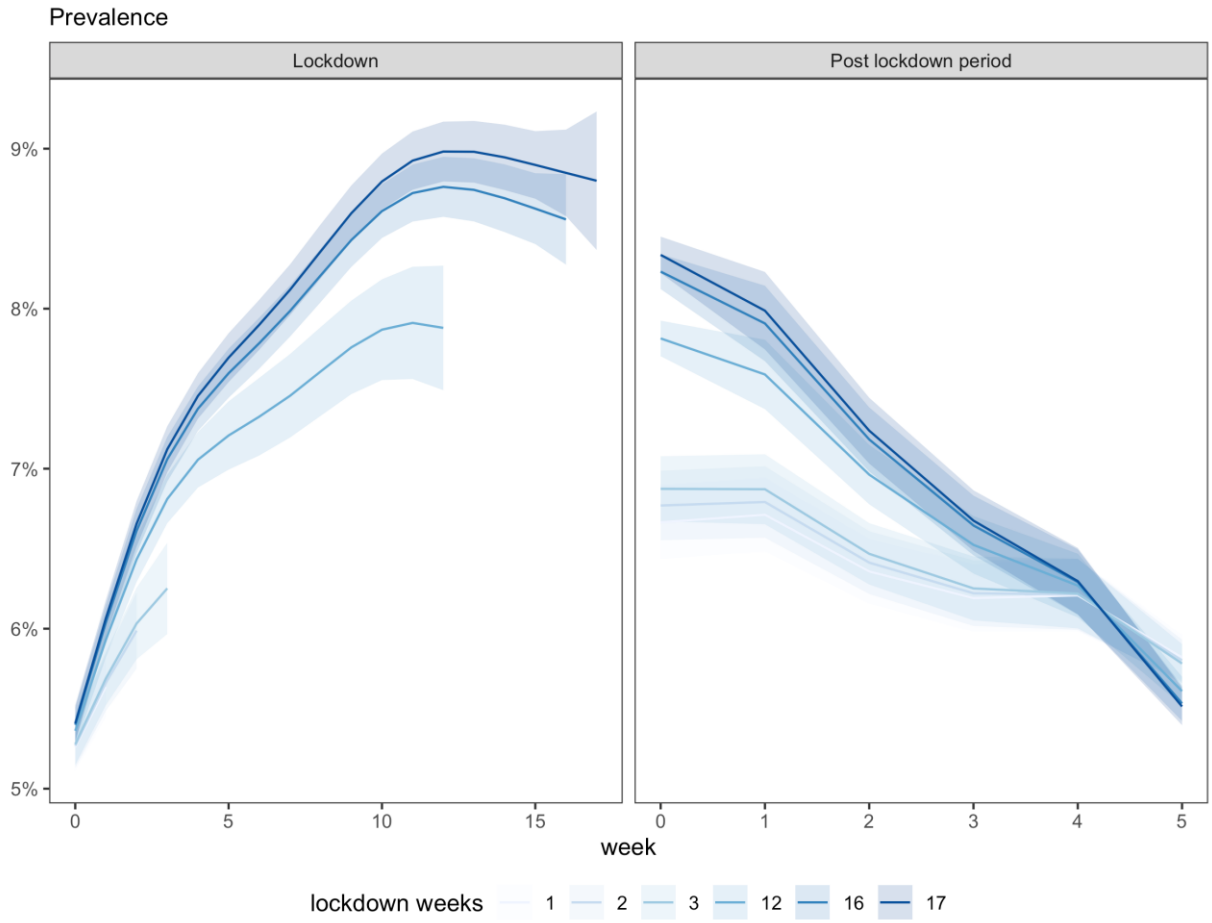
The daily prevalence of depression, as estimated by a weighted proportion of the population, is shown in Figure 1 for each state over the course of the COVID-19 pandemic. A linear regression of depression prevalence on time (month) revealed the average monthly increase in prevalence over the pandemic was

positive and significant in each state: β [95% CI] = 0.11 [0.1, 0.12], 0.1 [0.09, 0.11], 0.08 [0.07, 0.1], 0.16 [0.15, 0.17], 0.04 [0.03, 0.06] percent for NSW, QLD, SA, VIC, WA, respectively. Lockdown had a significant effect on increasing the prevalence of depression in each state: β [95% CI] = 2.49 [2.28, 2.71], 0.46 [0.13, 0.8], 0.65 [0.01, 1.28], 2.36 [2.19, 2.52], percent for NSW, QLD, SA, VIC respectively, except WA 0.18 [-0.38, 0.74].

Figure 1. Daily population prevalence of depression (±95% CI) by state

Note: Daily population weighted estimates of depression prevalence (±95% CI shaded) in each Australian State between the end of April 2020 and December 2021. Grey shaded regions indicate lockdown periods in each State.

Figure 2. Effect of lockdown on population prevalence of depression (±95% CI)



Note: Figure shows the estimated effect of lockdown on the population prevalence of depression as a function of time (weeks). In the lockdown period (left), the Week 0 estimate represents the average prevalence in the period immediately prior to lockdown. In the post-lockdown period (right), Week 0 represents the average depression during the prior lockdown and the Week 5 estimate represents the average prevalence after the 4th week post-lockdown period and before the next lockdown.

Figure 2 reports the estimated trajectories for depression by lockdown duration. The estimated depression prevalence increased week on week over a lockdown before peaking in week 10. These smoothed trajectories explained 76 percent of the variance in depression and were significantly non-linear (F = 55.46, p < .001). Including the random effect of lockdown duration in the lockdown model explained only an additional 0.2 percent of variance (F = 29.32, p < .001).

The smooth trajectories in the post lockdown period explained 72 percent of the variance and shows the prevalence of depression lowered rapidly in the initial two weeks after lockdown on average, before approaching stable levels (F = 22.34, p < .001). Including the random effect of lockdown duration in the post-lockdown model explained an additional 2 percent of variance (F = 217.37, p < .001). The prevalence fell to 6 percent by 4 weeks post-lockdown regardless of lockdown duration. Note however the week 5

post lockdown estimate falls below the week 4 post lockdown estimate, indicating depression levels still had further to fall after four weeks.

The varying effect of lockdown duration plotted in Figure 2 shows that short lockdowns (1-3 weeks) tended to have less impact on prevalence levels over the same initial period of a lockdown than longer lockdowns.

Table 3. Marginal effect of lockdown duration on depression

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	0.36	0.048	0.27	0.46
2	0.38	0.046	0.29	0.47
3	0.40	0.045	0.31	0.48
12	0.55	0.038	0.48	0.63
16	0.62	0.042	0.54	0.71
17	0.64	0.044	0.56	0.73

The marginal estimates of lockdown duration (Table 3) show the percent prevalence of depression increases between 0.36 to 0.4 percentage points every week over weeks 1-3 in a short lockdown (1-3 weeks), but a faster increase of 0.55 to 0.64 percentage points in longer lockdowns over the same initial period, and comparison of the 95% confidence intervals shows the rate of increase in each case is significantly greater than the short lockdowns.

The number of new lockdowns (“number”) had different and even opposite cumulative effects on depression prevalence in some states.

Table 4. Marginal effect of lockdown number on depression

State	marginal delta (%)	SE	lower 95%CI	upper 95%CI
VIC	0.450	0.032	0.387	0.51
NSW	0.465	0.060	0.348	0.58
QLD	0.080	0.034	0.013	0.15
SA	-0.072	0.102	-0.272	0.13
WA	-0.224	0.054	-0.331	-0.12

The marginal estimates (Table 4) show the percent prevalence of depression increases by 0.45 to 0.465 percentage points with each additional lockdown in VIC and NSW, was also positive in Queensland but in SA ranged around zero and was negative in WA. Comparison of the 95% confidence intervals shows the cumulative effect of each additional lockdown was significantly greater in VIC and NSW than any of the other states.

3.2 Anxiety

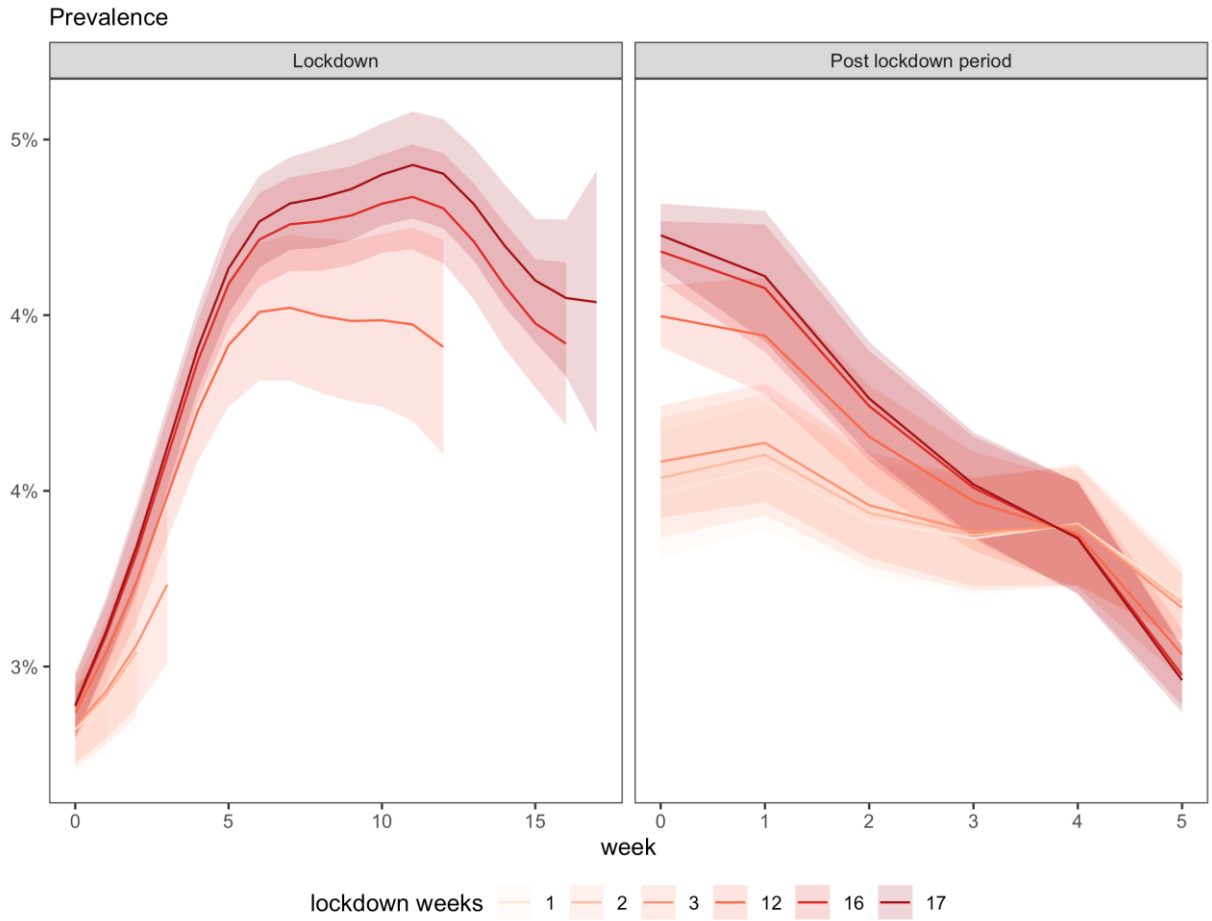
Figure 3 shows the daily prevalence of anxiety, as a weighted proportion of the population, for each state over the course of the COVID-19 pandemic. Changes in anxiety prevalence using this one question were much more modest during lockdown periods as compared to depression.

A linear regression of anxiety prevalence on time (month) by lockdown revealed the average monthly increase in prevalence over the pandemic was positive and significant in each state: β [95% CI] = 0.11 [0.1, 0.12], 0.07 [0.06, 0.08], 0.08 [0.07, 0.09], 0.14 [0.13, 0.14], 0.05 [0.04, 0.06] percent for NSW, QLD, SA, VIC, and WA, respectively. There were differences between states in the effect of lockdown on anxiety with lockdown increasing anxiety in NSW, SA, and VIC: β [95% CI] = 1.04 [0.88, 1.19], 0.89 [0.37, 1.42], 1.01 [0.89, 1.12], respectively, but no effect seen in, QLD -0.38 [-0.65, -0.1], or WA 0.11 [-0.4, 0.62].

Figure 3. Daily population prevalence of anxiety (±95% CI) by state and year

Note: Daily population weighted estimates of anxiety prevalence (±95% CI shaded) in each Australian State between the end of April 2020 and December 2021. Grey shaded regions indicate lockdown periods in each State

Figure 4. Effect of lockdown on population prevalence of anxiety (±95% CI)



Note: Figure shows the estimated effect of lockdown on the population prevalence of anxiety as a function of time (weeks). In the lockdown period (left), the Week 0 estimate represents the average prevalence in the period immediately prior to lockdown. In the post-lockdown period (right), Week 0 represents the average anxiety during the prior lockdown and the Week 5 estimate represents the average prevalence after the 4th week post-lockdown period and before the next lockdown.

The estimated trajectories in Figure 4 show similar patterns for the different lockdown durations, to the differences we observed for depression. The model estimates show anxiety prevalence increased rapidly week-on-week for the first 5 weeks, before falling after 10 weeks (adjusted R-squared = 65%, $F = 33.53$, $p < .001$). Adding the random effect of lockdown duration explained an additional 0.1 percentage points of variance ($F = 10.01$, $p < .001$).

The estimates of the post lockdown period further show the prevalence of anxiety declining over the four-week period modelled here (adjusted R-squared = 61.6%, $F = 6.20$, $p < .001$), and continuing to decline after this four-week period as indicated by the post-lockdown Week 5 estimate. Adding the random effect of lockdown duration explained an additional 1.1 percentage points of variance ($F = 85.71$, $p < .001$).

The varying effect of lockdown duration plotted in Figure 4 shows that short lockdowns (1-3 weeks) tended to have less impact on anxiety prevalence over the same period than longer lockdowns, but this effect was not significantly different in the estimated marginal effects of each additional lockdown week (Table 5).

As with depression, the cumulative number of lockdowns had differential effects on anxiety prevalence (Table 6). Anxiety increased with each additional lockdown in VIC and NSW, whereas for the other states anxiety either decreased (QLD, WA) or there was no evidence of change (SA).

Table 5. Marginal effect of lockdown duration on anxiety

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	0.091	0.039	0.016	0.17
2	0.099	0.037	0.026	0.17
3	0.107	0.036	0.036	0.18
12	0.178	0.032	0.114	0.24
16	0.209	0.036	0.140	0.28
17	0.217	0.037	0.145	0.29

Table 6. Marginal effect of lockdown number on anxiety

State	marginal delta (%)	SE	lower 95%CI	upper 95%CI
VIC	0.204	0.025	0.154	0.254
NSW	0.113	0.048	0.019	0.207
QLD	-0.125	0.027	-0.179	-0.071
SA	-0.043	0.082	-0.205	0.119
WA	-0.219	0.044	-0.306	-0.133

4. Discussion

This study is, to our knowledge, the first to describe how psychological distress rose and fell across multiple lockdowns, and assess whether mental wellbeing recovered following lockdowns. Using high temporal resolution daily survey data from Australian respondents, we found that the prevalence of psychological distress tended to increase over the course of the pandemic in almost all states. The consistent increase we demonstrated was not reported in a meta-analysis by Robinson et al. (2022), in which most studies which found that symptoms of distress tended to decline over the pandemic in European and North American countries after an initial rise, as health and wellbeing improved after an initial adverse response. Our data did not capture the immediate pandemic period and so there may also have been an initial increase in distress that we may have not measured. However, this general trend may not represent a COVID-19 effect as there were increasing baseline rates of distress in the community reported in the years prior to the pandemic (see Butterworth et al., 2020). This shifting baseline contaminates estimates of the average lockdown effect in other studies relying on comparisons between two timepoints unless carefully controlled. However, by considering the long-term trend in daily distress enabled us to distinguish the temporal effects of lockdown and its alleviation.

Our results suggest that distress, primarily depression and to a lesser extent anxiety, increased over lockdown periods, with lockdowns of 12 weeks or more producing a more rapid increase than shorter lockdowns. Lockdowns of one, two or three weeks had little to no impact on distress prevalence, potentially because their short and limited duration was often communicated to the public prior to their imposition We found that the effect of lockdowns on psychological distress was not permanent, with the levels of distress prevalence declining to near, but still slightly elevated, pre-lockdown levels within four weeks following the end of lockdown, and continued to decline over the subsequent post-lockdown period.

The results from this study are therefore consistent with previous work demonstrating poorer mental health during lockdown. However, our findings suggest that this adverse mental health effect was likely only experienced in the case of lockdowns lasting more than three weeks, and most of the increase in mental distress was transitory once lockdowns ended. However, a residual effect of lockdown may remain. We also found (see Appendix Section 2) that at least part of the association between lockdown duration and distress was mediated by financial concerns.

A key strength of this study is that the data came from five States in one country where there is a relatively homogeneous health and social care systems, and social and population structures who experienced similar Federal economic responses to the pandemic. The state variation in lockdown timing and duration enables some of these effects to be at least partially controlled, and the specific effects of lockdown be more evident. However, the degree of restriction within each lockdown varied although we could discern no pattern of association between this and distress. The temporal resolution of these data is the only available that we are aware of that can address our trajectory questions. Although the samples are large it is very likely that some respondents responded multiple times and these people will contribute more to findings. There is no a priori reason to believe that response bias exists, and thus that the number of surveys done would be associated with distress.

Overall, these high temporal resolution data from a very large sample, although limited to only two distress questions, provide a guide to how population distress rises and falls over the course of repeated lockdowns. These data may be useful for public health communication, and, assuming that demand for mental health services follows the same pattern, for policy makers and clinicians. They also remind us how resilient people are in general to major life stressors Kettlewell et al., 2020), an observation often missing from the social discourse.

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Appendix

1. Daily Sampling Rate

The daily sampling rate of Facebook users who responded to either the depression or anxiety item between April 2020 and December 2021 is shown in Table A1 for each state, stratified by age group and each gender:

Table A1.

STATE	AGE	FEMALES	MALES	FEMALE N/DAY	MALE N/DAY
VIC	18-24	11665 (65%)	6262 (35%)	19	10
	25-44	39705 (62%)	24775 (38%)	65	41
	45-64	31856 (59%)	22464 (41%)	52	37
	65+	11857 (52%)	10881 (48%)	19	18
NSW	18-24	10464 (66%)	5414 (34%)	17	9
	25-44	35830 (62%)	22144 (38%)	59	36
	45-64	29227 (59%)	19906 (41%)	48	33
	65+	11447 (53%)	10173 (47%)	19	17
QLD	18-24	9721 (69%)	4268 (31%)	16	7
	25-44	31656 (65%)	16888 (35%)	52	28
	45-64	27720 (61%)	17628 (39%)	45	29
	65+	10494 (52%)	9653 (48%)	17	16
SA	18-24	3978 (67%)	1971 (33%)	7	4
	25-44	12547 (65%)	6847 (35%)	21	11
	45-64	16214 (64%)	9046 (36%)	27	15
	65+	6863 (54%)	5817 (46%)	11	10
WA	18-24	4594 (65%)	2463 (35%)	8	4
	25-44	17431 (64%)	9952 (36%)	29	16
	45-64	18063 (60%)	11868 (40%)	30	19

65+	7510 (52%)	7044 (48%)	12	12

2. Supplementary Results

In follow-up sensitivity analyses we included the number of daily new infections and daily financial concerns as explanatory variables.

Each variable was added to the model as a penalized cubic regression spline, and we calculated the marginal effects of each lockdown duration as before. The results, when compared to the marginal effects reported in the main text, indicate the mediating effect of each variable (financial concerns or new infections) on the effect of lockdown duration.

2.1 Financial concern

Financial concerns during lockdown have been shown to be a significant mediating factor of psychological distress for various disadvantaged groups (Botha et al., 2022). Financial concern was measured by a single item:

"How worried are you about your household's finances in the next month?" (*Very, somewhat, not too worried, not at all*)

We included the weighted percentage of people reporting they were "very" or "somewhat" worried about their household finances as representing financial concern.

Table A2. Marginal effect of lockdown length on depression after including financial concerns

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	0.08	0.05	-0.01	0.17
2	0.10	0.04	0.01	0.19
3	0.12	0.04	0.03	0.20
12	0.28	0.03	0.21	0.34
16	0.35	0.04	0.27	0.42
17	0.36	0.04	0.29	0.44

Adding financial concerns improved the fit with depression prevalence (explained deviance increased from 76.1% to 79.1%) (see Table A2). In comparison to Table 2 (Marginal effect of lockdown duration on depression), the marginal effect of lockdown duration on depression prevalence was reduced by approximately 0.28 percentage points after including financial concerns. The remaining effect was indistinguishable from zero for short duration lockdowns (e.g., 1 week), and the effect at longer durations is almost half that observed without financial concerns (e.g., 0.36 vs. 0.64 during 17-week lockdown). Nevertheless, lockdowns of 2-week or longer tended to increase depression prevalence, with or without accounting for financial concerns.

Table A3. Marginal effect of lockdown length on anxiety after including financial concerns

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	-0.12	0.04	-0.20	-0.04
2	-0.11	0.04	-0.19	-0.04
3	-0.11	0.04	-0.18	-0.03
12	-0.04	0.04	-0.12	0.03
16	-0.02	0.04	-0.09	0.06
17	-0.01	0.04	-0.09	0.07

Adding financial concerns improved the fit with anxiety prevalence (explained deviance increased from 65.2% to 69.5%) (see Table A3). Comparing the marginal effect of lockdown duration on anxiety prevalence with and without financial concerns in the model (e.g., Table 4. Marginal effect of lockdown duration on anxiety), reveals financial concerns substantially mediated anxiety over varying lockdown durations. After accounting for financial concerns, short lockdowns up to 3-weeks tended to reduce anxiety, while the effect of longer lockdowns was indistinguishable from zero.

2.2 Fear of infection

Other factors such as daily media reports of the rate of new infections, or announcement of temporary changes in government support could also drive changes in daily psychological distress. Even people who have not directly experienced pandemic-related stressors such as infection, bereavement or job loss can nevertheless be negatively affected by the fear of experiencing them, often fueled by exposure to a continuous deluge of negative media coverage of the spreading infection rates in the community (Garfin et al., 2020; Bower et al., 2021; Digby et al., 2021). In Australia, the number of new infections was reported daily at official government press conferences, which were widely reported and tracked in the media. Thus, like lockdown, their impact on psychological distress may be transient and short lived – difficult to detect without daily measurements of both. However, controlling for daily changes in the salient influence of infection rate when estimating trends in distress has not been widely done.

Although the UMD Global CTIS included a single item measuring fear of infection, the responses were only collected between May 1st 2020 and May 20th 2021, which excludes the extended lockdown period in

NSW. Because of the restricted availability of this item, we adopted another measure as a proxy for fear of infection. Daily case numbers (new infections) reported by each State Government for the entire pandemic period were collected and curated by Anthony Macali at covidlive.com.au, and downloaded from www.covidlive.com.au/covid-live.csv on the 01-15-2022.

The correlation between (log) daily cases and responses to the fear of infection item over 2020 in VIC (i.e., the time period both were available over an extended lockdown period) was Pearson $\rho = 0.931$.

Table A4. Marginal effect of lockdown length on depression after including new infections

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	0.35	0.05	0.25	0.44
2	0.36	0.05	0.27	0.46
3	0.38	0.05	0.29	0.47
12	0.51	0.04	0.43	0.59
16	0.57	0.05	0.48	0.66
17	0.58	0.05	0.49	0.68

Adding new infections improved the fit with depression prevalence (explained deviance increased from 76.1% to 76.7%) (see Table A3). The marginal effect of lockdown duration on depression prevalence was very similar with and without new infections in the model (compare to Table 2).

Table A5. Marginal effect of lockdown length on anxiety after including new infections

lockdown length (weeks)	marginal delta (%)	SE	lower 95%CI	upper 95%CI
1	0.09	0.04	0.02	0.17
2	0.10	0.04	0.03	0.17
3	0.11	0.03	0.05	0.18
12	0.21	0.03	0.16	0.26
16	0.25	0.03	0.19	0.31
17	0.26	0.03	0.20	0.32

Adding financial concerns improved the fit with anxiety prevalence (explained deviance increased from 65.2% to 66.1%) (see Table A4). The marginal effect of lockdown duration on anxiety prevalence was very similar with and without new infections in the model (compare to Table 4).

Overall, the results including mediating variables indicated almost all the effect of lockdown on anxiety was mediated by financial concerns, as well as a substantial portion of the effect of lockdown on depression. Indeed, once financial concerns were explained, short lockdowns tended to decrease anxiety prevalence and had little further impact on depression. By contrast, new infections (a proxy for fear of infection) had little mediating impact on depression or anxiety.

3. Model Diagnostics

Model fits were checked and assessed for oversmoothing, as well as violation of the distributional assumptions.

The k-index represents the adequacy of the basis dimension for the fit (Wood, 2017). The further below 1, the more likely there is a missed pattern left in the residuals. The k-index for the random effect of lockdown duration was adequate in the models of depression (k-index = 0.5) and anxiety (k-index = 0.52).

Four residual plots were also inspected for each fit, with plots of deviance residuals against approximate theoretical quantiles of the deviance residual distribution according to the fitted model. The Q-Q plot (top left) indicated some deviation in the tails of the distribution from normal, however there were no identifiable pattern in the residual vs predicted scatterplot, and the histogram of residuals was approximately normal.

Figure A1: Depression model diagnostics

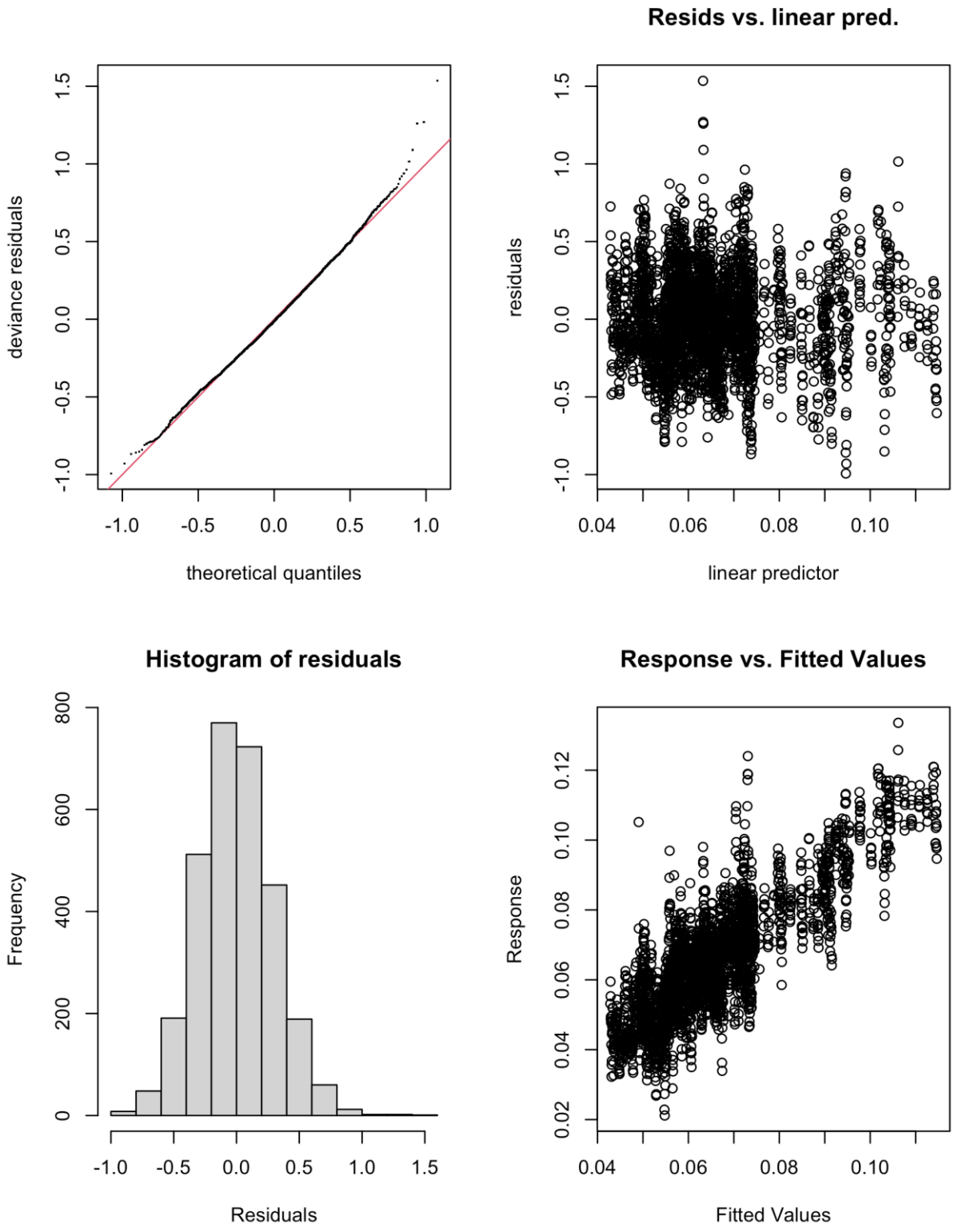

Figure A2: Anxiety model diagnostics