

Article

# Risk Factors and Changes in Depression and Anxiety over Time in New Zealand during COVID-19: A Longitudinal Cohort Study

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## Highlights:

### What We Already Know?

- The COVID-19 pandemic has caused substantial disruption to daily life.
- The pandemic increased anxiety and depression in the general population of New Zealand in its first 3 months.

### What This Article Adds?

- This study found that depression and anxiety reduced over the first year of the pandemic in New Zealanders.
- However, even in a country with low transmission, anxiety and depression remained elevated compared to pre-pandemic norms.
- Younger age, being a pet owner, negative life events, and having mental health disorder increased the risk of anxiety and depression.

**Abstract:** This longitudinal study investigated changes in and risk factors for anxiety and depression during the COVID-19 pandemic in a New Zealand cohort. Online surveys were distributed to 681 participants at three time-points: May 2020 (Time 1), August–September 2020 (Time 2), and March–April 2021 (Time 3). Participants completed measures of anxiety and depression, alongside measures of possible risk/protective factors. A total of 261 participants completed all three surveys and were included in analyses. Depression and anxiety reduced over time; however, levels were still significantly higher than pre-pandemic norms. Being younger, having a prior mental health disorder, experiencing negative life events due to COVID-19, and being a pet owner were risk factors for poorer depression and anxiety, whereas having higher positive mood was protective. This study demonstrates persisting negative effects of the pandemic on anxiety and depression in a context of low transmission and highlights the importance of providing psychological help to those most at risk.

**Keywords:** anxiety; COVID-19; depression; mental health; risk factors



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## 1. Introduction

Since its emergence in December 2019, the COVID-19 pandemic, caused by SARS-CoV-2, changed normal life. A global pandemic was declared by the World Health Organisation on the 11 March 2020, followed by the closure of many country borders, and the enforcement of preventative health measures, including lockdowns, self-isolation, social distancing, and mask wearing. These events resulted in multiple chronic stressors, including work and life

disruptions, fear of infection, financial instability, bereavement, sleep disruptions, constant news/misinformation exposure, and social isolation.

International research has demonstrated deterioration of mental health since the start of the pandemic, especially during the initial few months [1–3]. Two global surveys reported consistently high levels of stress, anxiety, and depression [4,5]. Similarly, multiple reviews have reported the prevalence of mental health disorders was higher during the pandemic, compared to pre-pandemic levels [6–8].

For New Zealand (NZ) specifically, two studies have reported the effect of the pandemic on psychological outcomes; both demonstrated increases in depression, anxiety and distress, compared with pre-pandemic [9,10]. Similar results have been found in the United Kingdom (UK) [11] and Australia [12]. However, it is also imperative to investigate the long-term impact of the pandemic on mental health

Research suggests that psychological outcomes can vary alongside the varying course of the pandemic. One longitudinal study demonstrated that higher rates of anxiety and depression did not decrease as the pandemic progressed [13], whilst another longitudinal study found that anxiety and depressive symptoms increased over time [14]. However, both of these studies had follow-up periods in March/April 2020, when the pandemic was still at its peak. Longitudinal studies with later follow-up dates (June–December 2020) demonstrated a reduction in psychological difficulties, albeit with levels of psychological morbidity remaining significantly higher than pre-pandemic levels [1,15]. These studies suggest that the deterioration of mental health is long-lasting, with worsened psychological outcomes up to nine months into the pandemic.

Compared to other countries, NZ experienced relatively low rates of transmission in the first year of the pandemic, which enables longitudinal outcomes to be examined in a different context to previous work. The first confirmed case of COVID-19 in NZ was on the 28 February 2020 [16]. In response, the government introduced a 4-tiered Alert System: Alert Level 4 (lockdown), Alert Level 3 (restrict), Alert Level 2 (reduce), and Alert Level 1 (prepare) [16]. NZ closed its borders on the 19 March 2020 and enforced a nationwide lockdown on the 25 March 2020 (Alert Level 4). The lockdown was gradually de-escalated on the 27 April 2020 (Alert Level 3) and returned to almost normal when there no longer any active cases (Alert Level 1) on 8 June 2020. Since then, certain regions were placed into short periods of restrictions, and NZ re-entered a nation-wide lockdown (Alert Level 4) on the 17 August 2021, after a six-month period of Alert Levels 1 or 2. A fast and early government response enabled NZ to contain community transmission quickly, and NZ had relatively low case incidence and mortality. The alert level system ended on 2 December 2021, moving to a new traffic light system. This paper reports a study conducted in NZ between May 2020 and April 2021.

As well as looking at prevalence, it is important to identify risk and protective factors for depression and anxiety to determine who is most in need of psychological support. Previous research has indicated that being female [7], being younger [5], having a prior mental health disorder [15,17], being lonely [4,18], living alone [4,15,19], and being most at risk for COVID-19 [8,10] are risk factors for poor mental health during the pandemic. On the other hand, positive mood [10,15], optimism [4], exercise [7,10,14], and pet ownership [10,20] appear to be protective. This paper adds to previous research by examining the long-term impact of these risk and protective factors, as previous studies had shorter time frames.

## 2. Aims of the Current Research

This article investigates the longitudinal prevalence and risk factors for anxiety and depression levels across three time-points of the pandemic in a NZ community cohort. Data from the COVID-19 Stress and Health Study were used. Previously, this project reported cross-sectional results relating to psychological outcomes during the first 10 weeks and made comparisons between NZ and the UK [10]. This paper focuses on predicting risk

factors for anxiety and depression at Time 3, over a year since the first cases were reported in NZ.

It was hypothesised that anxiety and depression levels would decrease over time, as infection rates and Alert levels in NZ decreased and social restrictions eased. However, it was hypothesised that these levels would be higher than pre-pandemic norms (gathered from a representative NZ sample of 1296 adults taken in 2018 [21]) at all time-points due to ongoing risk and restrictions. It was also hypothesised that female gender, younger age, prior mental health disorders, loneliness, living alone, being in a COVID-19 risk group, and COVID-19 worry would be risk factors for poorer depression and anxiety levels at Time 3, whereas positive mood, pet ownership, and exercise would be protective factors.

### 3. Methods

#### 3.1. Participant Recruitment and Eligibility

The Auckland Health Research Ethics Committee approved this study. Participants were recruited through social media campaigns across NZ. Further detail on recruitment procedures has been reported previously [10].

Participants were eligible if they lived in NZ, aged over 18 years, able to give informed consent, and read English. As reported previously [10], a power calculation showed that a sample of at least 252 participants would be sufficient to detect a R<sup>2</sup> value of 0.10, with 90% power and an alpha of 0.05. An upper limit was not placed on the sample size.

#### 3.2. Procedures and Measures

Consenting participants were invited to complete three surveys, across three periods (see Figure 1). Time 1 was from 8 May 2020 to 6 June 2020, during which NZ was under social distancing and restrictions (Alert Levels 2 and 3), Time 2 was 12 weeks later (29 July 2020 to 3 September 2020), which began with no restrictions (Alert Level 1), and ended with a regional lockdown in Auckland (Alert Level 3), and raised restrictions (Alert Level 2) for the rest of NZ from 12 August 2020. The rest of NZ returned to Alert Level 1 on 22 September 2020, while Auckland remained at Alert Level 2 until 8 October 2020. Time 3 was more than six months later (8 March 2021 to 10 April 2021) and was characterised by raised restrictions (Alert Level 2) in Auckland until 12 March 2021, and the rest of NZ in Alert Level 1.

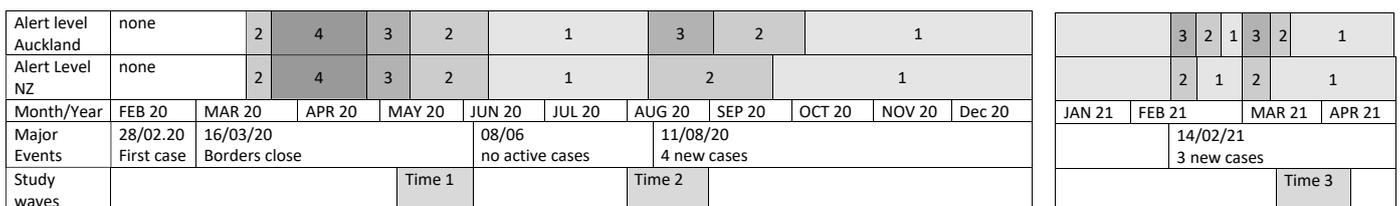


Figure 1. Timeline of alert levels for COVID-19 in New Zealand in relationship to this study.

At Time 1, socio-demographic data were collected, including gender, age, ethnicity, relationship status, education level, and living alone or with others. Ethnicity was re-coded into a binary variable, using BAME (Black, Asian, and Minority Ethnic groups) and not BAME (i.e., NZ European or European). Participants were also asked if they worked in a ‘keyworker’ role (such as being a healthcare worker, teacher, food chain worker, or government worker), and whether they were in a COVID-19 risk group. These risk groups were defined as: most at risk (e.g., suffering from advanced cancer, severe asthma, immunocompromised conditions), at increased risk (e.g., being pregnant, aged over 70), or not at risk. Health behaviours (smoking status, pet ownership, exercise frequency, and frequency of alcohol consumption) were also collected.

At Time 2, participants were asked whether they had previously been diagnosed with a mental illness (e.g., anxiety or depression). At Time 3, participants were asked whether they had experienced any life events due to COVID-19 from a predefined checklist. Positive

(i.e., gaining new employment, change in financial status for the better, change in living conditions for the better, and change in personal relations for the better) and negative (i.e., death of a relative or friend, major health event for you or a loved one requiring hospitalisation, you or your partner losing your job, change in financial status for the worse, change in living conditions for the worse, and change in personal relations for the worse) events were summed to get total scores for both positive and negative life events. At all three time-points, participants were asked whether they had received a positive COVID-19 test result.

Validated psychological measures were administered at all three time-points. These included the Generalized Anxiety Disorder Scale (GAD-7) [22], the Patient Health Questionnaire (PHQ-9) to measure depression [23], and the Scale of Positive and Negative Experience-Positive (SPANE-P) to measure positive mood [24]. Participants were asked to rate their perceived risk of getting COVID-19 at the moment on a scale of 1 (I don't think I will get it) to 10 (I know I will most certainly get it), and how lonely they felt over the past two weeks from 1 (not at all lonely) to 10 (extremely lonely). Lastly, participants were asked to rate their worry about contracting COVID-19. Options included: I do not worry about getting COVID-19, I occasionally worry about getting COVID-19, I spend much of my time worrying about getting COVID-19, and I spend most of my time worrying about COVID-19.

### 3.3. Statistical Analysis

Analyses were conducted using IBM SPSS Statistics 27 with those who completed surveys at all three time-points (completers). Independent samples *t*-tests and chi square tests were conducted to examine possible differences between completers and drop-outs. Depression and anxiety scores at all time-points were not normally distributed. Therefore, square-root transformations were applied, and transformed values were used in the repeated measures ANOVA and multivariate linear regression analyses. However, raw scores were used to compare data with pre-pandemic norms and to allow easier interpretation (scores of 5, 10 and 15 can be considered mild, moderate and severe for anxiety; scores of 5, 10, 15, and 20 represent mild, moderate, moderately severe, and severe for depression).

Average depression and anxiety scores were compared with pre-pandemic norms using one sample *t*-tests for each time-point. Pre-pandemic means for PHQ-9 and GAD-7 were retrieved from the 2018 New Zealand Mental Health Monitor, a nationally representative survey [21]. As transformed data were not available for the normative scores, these *t*-tests were conducted with the non-transformed depression and anxiety scores. Independent samples *t*-tests were conducted to compare average anxiety and depression scores between males and females.

Repeated measures ANOVAs were conducted on the square-root transformed anxiety and depression scores to examine differences across time-points, using the Greenhouse-Geisser adjustment. All significant interaction effects were followed up using simple pairwise comparisons with Bonferroni corrections.

Two multivariable linear regressions were conducted to explore the independent relationships of sociodemographic factors (age, gender, ethnicity, keyworker status, prior mental health disorders, living alone, COVID-19 risk group, positive and negative life events), Time 1 psychological factors (perceived loneliness, positive mood, perceived risk of COVID-19, COVID-19 worry), and Time 1 health behaviours (pet ownership, smoking status, exercise frequency and alcohol consumption), on square-root transformed depression and anxiety scores at Time 3.

## 4. Results

### 4.1. Sample Characteristics

Of the 781 participants who started the survey at Time 1, 681 (86%) completed the Time 1 survey. A total of 375 (48%) completed the entire follow-up survey at Time 2, and 328 (42%) completed the survey at Time 3. This resulted in a final sample of 261 (33%)

participants (completers) who completed all three surveys. The data from this sample of 261 completers was analysed in this manuscript. Demographic and baseline characteristics between the completers, and non-completers of all three surveys are presented in Table 1. Non-completers were, on average, significantly younger than completers, and significantly more likely to be male. Non-completers were more likely to have a bachelor's degree and less likely to have a postgraduate degree than completers. Bonferroni post hoc tests showed that non-completers were less likely to drink alcohol 4–6 times a week, and more likely to drink alcohol less than once a week, compared to completers.

**Table 1.** Summary of Demographic, Baseline Characteristics, and Health Behaviours between Completers and Non-Completers.

Baseline Characteristic	Completers	Non-Completers	<i>p</i> -Value
Gender, n (%)			<b>0.017</b> <sup>b,*</sup>
Male	17 (7%)	55 (12%)	
Female	243 (93%)	398 (88%)	
Age (years), M (SD)	43.87 (16.62)	40.26 (15.70)	<b>0.004</b> <sup>a,*</sup>
Ethnicity, n (%)			0.075 <sup>b</sup>
White-NZ European, European	224 (86%)	369 (81%)	
BAME background	37 (14%)	89 (19%)	
Relationship status, n (%)			0.073 <sup>b</sup>
Single, never married	49 (19%)	120 (26%)	
Single, divorced or widowed	27 (10%)	41 (9%)	
In a relationship/married, but living apart	20 (8%)	28 (6%)	
In a relationship/married, and cohabiting	165 (63%)	264 (58%)	
Education level, n (%)			<b>&lt;0.001</b> <sup>b,**</sup>
NCEA or lower (high school)	52 (20%)	101 (22%)	
Level 5 and 6 diploma or other	28 (11%)	41 (9%)	
Bachelor's degree	38 (15%)	136 (30%)	
Postgraduate degree	143 (55%)	180 (39%)	
Keyworker status, n (%)			0.705 <sup>b</sup>
Keyworker	117 (45%)	212 (46%)	
Not a keyworker	144 (55%)	246 (54%)	
Living alone, n (%)			0.641 <sup>b</sup>
Living alone	26 (10%)	49 (11%)	
Living with others	235 (90%)	393 (89%)	
COVID-19 risk group, n (%)			0.985 <sup>b</sup>
Most at risk	21 (8%)	36 (8%)	
At increased risk	34 (13%)	58 (13%)	
Not at risk	206 (79%)	364 (79%)	
Perceived risk of COVID-19, M (SD)	2.42 (1.74)	2.22 (1.52)	0.170 <sup>a</sup>
PHQ-9, M (SD)	7.92 (6.65)	7.89 (.17)	0.950 <sup>a</sup>
GAD-7, M (SD)	6.27 (5.54)	6.26 (5.30)	0.975 <sup>a</sup>
SPANE-P, M (SD)	19.90 (5.21)	20.01 (4.91)	0.790 <sup>a</sup>
Perceived loneliness, M (SD)	3.91 (2.70)	3.91 (2.85)	0.991 <sup>a</sup>
COVID-19 worry, n (%)			0.937 <sup>b</sup>
No worry	94 (36%)	163 (39%)	
Occasional worry	144 (55%)	227 (54%)	
Much worry	18 (7%)	27 (6%)	
Most worry	4 (2%)	6 (1%)	
Pet ownership, n (%)			0.432 <sup>b</sup>
Pet owner	153 (59%)	244 (56%)	
Non-pet owner	108 (41%)	195 (44%)	
Smoking status, n (%)			0.843 <sup>b</sup>
Smoker	14 (5%)	25 (6%)	
Non-smoker	247 (95%)	412 (94%)	
Exercise frequency, n (%)			0.125 <sup>b</sup>
Almost every day	129 (49%)	172 (39%)	

Table 1. Cont.

Baseline Characteristic	Completers	Non-Completers	<i>p</i> -Value
2–3 times a week	70 (27%)	148 (34%)	<b>0.047</b> <sup>b,*</sup>
Once a week	25 (10%)	49 (11%)	
Less than once a week	24 (9%)	46 (10%)	
Never	13 (5%)	24 (5%)	
Alcohol consumption, n (%)			
Daily	24 (9%)	43 (10%)	
4–6 times a week	43 (16%)	49 (11%)	
1–3 times a week	93 (37%)	133 (30%)	
Less than once a week	29 (11%)	75 (17%)	
Never	72 (28%)	137 (31%)	

Note: M = Mean, SD = Standard deviation, % = percentage of participants in that category, BAME = Black, Asian and Minority Ethnic, PHQ-9 = Patient Health Questionnaire, GAD-7 = Generalised Anxiety Disorder Scale, SPANE-P = Scale of Positive and Negative Experience-Positive. *p*-value was calculated by independent samples *t*-tests <sup>a</sup> and Chi-square tests <sup>b</sup>. Bolded *p*-values denote significance at \* *p* < 0.05, \*\* *p* < 0.001.

Only two participants in the sample reported testing positive for COVID-19 over the study period. Both positive cases were reported at Time 1, and both did not complete the Time 2 or Time 3 surveys, and thus were not included in the final sample.

#### 4.2. Depression and Anxiety over Time

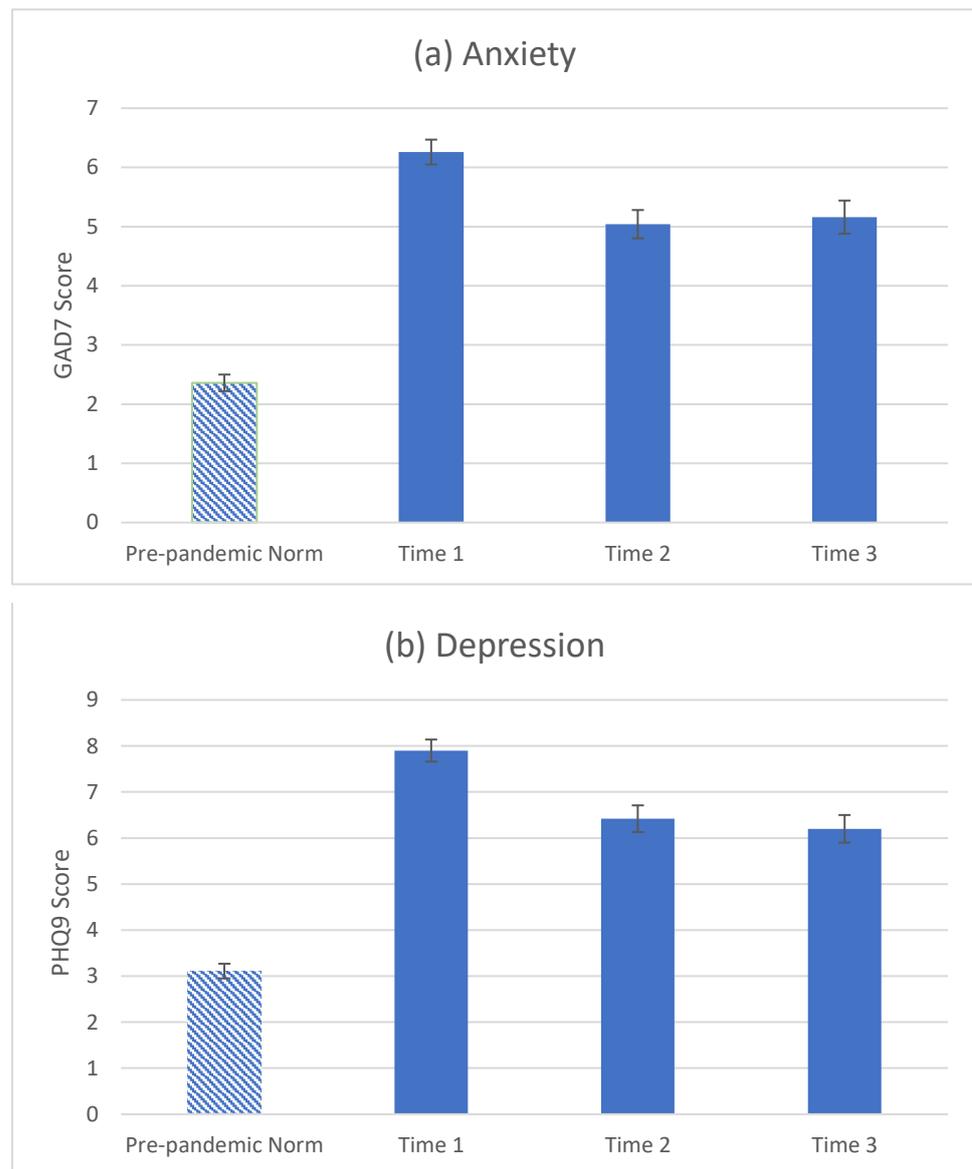
The average levels of depression and anxiety in the whole cohort at each time-point are presented in Figure 2, with comparisons to pre-pandemic population norms [21].

Average depression and anxiety scores in the sample of completers was significantly higher than previously reported NZ population norms from 2018 [21] at all three time-points (all *ps* < 0.001). There were no significant differences in depression or anxiety scores between male and female completers at any time-point (all *ps* > 0.05). However, there was a trend for females to report higher anxiety (*M* = 5.20, *SD* = 4.61), than males at Time 2 (*M* = 3.00, *SD* = 3.24, *p* = 0.054).

Both depression ( $F_{(2,519)} = 13.82$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.05$ ) and anxiety ( $F_{(2,511)} = 11.08$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.04$ ) showed significant changes over time, with large effect sizes. Time 1 square-root transformed depression scores (*M* = 2.49, *SD* = 1.31) were significantly higher than scores at Time 2 (*M* = 2.24, *SD* = 1.19,  $p < 0.001$ ) and Time 3 (*M* = 2.20, *SD* = 1.20,  $p < 0.001$ ). Depression scores at Time 2 and Time 3 did not significantly differ from each other ( $p > 0.999$ ). Similar results were found for anxiety; Time 1 square-root transformed anxiety scores (*M* = 2.18, *SD* = 1.24) were significantly higher than Time 2 (*M* = 1.96, *SD* = 1.14,  $p < 0.001$ ) and Time 3 (*M* = 1.93, *SD* = 1.21,  $p < 0.001$ ). Anxiety scores at Time 2 and Time 3 did not significantly differ ( $p > 0.999$ ).

#### 4.3. Risk Factors for Depression and Anxiety

The multivariable linear regression analyses showed that almost half of the variance in depression ( $F_{(26,176)} = 6.05$ ,  $p < 0.001$ ,  $R^2 = 0.47$ ) and anxiety ( $F_{(26,176)} = 4.83$ ,  $p < 0.001$ ,  $R^2 = 0.42$ ) at Time 3 were explained by the examined predictors (see Table 2). Being younger, having a history of prior mental health disorder(s), experiencing more negative life events due to the pandemic, having lower positive mood at Time 1, and being a pet owner, were independently and significantly associated with greater depression and anxiety scores at Time 3.



**Figure 2.** Mean scores for anxiety (a) and depression (b) scores at all three time-points, with comparison to pre-pandemic normative data from a nationally representative sample from New Zealand (2018,  $n = 1296$ ). Bars are mean scores at Time 1 ( $n = 681$ ), Time 2 ( $n = 375$ ), and Time 3 ( $n = 328$ ). Error bars represent standard errors.

**Table 2.** Regression Analysis Summaries Showing Associations between Sociodemographic Factors, Psychological Factors and Health Behaviours at Time 1, and Depression and Anxiety at Time 3.

Predictor	PHQ-9 <sup>a</sup>				GAD-7 <sup>a</sup>			
	B	95% CI	Standardised Beta	p-Value	B	95% CI	Standardised Beta	p-Value
Age (per year)	−0.01	[−0.02, −0.00]	−0.17	<b>0.023 *</b>	−0.02	[−0.03, −0.01]	−0.27	<b>&lt;0.001 **</b>
Female (yes/no)	0.20	[−0.35, 0.74]	0.04	0.476	0.27	[−0.31, 0.84]	0.06	0.359
BAME background (yes/no)	−0.22	[−0.66, 0.21]	−0.06	0.316	−0.11	[−0.57, 0.35]	−0.03	0.632
Keyworker (yes/no)	0.10	[−0.19, 0.40]	0.04	0.498	−0.01	[−0.32, 0.30]	−0.01	0.953
Prior mental health disorder (yes/no)	0.53	[0.23, 0.84]	0.22	<b>&lt;0.001 **</b>	0.56	[0.24, 0.89]	0.23	<b>&lt;0.001 **</b>
Living alone (yes/no)	−0.04	[−0.48, 0.41]	−0.01	0.875	0.14	[−0.33, 0.61]	0.04	0.550
COVID-19 risk group <sup>b</sup>								
Most at risk	0.26	[−0.24, 0.75]	0.06	0.308	0.11	[−0.41, 0.64]	0.03	0.668
Increased risk	0.02	[−0.43, 0.46]	0.05	0.943	0.25	[−0.22, 0.73]	0.07	0.288

Table 2. Cont.

Predictor	PHQ-9 <sup>a</sup>				GAD-7 <sup>a</sup>			
	B	95% CI	Standardised Beta	p-Value	B	95% CI	Standardised Beta	p-Value
Positive life events (per unit)	−0.19	[−0.46, 0.07]	−0.09	0.146	−0.23	[−0.51, 0.05]	−0.10	0.104
Negative life events (per unit)	0.31	[0.13, 0.50]	<b>0.21</b>	<b>&lt;0.001</b> **	0.29	[0.09, 0.48]	0.19	<b>0.004</b> *
Perceived loneliness (per unit)	0.06	[−0.01, 0.12]	0.12	0.104	0.03	[−0.04, 0.10]	0.06	0.431
SPANE-P (per unit)	−0.05	[−0.09, −0.02]	<b>−0.23</b>	<b>0.004</b> *	−0.05	[−0.09, −0.02]	−0.23	<b>0.005</b> *
Perceived risk of COVID-19 (per unit)	0.03	[−0.06, 0.12]	0.04	0.502	−0.01	[−0.10, 0.08]	−0.01	0.836
COVID-19 worry <sup>c</sup>								
No worry	0.04	[−0.26, 0.34]	0.02	0.792	−0.14	[−0.46, 0.17]	−0.06	0.374
Much worry	−0.33	[−0.93, 0.27]	−0.07	0.279	−0.15	[−0.78, 0.49]	−0.03	0.649
Most worry	0.33	[−0.71, 1.37]	0.04	0.527	0.36	[−0.74, 1.46]	0.04	0.520
Pet ownership (yes/no)	0.43	[0.15, 0.71]	0.18	<b>0.003</b> *	0.39	[0.10, 0.69]	0.16	<b>0.009</b> *
Smoker (yes/no)	−0.02	[−0.66, 0.62]	−0.01	0.947	0.31	[−0.37, 0.99]	0.06	0.365
Exercise frequency <sup>d</sup>								
Almost every day	−0.29	[−1.01, 0.43]	−0.12	0.430	0.30	[−0.47, 1.06]	0.12	0.447
2–3 times a week	−0.14	[−0.87, 0.59]	−0.05	0.711	0.24	[−0.54, 1.01]	0.09	0.545
Once a week	−0.39	[−1.22, 0.44]	−0.09	0.354	0.16	[−0.72, 1.04]	0.04	0.715
Less than once a week	−0.12	[−0.91, 0.67]	−0.03	0.766	0.17	[−0.67, 1.01]	0.04	0.692
Alcohol consumption <sup>e</sup>								
Daily	−0.21	[−0.78, 0.36]	−0.05	0.468	−0.16	[−0.76, 0.45]	−0.03	0.614
4–6 times a week	−0.19	[−0.63, 0.24]	−0.06	0.387	0.06	[−0.40, 0.52]	0.02	0.803
1–3 times a week	−0.18	[−0.53, 0.17]	−0.07	0.325	−0.14	[−0.51, 0.23]	−0.06	0.451
Less than once a week	−0.03	[−0.52, 0.45]	−0.01	0.900	−0.24	[−0.75, 0.28]	−0.06	0.366

Note: <sup>a</sup> a square-root transformation was applied to the dependent variables, <sup>b</sup> comparison reference group, “Not at risk,” <sup>c</sup> comparison reference group, “Occasional worry,” <sup>d</sup> comparison reference group, “Never,” <sup>e</sup> comparison reference group, “Never,” PHQ-9 = Patient Health Questionnaire, GAD-7 = Generalised Anxiety Disorder Scale, BAME = Black, Asian and Minority Ethnic, SPANE-P = Scale of Positive and Negative Experience-Positive. Bolded *p*-values denote significance at \* *p* < 0.05, \*\* *p* < 0.001.

## 5. Discussion

This longitudinal cohort study found that levels of anxiety and depression significantly decreased over the first year of the COVID-19 pandemic in NZ. However, anxiety and depression were significantly higher throughout the year compared to pre-pandemic NZ data. Significant risk factors for worse depression and anxiety at Time 3 were being younger, a history of a mental health disorder, more negative life events due to the pandemic, and being a pet owner. Positive mood was a protective factor.

These findings support previous longitudinal research that has demonstrated long-term impacts of the pandemic on psychological outcomes [1,15]. However, other studies have shown that mental health outcomes returned to pre-pandemic levels by mid-2020 [25]. In the current study, decreases over time did indicate some evidence of resilience; however, NZ’s border was still closed, travel restrictions remained, and the ongoing fear of another outbreak was present. Many businesses were affected by closures, which likely lead to long term consequences. This indicates that depression and anxiety may not necessarily be related to a country’s actual risk of infection, and psychological support needs to be continued, even for countries low in transmission.

Chronic anxiety and depression can increase the risk of COVID-19 infection [26] and decrease one’s antibody response to the COVID-19 vaccine [27]. It is therefore important to identify, monitor, and provide psychological support to those most at risk of depression and anxiety, to mitigate these effects. Duan and Zhu [28] suggest that training more frontline mental health workers, improving communication between medical and mental health agencies, and putting plans in place for such contingencies may reduce the psychological burden of the pandemic. Digital psychological interventions, through online communication platforms may also provide support.

Poor mental health in younger groups has been consistently reported during the pandemic [5,7,15]. Younger adults may have been disproportionately affected by job instability or income loss, as they are often in expendable working positions, or are students who experienced disruptions to their academic life and financial certainty [1]. Younger adults have an underlying predisposition for mental health conditions [29]. In contrast, older adults have had time to build resilience, and display lower reactivity to stress and better emotional stability [9]. These results demonstrate a need for more psychological support for younger adults during prolonged stressful periods.

Similar to other research [10,15], prior diagnosis of a mental health disorder was a significant risk factor for depression and anxiety. This is echoed in a NZ cross-sectional study from April 2020, which found prior mental health diagnoses were a risk factor for various psychological issues [17]. The removal of face-to-face social support and the transition to remote psychiatric services, may have exacerbated this effect. This highlights the need to provide support to those with prior mental health diagnoses, and incorporate proactive plans into psychiatric care.

As expected, the experience of negative life events due to the pandemic, was also a risk factor. Previous research has demonstrated that loss of income or employment [3,7,9] and other stressful life events, such as change in social circumstances and family illness/death, negatively affect psychological outcomes during the pandemic [11]. The results also demonstrated that higher positive mood was protective, which supports previous research [4,10,15].

Pet ownership predicted higher anxiety and depression at Time 3. This contrasts with previous research demonstrating the protective effects of pet ownership during COVID-19 lockdowns [10,20]. However, Time 3 in this study occurred whilst NZ was in Alert Levels 1 and 2, which allowed almost normal life to occur. It may be that as pet owners returned to work, they had concerns about leaving their pets, who had likely changed routine during lockdown and became more dependent on their owners. Indeed, a longitudinal study conducted in NZ found that 40% of pet owners were concerned about the wellbeing of their pet after lockdown, often due to fear of separation anxiety, loneliness, or boredom [30].

Similar to previous longitudinal studies during the pandemic, this study was limited by high participant drop out [1,14,15]. The sample was not representative of the NZ population, and the higher proportion of women in the sample may have contributed to the lack of gender differences found. The surveys also used self-report questionnaires, and therefore, clinical diagnoses were not able to be made.

These results may be informative for policy makers, who must weigh up the positive protective effects of social restrictions on reduced infections, morbidity, and mortality, against long-lasting negative effects on mental health. Policy makers should consult with youth, family, and mental health professionals to implement changes to support the most vulnerable.

## 6. Conclusions

This longitudinal cohort study demonstrated that the negative effects of the COVID-19 pandemic on depression and anxiety levels reduced over time, yet remained elevated up to 11 months into the pandemic. This is despite the fact that at the time of the last survey, NZ was predominately in Alert Level 1, which is characterised by relative normalcy and low risk of infection. This indicates that psychological support must continue to be provided as long as the pandemic continues to pose a threat. Psychological interventions could be targeted towards those most at risk, including younger adults, people with prior mental health diagnoses, and those who experience negative life events during the pandemic. Further research needs to be conducted to identify the best ways to support these at-risk groups.

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