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ABSTRACT

Objectives The COVID-19 pandemic has caused unprecedented disruption to daily life. This study investigated depression, anxiety and stress in New Zealand (NZ) during the first 10 weeks of the COVID-19 pandemic, and associated psychological and behavioural factors. It also compares the results with a similar cross-sectional study in the UK.

Setting NZ community cohort. Participants N=681 adults (≥18 years) in NZ. The cohort was predominantly female (89%) with a mean age of 42 years (range 18–87). Most (74%) identified as NZ European and almost half (46%) were keyworkers. Most were non-smokers (95%) and 20% identified themselves as having clinical risk factors which would put them at increased or greatest risk of COVID-19.

Main outcome measures Depression, anxiety, stress, positive mood and engagement in health behaviours (smoking, exercise, alcohol consumption).

Results Depression and anxiety significantly exceeded population norms (p<0.0001). Being younger (p=0.0001) and most at risk of COVID-19 (p<0.05) were associated with greater depression, anxiety and stress. Greater positive mood, lower loneliness and greater exercise were protective factors for all outcomes (p<0.0001). Smoking (p=0.037) and alcohol consumption (p=0.05) were associated with increased anxiety. Pet ownership was associated with lower depression (p=0.006) and anxiety (p=0.008). When adjusting for age and gender differences, anxiety (p=0.002) and stress (p=0.007) were significantly lower in NZ than in the UK. The NZ sample reported lower perceived risk (p=0.0001) and worry about COVID-19 (p<0.0001) than the UK sample.

Conclusions The NZ population had higher depression and anxiety compared with population norms. Younger people and those most at risk of COVID-19 reported poorer mental health. Interventions should promote frequent exercise, and reduce loneliness and unhealthy behaviours.

INTRODUCTION

In 2020 the COVID-19 pandemic, caused by SARS-CoV-2, disrupted normal ways of living, globally. COVID-19 was first reported in December 2019 in Wuhan city, China. By late January 2020, the WHO had acknowledged it as a public health emergency of international concern. Australia’s Department of Health confirmed their first COVID-19 case on 25 January and New Zealand’s (NZ’s) Ministry of Health on 28 February. By early July, COVID-19 had infected over 10 million people and caused more than 500 000 mortalities worldwide.

Although a pandemic was declared, the extent and timeliness of public health and containment efforts differed across countries. Efforts included closing international borders, restricting domestic travel, introducing mandatory self-isolation for at-risk and symptomatic individuals, social distancing and wearing face masks in public areas. NZ also introduced their now famous ‘bubble’ system, which restricted interaction to within households. Due to a fast response, NZ was able to control and contain the pandemic quickly, resulting in a total of 1528 cases and 22 deaths (0.00045% of the population) by
early July, compared with the UK’s 311965 cases and 43575 deaths (0.065% of the population) during the same period.

A growing body of evidence documents clear clinical impacts of the COVID-19 pandemic. A systematic review of 19 studies conducted in Italy, Turkey, China, Spain, USA, Denmark, Nepal and Iran explored the impact of the pandemic on the mental health of the general public. This uncovered differing and often elevated rates of depression (14.6%–48.3%), anxiety (6.33%–50.9%) and stress (8.1%–81.9%). Additionally, risk factors for psychological distress included being female, a student, unemployed, younger than 40 years or having a chronic illness. Evidence also shows disproportionate clinical impacts of the pandemic on other specific groups, such as older adults. Additionally, research in the USA and the UK also demonstrates that people from black, Asian and minority ethnic groups are more likely to be affected. According to data collected during the pandemic, key/essential workers, especially health care workers were not only more at risk of contracting the virus, but also of increased anxiety and depression. A study by Liu et al in China reported the prevalence of depression and anxiety in medical staff to be over 50% and 40%, respectively.

The pandemic and related containment efforts also introduced a multitude of additional stressors to populations, beyond bereavement and fear of infection. Changes such as wearing face masks, ceased interpersonal interaction through social distancing, loss of income and lockdowns have also been reported to impact mental health. Other possible stressors may include redundancies, border closures, changed events (eg, funerals and weddings) and significant changes in the working hours of the employed. In many countries like NZ and the UK, which enforced a lockdown, changes to daily living also included homeschooling and working remotely.

The effects of these stresses on the well-being of NZ and similar populations remains unknown, but are expected to pose a profound threat to psychological health. Research on the general population in China during 'significant emergency' status of the pandemic indicated moderate or high psychological symptoms of phobic anxiety, obsessive compulsion, psychoticism and interpersonal sensitivity in more than 70% of participants. Another study with 1738 responses across 19 Chinese cities reported population mean scores indicating symptoms of post-traumatic stress disorder. Additionally, 28.8% of the sample met the threshold for moderate-to-severe anxiety. These scores persisted when measured four weeks later. Research from the severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome pandemics can also be drawn on to identify possible consequences. These show that isolation and quarantine may cause depression and anxiety, with symptoms such as anger presenting after only two weeks. It is important to explore whether these impacts are also replicated in other countries.

The primary aim of the present study was to investigate levels of stress, anxiety and depression in NZ, and the psychological and behavioural factors associated with them. A secondary aim was to compare these results with the UK population. This was possible as the researchers from the UK and NZ study teams collaborated on the design of the research. We hypothesised that stress, depression and anxiety levels would be negatively affected during the first 10 weeks of social distancing, during the COVID-19 pandemic.

METHODS
Study design and recruitment
Recruitment began on 8 May 2020 and ended 30 days later, on 6 June. Participants were recruited via a mainstream and social media campaign that advertised a link to the study website. Advice was sought from Māori health advisors, and the study was advertised to as wide a network as possible to help reduce potential recruitment bias. Specifically, this included digital media, radio and social media (Facebook, Twitter and Instagram). Local district health boards, regional and city councils and various other organisations (universities, general practices and student and community groups representing older adults and ethnic minority groups) also shared the website with their networks. The website (www.covidstressstudy.com) contained the participant information sheet and the link to the online survey (content described under procedures and measures).

To be eligible to participate, individuals had to be over 18 years old, able to give informed consent, able to read English and reside in NZ. Participants gave their informed consent on the survey after reading an information sheet and consent form.

Patient and public involvement
This study used the same survey questions as the UK study by Jia et al with the exception of additional questions on health behaviours. The design of the study, clarity of language in the participant information sheet and overall recruitment strategy were determined during a virtual patient and public involvement group on Microsoft Teams. The public were also involved in the recruitment strategy, by sharing the study with their networks and communities. Likewise, the NZ and UK research teams have been providing feedback to the public via the study website and the study social media pages (Twitter and Facebook).

Sample size
No upper limit was placed on the number of participants as the aim of the study was to explore the mental health status of the NZ population during the first 10 weeks of the pandemic with enough power to make comparisons between subgroups. A power calculation showed that 252 participants would be sufficient to detect an $R^2$ value of 0.1 with 90% power and an $\alpha$ of 0.05.
Procedures and measures
Participants completed an online survey implemented through Qualtrics. This contained the consent form, questions on demographic information and validated measures capturing mental health outcomes. Anxiety was assessed using the Spitzer et al.21 7-item Generalized Anxiety Disorder (GAD-7) Scale. The 9-item Patient Health Questionnaire (PHQ-9) provided an index for depression and the 4-item Perceived Stress Scale (PSS-4) measured stress.22 23 These measures are widely used, validated and have good internal reliability: anxiety (α=0.88), depression (α=0.92) and stress (α=0.76).21 23 Scale reliability in our sample was strong and consistent with that in literature: anxiety (α=0.92), depression (α=0.91) and stress (α=0.77).

Other modifiable and non-modifiable variables that could be directly related to these mental health outcomes or associated with increased risk of contracting COVID-19 were also measured. Non-modifiable variables included age, gender, ethnicity, keyworker status, living alone and risk of poor health consequences (ie, hospitalisation or mortality) due to COVID-19 (due to health issues). Modifiable factors included positive mood Scale of Positive and Negative Experience - Positive Feelings (SPANE-P) by Diener et al.,24 worry about contracting COVID-19, perceived loneliness, perceived risk of contracting COVID-19, owning a pet and health behaviours: smoking status and the frequency of exercise and alcohol consumption. More information about the measures is presented in online supplemental appendix 1. The same questions were used in the UK study for all variables except those pertaining to pet ownership and health behaviours.

Statistical analysis
Analyses were conducted in IBM SPSS V.26. Statistical significance was defined as p<0.05.

Participant characteristics and outcome variables (depression, anxiety and stress scores) were first presented as descriptive statistics, using means and SD. Comparisons were made to established norms for the whole sample and subgroups based on age and gender using one-sample t-tests. Normality was assessed using histograms and scatterplots.

Univariable linear regressions were generated to explore the associations between the modifiable and non-modifiable variables and the outcomes. Multivariable linear regressions then explored the independent relationships of the non-modifiable variables on mental health outcomes. COVID-19 risk status (most at risk and at increased risk) was treated as a categorical variable in all models, with ‘neither category’ treated as the reference. Modifiable variables were then added in subsequent models, to explore the additional and independent contribution of these factors. Worry about COVID-19 was treated as a categorical variable in all models, with ‘occasional worry’ treated as the reference. Smoking status, gender and keyworker status were treated as binary variables in the regressions.

Assumptions of linear regression and the presence of outliers were assessed graphically and variance inflation factors provided no evidence of multicollinearity between variables. Square root transformations were applied to depression and anxiety scores, to satisfy assumptions of normality and homoscedasticity of residuals and linearity with continuous variables. Twenty-four participants were not represented in the final multivariable model for perceived risk of COVID-19, as this question was not asked to participants who thought they had COVID-19 or were tested for it.

Depression and anxiety scores were also categorised according to established cut-offs indicating severity of symptoms (scores of >10 indicate moderate or severe levels). One-sample t-tests were generated to compare mean levels of depression, anxiety, stress and perceived risk of COVID-19 in NZ and a UK sample recruited during the COVID-19 pandemic using the same measures, including age and gender subgroups.20 Age-adjusted and gender-adjusted linear regressions were performed for depression, anxiety and stress scores, to account for differences between the NZ and UK populations (online supplemental appendix 2). χ² Tests were also generated to investigate differences in worry about COVID-19, between the two samples.

RESULTS
Participant characteristics
Fifty-nine per cent (n=1846) of visitors to the study website came through direct access, such as via the website URL or by clicking a URL linked in an email. A further 828 visits (26%) came through Facebook, 124 (4%) came from Instagram and 26 (1%) came through Twitter. Ten per cent (n=508) came from other websites, linked to the study web page.

A total of 789 individuals were recruited. The survey was completed in full by 86% of those who started it. This meant that there was missing data for 108 people. Consequently, these 108 were excluded from the analyses, leaving 681 study participants.

Table 1 summarises the main characteristics of the participants and reveals that our sample was predominantly female and aged between 18 years and 87 years, with a mean age of 42 years (SD=16). Participants resided across NZ and included representation from both the North and the South Islands. Most (74%) identified as NZ European and 26.1% came from ethnic minority groups or identified as ‘other’. Almost half (46%) were keyworkers. Most (85%) lived with others and were non-smokers (95%). More than half (57%) owned a pet, and 20% identified themselves as having clinical risk factors which would put them at increased or greatest risk of COVID-19.

The NZ sample were slightly older than the general NZ population. In the NZ sample, the median age of participants was 40 years, compared with 37.4 years of the general population (Statistics New Zealand, 2019). Men
### Table 1  Participant demographics (n=681)

| Participants | n (%) |
|--------------|-------|
| **Gender**   |       |
| Male         | 68 (10.0%) |
| Female       | 608 (89.3%) |
| Other        | 4 (0.6%) |
| Prefer not to say | 1 (0.1%) |
| **Age groups (years)** |       |
| 18–24        | 114 (16.7%) |
| 25–34        | 173 (25.4%) |
| 35–44        | 100 (14.7%) |
| 45–54        | 124 (18.2%) |
| 55–64        | 102 (15.0%) |
| 65–74        | 47 (6.9%) |
| ≥75          | 21 (3.1%) |
| **Ethnicity** |       |
| New Zealand/European | 503 (73.9%) |
| Māori        | 14 (2.1%) |
| Samoan       | 5 (0.7%) |
| Cook Island Māori | 1 (0.1%) |
| Chinese      | 19 (2.8%) |
| Indian       | 20 (2.9%) |
| Other        | 119 (17.5%) |
| **Relationship status** |       |
| Single, never married | 155 (22.8%) |
| Single, divorced or widowed | 66 (9.7%) |
| In a relationship/married but living apart | 47 (6.9%) |
| In a relationship/married and cohabiting | 408 (59.9%) |
| Prefer not to say | 5 (0.7%) |
| **Education (highest level of attainment)** |       |
| None         | 6 (0.9%) |
| Seventh grade or lower (primary school) | 4 (0.6%) |
| NCEA levels 1–3 | 134 (19.7%) |
| Levels 5 and 6 diploma | 36 (5.3%) |
| Bachelor's degree | 161 (23.6%) |
| Postgraduate | 311 (45.7%) |
| Other (eg, Wānanga—Iwi) | 29 (4.3%) |
| **Place of residence** |       |
| Northland    | 11 (1.6%) |
| Auckland     | 292 (42.9%) |
| Waikato      | 69 (10.1%) |
| Bay of Plenty/Gisborne | 19 (2.8%) |
| Hawkes Bay   | 22 (3.2%) |
| Taranaki     | 22 (3.2%) |
| Manawhātu-Whanganui | 18 (2.6%) |
| Wellington   | 69 (10.1%) |

| Participants | n (%) |
|--------------|-------|
| **Keyworker status** |       |
| Health, social care or relevant related support worker | 224 (32.9%) |
| Teacher or childcare worker still travelling in to work | 14 (2.1%) |
| Transport worker still travelling in to work | 1 (0.1%) |
| Food chain worker (eg, production, sale, delivery) | 7 (1.0%) |
| Key public services worker (eg, justice staff, public service journalist or mortuary worker) | 7 (1.0%) |
| Local or national government worker delivering essential public services | 16 (2.3%) |
| Utility worker (eg, energy, sewerage, postal service) | 3 (0.4%) |
| Public safety or national security worker | 3 (0.4%) |
| Worker involved in medicines or protective equipment production or distribution | 2 (0.3%) |
| Other ‘keyworker’ role not listed | 33 (4.8%) |
| Not a keyworker | 371 (54.5%) |
| **Living alone (or with others)** |       |
| Living alone | 72 (10.6%) |
| Living with others | 609 (84.9%) |
| **COVID-19 risk status** |       |
| Most at risk (eg, suffering from advanced cancer, severe asthma/COPD, etc) | 48 (7.0%) |
| At increased risk (eg, being pregnant, aged over 70 years, etc) | 90 (13.2%) |
| Not at risk | 543 (79.7%) |
| **Pet ownership** |       |
| Yes | 389 (57.1%) |
| No | 292 (42.9%) |
| **Health behaviours** |       |
| Smoker | 36 (5.3%) |
| Non-smoker | 645 (94.7%) |
| **Exercise frequency** |       |
| Every day | 295 (43.3%) |
| 2–3 times a week | 212 (31.1%) |
| Once a week | 71 (10.4%) |
| Less than once a week | 68 (10.0%) |
| Never | 35 (5.1%) |
were under-represented in the study (10%), and make up 49% of the general population (Statistics New Zealand, 2019).

The NZ sample overall were younger (M=42 years) than the UK sample (M=44 years) (Jia et al, 2020). This was also reflected in 42% of the NZ sample being younger than 34 years, compared with 29% of the UK sample. More women (89%) and less men (10%) participated in the NZ study compared with the UK sample (85% and 15%, respectively).

### Mental health status in NZ, compared with population norms and a UK cohort

Depression and anxiety in the NZ sample were examined using the categories of the established cut-offs for depression and anxiety in the PHQ-9 and GAD-7 scales (see online supplemental appendix 1). Accordingly, 64% of participants reported symptoms of depression and 53% reported symptoms of anxiety. Thirty-one percent reported moderate-to-severe symptoms of depression, and 24% reported moderate-to-severe symptoms of anxiety.

Depression, anxiety and stress in the NZ cohort were compared with population norms (see table 2). The overall mean values for the depression and anxiety measures were significantly higher than those reported for the general population (Statistics New Zealand, 2019). When adjusting for age and gender differences between the UK and NZ samples, there was no significant difference in depression (p=0.138). However, there was a significant difference between scores for anxiety (p=0.002). Anxiety scores were on average 0.15 lower (95% CI –0.25 to –0.05) in NZ than UK. There was also a significant difference between stress scores (p=0.007). Stress scores were on average 0.36 lower (95% CI –0.63 to –0.10) in NZ than UK.

A $\chi^2$ test was performed to examine the differences in worry about COVID-19 between NZ and the UK (table 3). A greater proportion of people in the UK sample reported worrying about COVID-19 most of the time, much of the time, and occasionally, and a smaller proportion reported never worrying about it compared with the NZ sample, $\chi^2 (3, n=3777) = 163.27$, p<&lt;0.001. The NZ sample also reported lower levels of perceived risk of COVID-19 (M=2.29, SD=1.65) than the UK sample (M=4.75, SD=2.2), t(656) = −38.10, p<&lt;0.0001.

### Individuals most at risk of depression, anxiety and stress

Multivariable models explored the associations between non-modifiable explanatory variables and depression, anxiety and stress (table 4). The outcome variables by gender and age groups are also presented in online supplemental appendix 4. Being younger and being most at risk for COVID-19 were independently significantly associated with greater levels of anxiety. This model accounted for 10% of the variance in depression scores. Being younger and being most at risk for COVID-19 were also independently significantly associated with greater levels of anxiety. This model accounted for 8% of the variance in anxiety scores. For stress, being younger and being most at increased risk for COVID-19 were independently significantly associated with greater levels of anxiety. This model accounted for 9% of the variance in stress scores.

### Mental health status and modifiable variables

Modifiable explanatory variables included loneliness, positive mood, perceived risk of COVID-19 and worry about COVID-19. The cohort’s mean score of loneliness was 3.91 (SD=2.8). The age group 18–24 years reported the highest level of loneliness (M=5.21, SD=2.8), compared with the oldest age group who reported the lowest level (M=1.95, SD=1.4). The mean score of positive mood was 19.97 (SD=5.0). Again, the youngest age group presented the lowest mean score (M=18.48, SD=4.7) and the oldest age group the highest (M=23.9, SD=4.5). The mean score for perceived risk of COVID-19 was 2.29 (SD=1.7). Of the whole cohort, 54% worried about COVID-19 occasionally, 37% never, 7% much of the time and 2% most of the time.

Other modifiable variables included health behaviours (smoking, exercise and alcohol consumption frequency) and pet ownership. A $\chi^2$ test of independence was performed to examine the relation between pet ownership and mental health status.
|                          | PHQ-9 Score | GAD-7 Score | PSS-4 Score |
|--------------------------|-------------|-------------|-------------|
|                          | Participants | Norms      | Participants | Norms      | t            |
| Total score              | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 7.88 (6.4)  | 2.91 (3.5)  | 6.26 (5.4)  | 2.95 (3.4) | 15.98†       |
|                          | 6.31 (3.3)  | 6.11 (3.1)  | 1.58 (p=0.11)|            |
| Gender                   |             |             |             |            |              |
| Male                     | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 7.03 (6.2)  | 2.7 (3.5)   | 5.54 (5.6)  | 2.66 (3.2) | 4.27†        |
|                          | 5.94 (3.5)  | 5.56 (3.0)  | 0.91 (p=0.37)|            |
| Female                   | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 7.94 (6.4)  | 3.1 (3.5)   | 6.32 (5.4)  | 3.20 (3.5) | 14.25†       |
|                          | 6.34 (3.3)  | 6.38 (3.2)  | −0.334 (p=0.74)|            |
| Age groups (years)       |             |             |             |            |              |
| 18–24                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 11.73 (6.7) | ....        | 9.04 (6.0)  | ....        | 8.16 (3.0)   |
| 25–34                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 8.32 (6.1)  | 2.3 (3.2)   | 6.85 (5.5)  | 2.81 (3.3) | 9.72†        |
|                          | 6.65 (3.2)  | ....        | 6.17 (3.5)  | ....        |
| 35–44                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 7.34 (6.5)  | 2.6 (3.5)   | 6.39 (5.6)  | 2.82 (3.3) | 6.42†        |
|                          | 6.17 (3.5)  | ....        | 5.59 (3.1)  | ....        |
| 45–54                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 6.51 (4.9)  | 2.8 (3.5)   | 4.79 (4.3)  | 3.14 (3.4) | 4.27†        |
|                          | 5.65 (3.1)  | ....        | 4.87 (3.2)  | ....        |
| 55–64                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 7.27 (6.2)  | 3.2 (3.5)   | 5.60 (4.9)  | 3.25 (3.6) | 4.84†        |
|                          | 5.59 (3.1)  | ....        | 4.76 (3.1)  | ....        |
| 65–74                    | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 5.21 (5.7)  | 3.3 (3.6)   | 4.00 (4.4)  | 2.79 (3.2) | 1.87 (p=0.07)|
|                          | 4.87 (3.2)  | ....        | 4.76 (3.1)  | ....        |
| ≥75                      | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)  | t            |
|                          | 2.86 (4.3)  | 4.4 (3.9)   | 2.81 (4.2)  | 3.05 (3.4) | −0.26 (p=0.8) |
|                          | 4.76 (3.1)  | ....        | ....        |            |

*p<0.05.
†p<0.0001.
‡Published population normative data for PHQ-9, GAD-7 and PSS-4.
GAD-7, 7-item Generalized Anxiety Disorder; PHQ-9, 9-item Patient Health Questionnaire; PSS-4, 4-item Perceived Stress Scale.
### Table 3

Comparing depression (PHQ-9), anxiety (GAD-7) stress (PSS-4) and worry about COVID-19 in New Zealand (NZ) and the UK during COVID-19 pandemic.

|                     | PHQ-9 Score |                       | GAD-7 Score |                       | PSS-4 Score |                       |
|---------------------|-------------|------------------------|-------------|------------------------|-------------|------------------------|
|                     | NZ          | UK                     | NZ          | UK                     | NZ          | UK                     |
|                     | Mean (SD)   | Mean (SD)              | Mean (SD)   | Mean (SD)              | Mean (SD)   | Mean (SD)              |
| **Total score**     | 7.88 (6.4)  | 7.69 (6.0)             | 6.26 (5.4)  | 6.59 (5.6)             | 6.31 (3.3)  | 6.48 (3.3)             |
| **Gender**          |             |                        |             |                        |             |                        |
| Male                | 7.03 (6.2)  | 6.49 (6.1)             | 5.54 (5.6)  | 5.22 (5.4)             | 5.94 (3.5)  | 5.88 (3.3)             |
| Female              | 7.94 (6.4)  | 7.91 (6.0)             | 6.32 (5.4)  | 6.84 (5.5)             | 6.34 (3.3)  | 6.59 (3.3)             |
| **Age groups (years)** |            |                        |             |                        |             |                        |
| 18–24               | 11.73 (6.7) | 11.24 (6.4)            | 9.04 (6.0)  | 9.02 (6.0)             | 8.16 (3.0)  | 8.13 (3.3)             |
| 25–34               | 8.32 (6.1)  | 8.74 (5.9)             | 6.85 (5.5)  | 7.73 (5.6)             | 6.65 (3.2)  | 6.94 (3.3)             |
| 35–44               | 7.34 (6.5)  | 8.23 (6.0)             | 6.39 (5.6)  | 7.25 (5.7)             | 6.17 (3.5)  | 6.46 (3.2)             |
| 45–54               | 6.51 (4.9)  | 7.32 (5.7)             | 4.79 (4.3)  | 6.28 (5.3)             | 5.65 (3.1)  | 6.16 (3.0)             |
| 55–64               | 7.27 (6.2)  | 6.35 (5.6)             | 5.60 (4.9)  | 5.43 (5.1)             | 5.59 (3.1)  | 5.94 (3.2)             |
| 65–74               | 5.21 (5.7)  | 3.83 (4.3)             | 4.00 (4.4)  | 3.32 (3.8)             | 4.87 (3.2)  | 5.07 (3.0)             |
| ≥75                 | 2.86 (4.3)  | 4.39 (5.8)             | 2.81 (4.2)  | 2.92 (4.4)             | 4.76 (3.1)  | 4.80 (3.0)             |
| **Worry about COVID-19** |         |                        |             |                        |             |                        |
| Never               | 255<sub>a</sub> | 512<sub>b</sub>           |             |                        |             |                        |
| Occasionally        | 370<sub>b</sub> | 2050<sub>a</sub>         |             |                        |             |                        |
| Much                | 45<sub>a</sub> | 413<sub>a</sub>          |             |                        |             |                        |
| Most                | 10<sub>b</sub> | 122<sub>a</sub>          |             |                        |             |                        |

Subscripts a and b indicate significant differences at p<0.05.

* p<0.05.
† p<0.0001.
‡ Published UK population normative data during the COVID-19 pandemic.

GAD-7, 7-item Generalized Anxiety Disorder; PHQ-9, 9-item Patient Health Questionnaire; PSS-4, 4-item Perceived Stress Scale.
ownership and exercise, and pet ownership and loneliness. The relation between pet ownership and exercise was not significant, \( \chi^2 (4, \ n=681)=1.35, \ p=0.854 \). There was also not a significant difference in the loneliness scores for pet ownership; \( t(679)= 0.57, \ p=0.570 \).

Modifiable explanatory variables were added into two multivariable models for depression (table 5). We observed that greater perceived loneliness and lower positive mood were independently and significantly associated with greater levels of depression, in addition to age, gender and being most at risk of contracting COVID-19. The model accounted for 56% of the variance in depression scores.

For modifiable health behaviours, those who owned a pet, or who exercised every day or exercised two to three times a week (compared with never) had significantly lower depression scores. The model accounted for 15% of the variance in depression scores.

Higher levels of perceived loneliness, lower positive mood and worrying about COVID-19 much of the time
Table 5  Regression models showing associations between modifiable explanatory variables and depression scores

| PHQ-9 total score§ | Regression coefficient B | 95% CI lower | 95% CI upper | β | P value |
|--------------------|--------------------------|--------------|--------------|---|---------|
| Loneliness, positive mood, perceived risk and worry | | | | | |
| Age (per decade) | −0.12 | −0.16 | −0.08 | −0.16 | p<0.0001‡ |
| Female | 0.26 | 0.05 | 0.46 | 0.06 | p<0.05* |
| Live alone | −0.02 | −0.23 | 0.20 | −0.00 | 0.88 |
| BAME background | −0.04 | −0.23 | 0.14 | −0.01 | 0.65 |
| Keyworker | −0.03 | −0.16 | 0.10 | −0.01 | 0.64 |
| COVID-19 risk status¶ | | | | | |
| Most at risk | 0.31 | 0.05 | 0.56 | 0.06 | p<0.05* |
| Increased risk | −0.03 | −0.22 | 0.17 | −0.01 | 0.80 |
| Perceived loneliness (per unit) | 0.08 | 0.05 | 0.11 | 0.17 | p<0.0001‡ |
| Positive mood (per unit) | −0.15 | −0.16 | −0.13 | −0.58 | p<0.0001‡ |
| Perceived risk of COVID-19 (per unit) | −0.03 | −0.07 | 0.01 | −0.04 | 0.17 |
| COVID-19 worry** | | | | | |
| Never | 0.05 | −0.09 | 0.19 | 0.02 | 0.46 |
| Much of the time | 0.22 | −0.07 | 0.51 | 0.04 | 0.13 |
| Most of the time | 0.23 | −0.34 | 0.79 | 0.02 | 0.43 |
| Adjusted R²=0.56, n=657 | | | | | |
| Health behaviours | | | | | |
| Age (per decade) | −0.22 | −0.28 | −0.16 | −0.29 | p<0.0001‡ |
| Female | 0.18 | −0.09 | 0.46 | 0.05 | 0.19 |
| Live alone | 0.15 | −0.15 | 0.44 | 0.04 | 0.33 |
| BAME background | −0.20 | −0.46 | 0.06 | −0.06 | 0.13 |
| Keyworker | 0.13 | −0.05 | 0.31 | 0.05 | 0.15 |
| COVID-19 risk status¶ | | | | | |
| Most at risk | 0.27 | −0.08 | 0.62 | 0.06 | 0.13 |
| Increased risk | 0.04 | −0.23 | 0.31 | 0.01 | 0.79 |
| Pet ownership | −0.25 | −0.43 | −0.07 | −0.10 | p<0.01† |
| Smoker (yes/no) | 0.36 | −0.04 | 0.77 | 0.07 | 0.08 |
| Exercise†† | | | | | |
| Every day | −0.82 | −1.24 | −0.41 | −0.33 | p<0.0001‡ |
| 2–3 times a week | −0.73 | −1.15 | −0.31 | −0.27 | p<0.01† |
| Once a week | −0.33 | −0.81 | 0.14 | −0.08 | 0.17 |

Continued
were independently and significantly associated with greater levels of anxiety, in addition to age and gender (Table 6). Never worrying about COVID-19 was associated with lower levels of anxiety. The model accounted for approximately 54% of the variance in anxiety scores.

For modifiable health behaviours, smoking, consuming alcohol less than once a week, and consuming alcohol four to six times a week (compared with never) were independently and significantly associated with greater levels of anxiety, in addition to age. Those who owned a pet, and those who exercised every day, two to three times a week or once a week, compared with those who never exercised had significantly lower levels of anxiety. The model accounted for 13% of the variance in anxiety scores.

Higher levels of perceived loneliness, lower positive mood and greater perceived risk of COVID-19 were independently and significantly associated with higher levels of stress, in addition to age, gender and being most or at increased risk of contracting COVID-19 (Table 7). The model accounted for 58% of the variance in stress scores. For health behaviours, exercising every day, two to three times a week, once a week and less than once a week compared with no exercise were independently and significantly associated with lower levels of stress, in addition to age and being a keyworker. The model accounted for 13% of the variance in stress scores.

Table 1 in online supplemental appendix 5 presents the same regression models with the psychological predictors, but excluding perceived risk of COVID-19. This model accounted for 13% of the variance in stress scores.

DISCUSSION

The effects of the COVID-19 pandemic and social distancing on the general population are expected to pose a profound threat to psychological health. The findings of the present study build on existing literature exploring the impacts on mental health status, especially depression, anxiety and stress. To our knowledge, this is the first study that explores the mental well-being of the NZ population, during the COVID-19 pandemic. It uses a similar design to the research recently published by Jia et al. [20] from the UK to enable for comparisons to be made, but builds on this by also considering the associations of behaviours (smoking, exercise and alcohol consumption) and pet ownership on mental health during the pandemic.

As hypothesised, depression and anxiety were negatively affected during the first 10 weeks of social distancing, during the COVID-19 pandemic. This was consistent with the anticipated findings in the NZ population during the COVID-19 pandemic. Unsurprisingly, those at higher risk for COVID-19 were more likely to experience poorer mental health status.

| PHQ-9 total score§ | Regression coefficient B | 95% CI lower | 95% CI upper | β | P value |
|--------------------|----------------------------|-------------|-------------|----|---------|
| Less than once a week | -0.21                      | -0.68       | 0.27        | -0.05 | 0.40 |
| Alcohol consumption‡‡ | Daily                      | 0.15        | -0.19       | 0.49 | 0.04 | 0.39 |
|                     | 4–6 times a week           | 0.00        | -0.29       | 0.30 | 0.00 | 0.98 |
|                     | 1–3 times a week           | -0.01       | -0.24       | 0.22 | -0.00 | 0.93 |
|                     | Less than once a week      | 0.23        | -0.05       | 0.51 | 0.07 | 0.11 |

Adjusted $R^2=0.15$, n=681

*p<0.05.
†p<0.01.
‡p<0.0001.
§Square root of total score.
ǁComparison reference group: ‘never’.
‡Comparison reference group: ‘occasionally worry about getting COVID-19’.
††Comparison reference group: never consume alcohol.
BAME, black, Asian and minority ethnic; PHQ-9, 9-item Patient Health Questionnaire.

Table 5 Continued
Table 6  Regression models showing associations between modifiable explanatory variables and anxiety scores

| GAD-7 total score§ | Regression coefficient B | 95% CI lower | 95% CI upper | β  | P value |
|---------------------|--------------------------|--------------|--------------|----|---------|
| Loneliness, positive mood, perceived risk and worry | | | | | |
| Age (per decade) | −0.10 | −0.14 | −0.06 | −0.14 | p<0.0001‡ |
| Female | 0.23 | 0.03 | 0.43 | 0.06 | p<0.05* |
| Live alone | −0.03 | −0.25 | 0.18 | −0.01 | 0.75 |
| BAME background | −0.00 | −0.18 | 0.18 | −0.00 | 0.97 |
| Keyworker | −0.06 | −0.19 | 0.07 | −0.03 | 0.34 |
| COVID-19 risk status§ | | | | | |
| Most at risk | 0.21 | −0.04 | 0.46 | 0.05 | 0.10 |
| Increased risk | 0.07 | −0.12 | 0.27 | 0.02 | 0.48 |
| Perceived loneliness (per unit) | 0.07 | 0.05 | 0.10 | 0.17 | p<0.0001‡ |
| Positive mood (per unit) | −0.13 | −0.15 | −0.12 | −0.55 | p<0.0001‡ |
| Perceived risk of COVID-19 (per unit) | −0.01 | −0.06 | 0.03 | −0.02 | 0.52 |
| COVID-19 worry** | | | | | |
| Never | −0.19 | −0.32 | −0.05 | −0.07 | p<0.01† |
| Much of the time | 0.42 | 0.13 | 0.70 | 0.08 | p<0.01† |
| Most of the time | 0.27 | −0.29 | 0.82 | 0.03 | 0.35 |
| Adjusted R²=0.54, n=657 | | | | | |
| Health behaviours | | | | | |
| Age (per decade) | −0.21 | −0.27 | −0.15 | −0.29 | p<0.0001‡ |
| Female | 0.25 | −0.03 | 0.52 | 0.07 | 0.08 |
| Live alone | 0.12 | −0.16 | 0.41 | 0.03 | 0.39 |
| BAME background | −0.09 | −0.34 | 0.16 | −0.03 | 0.48 |
| Keyworker | 0.08 | −0.09 | 0.26 | 0.04 | 0.35 |
| COVID-19 risk status¶ | | | | | |
| Most at risk | 0.29 | −0.06 | 0.63 | 0.06 | 0.11 |
| Increased risk | 0.19 | −0.08 | 0.46 | 0.05 | 0.16 |
| Pet ownership | −0.24 | −0.42 | −0.06 | −0.10 | p<0.01† |
| Smoker (yes/no) | 0.42 | 0.03 | 0.81 | 0.08 | p<0.05* |
| Exercise†† | | | | | |
| Every day | −0.83 | −1.24 | −0.42 | −0.34 | p<0.0001‡ |
| 2–3 times a week | −0.73 | −1.14 | −0.31 | −0.28 | p<0.01† |
| Once a week | −0.66 | −1.13 | −0.20 | −0.17 | p<0.01† |

Continued
disproportionately affected and more likely to report greater levels of anxiety, stress and depression. Some research from China and the Philippines explains why younger people may have been more impacted during the COVID-19 pandemic, highlighting that they were more likely to be students and that student status was a risk factor for anxiety, depression and stress.28 29 Many students experienced academic delays and significant changes to daily routine during the pandemic.30 Other research highlights that younger populations tend to generally have worse mental health outcomes.31–33 Common stressors that cause poor mental health in young adults include exams and study, paying rent, affording a house, pressure to succeed, career prospects, job instability, appearance and lower finances and living security.34 35 Older adults may have more experience with these stressors, so may be more resilient to them. The pandemic and social distancing regulations may have further exacerbated stress in younger populations, by causing unemployment and financial problems, limiting social interaction and support, and requiring students to study remotely while experiencing academic uncertainty.

Poor mental health status was also associated with worry and heightened perceptions of risk of COVID-19. In the NZ cohort, worry about COVID-19 was associated with anxiety, and perceived risk of COVID-19 was associated with stress. Greater positive mood and lower perceived loneliness were protective factors for all outcomes. Previous literature has reinforced that the effects of positive mood are independent of negative mood.36 37 This means that individuals can be depressed or worried, but still report positive mood. However, the NZ sample demonstrated that positive mood protected against perceived loneliness was a protective factor, as social capital significantly impacts well-being, stress, depression, quality of life, coping and health-promoting behaviours.48 Similarly, a literature review by Leigh-Hunt et al. found that social isolation and loneliness are associated with worse health outcomes. Research from the SARS and Middle East respiratory syndrome pandemics have found similar results, whereby severe isolation and quarantine caused significant mental health problems, including depression and anxiety.17 18 It is possible that social isolation due to social distancing regulations during the COVID-19 pandemic may have amplified feelings of loneliness.

The present study builds on that by Jia et al.20 by highlighting that smoking and alcohol consumption were associated with poor mental health during the COVID-19 pandemic, and that these behaviors are associated with worse physical health outcomes. It has been widely documented that people with poor mental health are more likely to engage in unhealthy behaviors such as smoking and frequent alcohol consumption.49 Unhealthy behaviors may be used as a coping mechanism to temporarily alleviate psychological distress.

### Table 6

| GAD-7 total score§ | Regression coefficient B | 95% CI lower | 95% CI upper | β | P value |
|--------------------|--------------------------|--------------|--------------|---|---------|
| Less than once a week | −0.39 | −0.86 | 0.07 | −0.10 | 0.10 |
| Alcohol consumption‡‡ | Daily | 0.24 | −0.10 | 0.57 | 0.06 | 0.16 |
| 4–6 times a week | 0.34 | 0.05 | 0.63 | 0.10 | p<0.05* |
| 1–3 times a week | 0.16 | −0.06 | 0.38 | 0.06 | 0.16 |
| Less than once a week | 0.31 | 0.04 | 0.58 | 0.09 | p<0.05* |

Adjusted $R^2=0.13$, n=681

*p<0.05.
†p<0.01.
‡p<0.0001.
§Square root of total score.
*Comparison reference group: neither category.
**Comparison reference group: ‘I occasionally worry about getting COVID-19’.
††Comparison reference group: ‘I frequently worry about getting COVID-19’.
‡‡Comparison reference group: never consume alcohol.
BAME, black, Asian and minority ethnic; GAD-7, 7-Item Generalized Anxiety Disorder.
### Table 7  Regression models showing associations between modifiable explanatory variables and stress scores

| PSS-4 total score | Regression coefficient B | 95% CI lower | 95% CI upper | β | P value |
|-------------------|--------------------------|--------------|--------------|---|---------|
| Loneliness, positive mood, perceived risk and worry | | | | | |
| Age (per decade) | −0.28 | −0.39 | −0.17 | −0.14 | p<0.0001§ |
| Female | 0.71 | 0.18 | 1.24 | 0.07 | p<0.01† |
| Live alone | 0.34 | −0.21 | 0.90 | 0.03 | 0.23 |
| BAME background | 0.43 | −0.05 | 0.90 | 0.05 | 0.08 |
| Keyworker | 0.22 | −0.12 | 0.56 | 0.03 | 0.21 |
| COVID-19 risk status¶ | | | | | |
| Most at risk | 0.69 | 0.03 | 1.36 | 0.05 | p<0.05* |
| Increased risk | 0.53 | 0.01 | 1.04 | 0.15 | p<0.05* |
| Perceived loneliness (per unit) | 0.18 | 0.11 | 0.25 | −0.61 | p<0.0001§ |
| Positive mood (per unit) | −0.40 | −0.44 | −0.36 | −0.61 | p<0.0001§ |
| Perceived risk of COVID-19 (per unit) | 0.12 | 0.01 | 0.23 | 0.06 | p<0.05* |
| COVID-19 worry** | | | | | |
| Never | 0.22 | −0.15 | 0.58 | 0.03 | 0.24 |
| Much of the time | 0.06 | −0.69 | 0.81 | 0.01 | 0.87 |
| Most of the time | 0.49 | −0.97 | 1.95 | 0.02 | 0.51 |
| Adjusted R²=0.58, n=657 |
| Health behaviours | | | | | |
| Age (per decade) | −0.57 | −0.74 | −0.41 | −0.28 | p<0.0001§ |
| Female | 0.52 | −0.22 | 1.25 | 0.05 | 0.17 |
| Live alone | 0.65 | −0.13 | 1.42 | 0.06 | 0.10 |
| BAME background | −0.07 | −0.76 | 0.61 | −0.01 | 0.84 |
| Keyworker | 0.51 | 0.03 | 0.99 | 0.08 | p<0.05* |
| COVID-19 risk status¶ | | | | | |
| Most at risk | 0.83 | −0.10 | 1.77 | 0.07 | 0.08 |
| Increased risk | 0.66 | −0.07 | 1.38 | 0.07 | 0.08 |
| Pet ownership | −0.39 | −0.88 | 0.09 | −0.06 | 0.11 |
| Smoker (yes/no) | 0.65 | −0.42 | 1.72 | 0.04 | 0.23 |
| Exercise†† | | | | | |
| Every day | −2.76 | −3.87 | −1.65 | −0.42 | p<0.0001§ |
| 2–3 times a week | −2.59 | −3.71 | −1.47 | −0.36 | p<0.0001§ |
| Once a week | −1.72 | −2.99 | 0.45 | −0.16 | p<0.01† |

Continued
Healthy behaviours such as exercise and pet ownership were found to be protective factors for poorer mental health during the first 10 weeks of the pandemic. It was expected that individuals who own a pet (e.g., dog) may be more likely to exercise, but no correlation was found between these variables. Participants may have owned animals that do not require exercising (e.g., cats, rabbits or fish). The benefits of exercise, as well as animal companionship, are well documented in the literature on mental health. Exercise is known to improve cerebral blood flow, sleep, mental alertness, self-esteem and energy, and prevent social withdrawal. It may also provide a distraction to daily challenges. Studies on animal contact have also reinforced the positive impacts on mood and physiological responses such as reductions in cortisol, blood pressure and heart rate. Indeed, pets may have also provided a welcome distraction and companionship during the pandemic, even though loneliness was not lower in pet owners.

Population-based interventions during the remainder of the COVID-19 pandemic and future pandemics should promote exercise and positive mood and target loneliness, and excessive alcohol and tobacco consumption. While pet ownership was also a protective factor, it is impractical to promote purchasing pets. Upstream approaches should include targeting the consequences of social isolation, such as loneliness. Maguire and Looi51 support the need to target loneliness, stating that more targeted strategies to combat boredom and loneliness during the COVID-19 pandemic (especially when socially isolating) are required for people, especially when socially isolating, such as scholars, for people with mental health needs, such as those with schizophrenia. Accordingly, psychosocial approaches should be leveraged in social media to disseminate messages of support, and to promote healthy behaviors. This may also help to mitigate the impacts of social isolation. Other interventions that may be effective in reducing anxiety and stress are targeted public health approaches, such as leveraging in remote areas of the population to combat boredom and loneliness during the COVID-19 pandemic include cognitive behavioral therapy, which can be made available online or over smartphones. When adjusting for age and gender differences, anxiety and stress were significantly lower in the UK sample compared with the NZ sample. However, the overall mean scores for depression were not significantly different between the two samples. Due to the cross-sectional nature of the study, caution must be exercised when firmly concluding that the sample in the UK had significantly lower anxiety and stress than the sample in NZ. Worry about COVID-19 and related mortality-force may have resulted in the UK sample feeling more anxious than the NZ sample, which can be made available online or over smartphones.

Table 7

| PSS-4 total score | Regression coefficient B | 95% CI lower | 95% CI upper | β | P value |
|-------------------|--------------------------|--------------|--------------|---|---------|
| Less than once a week | −1.70                    | −2.97        | −0.43        | −0.16 | p<0.01† |
| Alcohol consumption‡‡ | Daily                     | 0.25         | −0.65        | 1.16 | 0.02    | 0.59 |
|                   | 4–6 times a week          | 0.04         | −0.75        | 0.83 | 0.00    | 0.93 |
|                   | 1–3 times a week          | −0.27        | −0.87        | 0.33 | −0.04   | 0.38 |
|                   | Less than once a week     | 0.15         | −0.60        | 0.89 | 0.02    | 0.70 |

Adjusted R²=0.13, n=681

*p<0.05.
†p<0.01.
‡p<0.001.
§p<0.0001.
Comparison reference group: neither category.
Comparison reference group: ‘I occasionally worry about getting COVID-19’.
Comparison reference group: ‘I occasionally worry about getting COVID-19’.
Comparison reference group: never consume alcohol.
BAME, black, Asian and minority ethnic; PSS-4, 4-item Perceived Stress Scale.
COVID-19 pandemic caused the mental health status reflected in the data. The nature of the study also means we cannot comment on causal associations or be certain of the direction of the relationships (eg, lower positive mood may lead to greater depression and vice versa). More longitudinal research is required to fully explore the ongoing impacts of COVID-19. The sample consisted of a relatively small proportion of the total NZ population, and therefore may not be representative. The sample was predominantly female (89%), and only 2.1% identified as Māori, compared with 16.5% of the total NZ population.54 The online delivery of the survey may have introduced selection bias. The survey also featured self-reported (although validated) questionnaires to measure psychiatric symptoms and did not make clinical diagnoses. The gold standard for establishing psychiatric diagnoses involves structured clinical interview and functional neuroimaging.55–57 Response bias may have also been evident, whereby individuals who were more anxious, stressed and perceived to be impacted by the pandemic may have been more likely to participate. This could result in worse mental well-being reflected in the data. These factors may limit the generalisability of the results. Research that includes stress hormones (ie, cortisol) is also required to measure biological correlates of stress.

The cross-sectional method allowed for multiple modifiable and non-modifiable variables to be explored, as well as their associations with validated measures for depression, anxiety, stress and positive mood. A significant strength of the study included using a similar design and survey to the study by Jia et al80 conducted on a UK cohort during the COVID-19 pandemic. This allowed for accurate comparisons to be made.

CONCLUSION

This study explored the mental health status of a NZ population during the first 10 weeks of the COVID-19 pandemic. As the first study to explore mental well-being in this population during the pandemic, the findings add to a body of knowledge on how mental well-being has been impacted. It also contributes a number of novel insights on protective behaviours. Overall, the NZ population had greater levels of depression and anxiety during the first 10 weeks of the COVID-19 pandemic, compared with population norms. People who are younger and most at risk of COVID-19 experienced poorer mental health. The NZ population reported lower levels of anxiety and stress than a UK sample, when adjusting for differences in age and gender. The NZ sample also reported lower perceived risk of COVID-19 and less worry about COVID-19, than the UK sample. The findings revealed that smoking and alcohol were associated with poorer mental well-being, and that pet ownership and exercise were protective factors. Future population-based interventions could promote frequent exercise, positive mood and pet ownership, and target loneliness and unhealthy behaviours, especially among young adults.

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Supplementary Appendices

Appendix 1: Summary of modifiable and non-modifiable explanatory factors considered in the analysis
Appendix 2: Age/gender adjusted comparisons between NZ and the UK
Appendix 3: Prevalence of cases and distribution of modifiable variables (loneliness, worry, risk, mood)
Appendix 4: Boxplots of outcome variables
Appendix 5: Multivariable regression models, excluding perceived risk of COVID-19

Table 1: Explanatory factors considered in the analysis

| Non-modifiable factors       | Question/scale                                      | Response(s)                                                                 |
|------------------------------|-----------------------------------------------------|----------------------------------------------------------------------------|
| Gender*                      | What was your gender at birth?                      | Male, Female, Other, Prefer not to say                                      |
| Age                          | How old are you?                                   | ..                                                                         |
| Ethnicity*                   | What is your ethnicity                              | New Zealand/ European, Māori, Samoan, Cook Island Māori, Tongan, Niuean, Chinese, Indian, Other |
| Keyworker status             | Are you currently fulfilling any of the government’s identified ‘keyworker’ roles? | Health, social care, relevant support worker, Teacher or childcare worker still travelling in to work, Transport worker still travelling in to work, Food chain worker (e.g. production, sale, delivery) |
Key public services worker (e.g. justice staff, religious staff, public service journalist or mortuary worker)
Local or national government worker delivering essential public services
Utility worker (e.g. energy, sewerage, postal service)
Public safety or national security worker
Worker involved in medicines or protective equipment production or distribution
Other ‘keyworker’ role not listed
None of these

Living alone/with others

Do you live with someone?
Yes
No

Modifiable factors

Perceived loneliness
On a scale of 1-10, how lonely have you felt over the past 2 weeks?
1 (Not at all lonely) - 10 (Extremely lonely)

Perceived risk of COVID-19
On a scale of 1-10, what do you believe your risk of getting COVID-19 is?
1 (I don’t think I will get it) - 10 (I know I will most certainly get it)

Positive mood
In the past 2 weeks, I have felt Positive.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always
In the past 2 weeks, I have felt Good.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always
In the past 2 weeks, I have felt Pleasant.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always
In the past 2 weeks, I have felt Happy.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always
In the past 2 weeks, I have felt Joyful.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always
In the past 2 weeks, I have felt Contented.
1=Very rarely or never/ 2=Rarely/ 3=Sometimes/ 4=Often/ 5=Very often or always

Worry about contracting COVID-19
Please read the following statements carefully and then select the one which best describe how you have felt over the past 2 weeks.

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.
I spend most of my time worrying about getting COVID-19.

Pet ownership
Do you have a pet? (i.e. dog, cat or other)
Yes
No

Smoking status
Over the past 2 weeks, how frequently have you smoked tobacco?
Multiple times daily
Once a day
2 or 3 times a week
| Exercise frequency       | Over the past 2 weeks, how frequently have you exercised? |
|-------------------------|------------------------------------------------------------|
| At least once a week    |                                                            |
| At least once a month   |                                                            |
| Less often than once a month |                                                  |
| Never                   |                                                            |

| Frequency of alcohol consumption | Over the past 2 weeks, how frequently have you consumed alcohol? |
|----------------------------------|---------------------------------------------------------------|
| Almost every day                 |                                                              |
| 2-3 times per week               |                                                              |
| Once a week                      |                                                              |
| Less than once a week             |                                                              |
| Never                             |                                                              |
| Daily                             |                                                              |
| 4-6 times a week                  |                                                              |
| 2 or 3 times a week               |                                                              |
| Once a week                       |                                                              |
| Once a fortnight                  |                                                              |
| Once monthly                      |                                                              |
| On special occasions              |                                                              |
| Never                             |                                                              |

*Gender and ethnicity were treated as binary variables in all analyses: gender (male, female), ethnicity (NZ/European, not NZ/European).

†The factors in italic were hypothesised to be associated with an increased risk of adverse mental health status, apart from keyworker status where evidence exists that some keyworker roles are also associated with an increased risk of adverse COVID-19 outcomes. All other factors were hypothesised to be associated with an increased risk of contracting COVID-19 and/or poorer disease outcomes.

‡Positive mood was measured using the positive items from SPANE: Scale of Positive and Negative Experience (α=0.94) (Diener et al., 2010).
Appendix 2: Age/gender adjusted comparisons between NZ and the UK

Figure 1. Figure showing differences in age between NZ and the UK
Median age of participants: New Zealand 40 years (IQR 27 to 54), UK 45 years (IQR 33 to 56)

Table 1. Regression analyses adjusting for differences in age/gender distributions of participants

1. Depression scores – square root transformed

|       | Coef.   | Std. Err. | t       | P>|t|   | [95% Conf. Interval]       |
|-------|---------|-----------|---------|-------|---------------------------|
| country | -.1512188 | .049124   | -3.04   | 0.002 | -.2488463    -.0535912 |
| age10  | -.2365958 | .0125005  | -18.93  | 0.000 | -.2611042   -.2120875 |
| female | .404044   | .0542345  | 7.45    | 0.000 | .297712     .5103759  |

2. Anxiety scores - square root transformed

|       | Coef.   | Std. Err. | t       | P>|t|   | [95% Conf. Interval]       |
|-------|---------|-----------|---------|-------|---------------------------|
| country | -.0728954 | .049124   | -1.48   | 0.138 | -.1692877    .0234160  |
| age10  | -.261392 | .0123321  | -21.20  | 0.000 | -.2855702   -.2372138 |
| female | .3342756 | .0542345  | 6.25    | 0.000 | .2293763     .439175  |

3. Stress scores (not transformed)

|       | Coef.   | Std. Err. | t       | P>|t|   | [95% Conf. Interval]       |
|-------|---------|-----------|---------|-------|---------------------------|
| country | -.0728954 | .049124    | -1.48  | 0.138 | -.1692877    .0234160  |
| age10 | -.261392 | .0123321    | -21.20 | 0.000 | -.2855702    -.2372138 |
| female | .3342756 | .0535039   | 6.25   | 0.000 | .2293763     .439175  |

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### Appendix 3: Prevalence of cases and distribution of modifiable variables (loneliness, worry, risk, mood) for the NZ cohort

Table 1. Prevalence of depressive and anxiety cases in the NZ cohort

| Categories | All (n) | Male (n) | Female (n) |
|------------|---------|----------|------------|
| Depression (PHQ-9) |         |          |            |
| No-Minimal Depression (0-4) | 244 | 26 | 218 |
| Mild Depression (5-9) | 227 | 25 | 199 |
| Moderate Depression (10-14) | 103 | 8 | 94 |
| Moderately Severe Depression (15-19) | 54 | 4 | 50 |
| Severe Depression (20-27) | 53 | 5 | 47 |
| Anxiety (GAD-7) |         |          |            |
| No-Minimal Anxiety (0-4) | 321 | 39 | 281 |
| Mild Anxiety (5-9) | 199 | 17 | 180 |
| Moderate Anxiety (10-14) | 86 | 3 | 82 |
| Severe Anxiety (15-21) | 75 | 9 | 65 |
Table 2. Loneliness, worry about COVID-19, perceived risk of COVID-19, and positive mood in the NZ cohort

|                  | Gender | Age | Groups | (years) |
|------------------|--------|-----|--------|---------|
|                  | Whole sample | Male | Female | 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65-74 | ≥75 |
| Loneliness Mean (SD) | 3.91 (2.8) | 4.00 (3.1) | 3.90 (2.8) | 5.21 (2.8) | 4.36 (2.8) | 3.43 (2.8) | 3.20 (2.6) | 3.51 (2.6) | 3.74 (3.1) | 1.95 (1.4) |
| Positive mood Mean (SD) | 19.97 (5.0) | 19.57 (5.9) | 20.04 (4.9) | 18.48 (4.7) | 19.29 (4.9) | 20.55 (5.1) | 20.71 (4.8) | 19.77 (5.2) | 21.89 (4.9) | 23.90 (4.5) |
| Perceived risk of COVID-19 Mean (SD) | 2.29 (1.7) | 2.30 (1.5) | 2.30 (1.7) | 2.30 (1.4) | 2.20 (1.4) | 2.30 (1.7) | 2.40 (1.8) | 2.50 (2.0) | 2.00 (1.3) | 2.70 (2.3) |
| Worry about COVID-19 n (%) | 255 (37.4%) | 37 (54.4%) | 216 (35.5%) | 48 (42.1%) | 69 (39.9%) | 33 (33.0%) | 45 (36.3%) | 28 (27.7%) | 25 (53.2%) | 28 (33.3%) |
| No worry/never | 370 (54.3%) | 25 (36.8%) | 342 (56.3%) | 56 (49.1%) | 91 (52.6%) | 90 (60.0%) | 68 (54.8%) | 61 (60.4%) | 21 (44.7%) | 13 (61.9%) |
| Occasional worry | 45 (6.6%) | 5 (7.4%) | 40 (6.6%) | 8 (7.0%) | 13 (7.5%) | 6 (6.0%) | 9 (7.3%) | 8 (7.9%) | 0 (0.0%) | 1 (4.8%) |
| Much worry | 10 (1.5%) | 67 (98.5%) | 10 (1.6%) | 2 (1.8%) | 0 (0.0%) | 1 (1.0%) | 2 (1.6%) | 4 (4.0%) | 1 (2.1%) | 0 (0.0%) |

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Appendix 4: Boxplots of outcome variable scores by gender and age groups

Figure 1: Boxplot of depression (PHQ-9) scores

Box plot of depression scores by age and gender

Gender
- Male
- Female

Figure 2: Boxplot of anxiety (GAD-7) scores

Box plot of anxiety scores by age and gender

Gender
- Male
- Female
Figure 3: Boxplot of stress (PSS-4) scores

Box plot of stress scores by age and gender

| Gender  | Male | Female |
|---------|------|--------|

Gasteiger N, et al. *BMJ Open* 2021; 11:e045325. doi: 10.1136/bmjopen-2020-045325
## Appendix 5: Multivariable regression models, excluding perceived risk of COVID-19

Table 1: Regression model showing associations between modifiable explanatory variables and depression, anxiety and stress scores (excluding perceived risk of COVID-19) in the NZ cohort

|                | B     | 95% CI Lower | 95% CI Upper | β     | p             |
|----------------|-------|--------------|--------------|-------|---------------|
| **PHQ-9 Total Score**<sup>a</sup> |       |              |              |       |               |
| Age (per decade)    | -0.12 | -0.16        | -0.07        | -0.15 | ****p<0.0001  |
| Female              | 0.25  | 0.05         | 0.44         | 0.06  | *p<0.05       |
| Live alone          | -0.02 | -0.23        | 0.19         | -0.01 | 0.84          |
| BAME background     | -0.06 | -0.24        | 0.12         | -0.02 | 0.49          |
| Keyworker           | -0.03 | -0.15        | 0.10         | -0.01 | 0.58          |
| COVID-19 risk status<sup>b</sup> |       |              |              |       |               |
| Most at-risk        | 0.28  | 0.03         | 0.53         | 0.06  | *p<0.05       |
| Increased risk      | -0.02 | -0.21        | 0.17         | -0.01 | 0.85          |
| Perceived loneliness (per unit) | 0.08  | 0.05         | 0.10         | 0.17  | ****p<0.0001  |
| Positive mood (per unit) | -0.15 | -0.16        | -0.13        | -0.58 | ****p<0.0001  |
| COVID-19 worry<sup>c</sup> |       |              |              |       |               |
| Never               | 0.08  | -0.05        | 0.22         | 0.03  | 0.22          |
| Much of the time    | 0.20  | -0.06        | 0.47         | 0.04  | 0.14          |
| Most of the time    | 0.20  | -0.33        | 0.72         | 0.02  | 0.46          |
| **Adjusted R² = 0.57, n=681** |       |              |              |       |               |

| **GAD-7 Total Score**<sup>a</sup> |       |              |              |       |               |
| Age (per decade)    | -0.10 | -0.14        | -0.06        | -0.13 | ****p<0.0001  |
| Female              | 0.23  | 0.04         | 0.43         | 0.06  | *p<0.05       |
| Live alone          | -0.05 | -0.26        | 0.15         | -0.01 | 0.62          |
| BAME background     | -0.00 | -0.18        | 0.17         | -0.00 | 0.96          |
| Keyworker           | -0.06 | -0.18        | 0.07         | -0.02 | 0.38          |
| COVID-19 risk status<sup>b</sup> |       |              |              |       |               |
| Most at-risk        | 0.20  | -0.05        | 0.45         | 0.04  | 0.11          |
| Increased risk      | 0.07  | -0.12        | 0.26         | 0.02  | 0.49          |
| Perceived loneliness (per unit) | 0.07  | 0.04         | 0.10         | 0.16  | ****p<0.0001  |
| Positive mood (per unit) | -0.13 | -0.15        | -0.12        | -0.58 | ****p<0.0001  |
| COVID-19 worry<sup>c</sup> |       |              |              |       |               |
| Never               | -0.15 | -0.28        | -0.02        | -0.06 | *p<0.05       |
| Much of the time    | 0.44  | 0.18         | 0.71         | 0.10  | **p<0.01      |
| Most of the time    | 0.19  | -0.33        | 0.71         | 0.02  | 0.46          |
| **Adjusted R² = 0.55, n=681** |       |              |              |       |               |

| **PSS-4 Total Score**<sup>a</sup> |       |              |              |       |               |
| Age (per decade)    | -0.28 | -0.39        | -0.17        | -0.14 | ****p<0.0001  |
| Female              | 0.58  | 0.07         | 1.10         | 0.06  | *p<0.05       |
| Live alone          | 0.28  | -0.27        | 0.83         | 0.03  | 0.31          |
| BAME background     | 0.37  | -0.10        | 0.84         | 0.04  | 0.12          |
| Keyworker           | 0.17  | -0.16        | 0.50         | 0.03  | 0.32          |
| COVID-19 risk status<sup>b</sup> |       |              |              |       |               |
| Most at-risk        | 0.76  | 0.10         | 1.42         | 0.06  | *p<0.05       |
| Increased risk      | 0.51  | 0.00         | 1.01         | 0.05  | *p<0.05       |
| Perceived loneliness (per unit) | 0.17  | 0.09         | 0.24         | 0.14  | ****p<0.0001  |
| Positive mood (per unit) | -0.40 | -0.44        | -0.36        | -0.61 | ****p<0.0001  |
| COVID-19 worry<sup>c</sup> |       |              |              |       |               |
| Never               | 0.16  | -0.19        | 0.51         | 0.02  | 0.36          |
| Much of the time    | 0.39  | -0.31        | 1.09         | 0.03  | 0.28          |
| Most of the time    | 0.60  | -0.78        | 1.98         | 0.02  | 0.39          |
| **Adjusted R² = 0.57, n=681** |       |              |              |       |               |

**** p<0.0001, *** p<0.001, ** p<0.01, * p<0.05

a. Square root of total score  
b. Comparison reference group: neither category  
c. Comparison reference group “I occasionally worry about getting COVID-19