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ABSTRACT

Physical Isolation and Loneliness: Evidence from COVID Lockdowns in Australia*

Using mandatory stay-at-home orders in Australia as a natural experiment and data from a long-running panel study, this paper investigates the causal link between physical isolation and loneliness. We exploit variations in the number of lockdown days in 2020 the respondent had experienced up until the interview date to estimate the causal link and find, based on difference-in-differences analyses with three-way fixed-effects estimations, that the number of days in lockdown does not significantly affect loneliness. Further, we use triple differences to examine heterogeneous effects. For income, age, personality, living arrangements, and remoteness, we find insignificant effects; for extroverts and young people, we find weak significance. We investigate exclusion restrictions through channels such as social contacts, internet access, job industry, and household characteristics on loneliness. Whereas many believe that 'being alone' and 'being lonely' are similar concepts, our study provides the first empirical causal evidence of no links between the two. Our findings also refine understanding of social isolation and demonstrate that it likely encompasses factors other than physical isolation.

JEL Classification: I12, I31, O1

Keywords: COVID-19, loneliness, physical isolation, lockdown, natural experiment, quasi-experimental design

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* This research uses data from the Household, Income and Labour Dynamics in Australia from the Melbourne Institute: Applied Economic & Social Research (HILDA) Survey (https://melbourneinstitute.unimelb.edu.au/hilda). We are grateful to seminar participants at the University of Queensland, Victoria University of Wellington, and the University of Sydney.

1. INTRODUCTION

Loneliness has become a prevalent social, public health, and economic issue (Cacioppo & Cacioppo, 2018; Murthy, 2020); for instance, mortality risk associated with loneliness is comparable to obesity, smoking, alcohol consumption, and drug use (Holt-Lunstad et al., 2015) Thus better understanding of the causes of loneliness can help in the design of interventions that improve public health, reduce socioeconomic inequality, and minimise healthcare costs.

Prior research on physical isolation and loneliness provides correlational and not causal evidence (e.g., Weiss, 1975; Laursen & Hartl, 2013; Vanhalst et al., 2013), mainly because such studies cannot randomize people into isolation. We use the COVID lockdown in Australia as a natural experiment to understand the causal relationship between physical isolation and loneliness. This setting enables a quasi-experimental design, which eliminates reverse causality from feeling lonely to being alone. It also is exogenous to individuals' characteristics[1] and removes other factors that may contribute to both physical isolation and loneliness.

We chose Australia as the study's setting based on several novel features of Australian lockdowns. First, Australia is entirely surrounded by water, and thus it was possible to effectively implement a strict COVID lockdown policy; in turn, the high compliance rate increases the validity of the exogenous physical isolation. Second, Australia enforced a more extensive lockdown period than most Western countries, which allows us to capture a maximum of 154 days of lockdown. The large variation in treated time gives us a foundation for our causal identification. Third, Australia is one of few countries that was able to remain relatively COVID-free in 2020. This reduces reverse causality from the possibility that contracting COVID affects loneliness.

We draw on rich individual panel data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, which we merged with the number of lockdown days

[1] We validate this exogenous assignment of treatment by conducting tests in Section 4.4.

at regional level, and conduct difference-in-differences (DID) analyses using a continuous treatment that varies across individuals. Our identification relies on the fact that the number of lockdown days individuals experienced up until the survey interview (treatment) is randomly assigned. We use three-way fixed effects to control for any unobserved heterogeneity at individual, year, and regional level. We validate our identification by (1) testing the random assignment of lockdown days against income, education, and health status; (2) performing balance tests for pre-lockdown characteristics between treated and control groups; and (3) conducting an event study to support the common trend assumption.

Contrary to common belief, we find that physical isolation has little effect on loneliness. Our point estimates suggest that 100 days of lockdown increases loneliness by 2.1% of a SD, and the estimates are insignificant across all specifications. We benchmark this to the effect of a control variable—widowhood—which increases loneliness by 49% of a SD, and to a lockdown effect on mental health using the same identification, which increases loneliness by 13% of a SD.

We test whether the level of loneliness is persistent or transitory by examining concurrent and cumulative effects on individuals in Melbourne—the only region that had a significant lockdown during the survey interview period—and do not find significant variations over time. We also test for exclusion restrictions through household, health, work, social, COVID, and macroeconomic channels, and our results are consistent after controlling for these confounders.

We use triple differences and find little difference across gender, living arrangements, remoteness, income, immigrant status, and indigenous population and identify weak significance for an increased level of loneliness among individuals aged 15-25 and those who are extroverted. We also examine whether already lonely people are more likely to be affected, and conduct sensitivity analyses by (1) using different thresholds for lockdown days; restricting

samples to (2) living alone, (3) not having moved, and (4) major cities; and (5) including the 10 prior waves. All results find no significance of lockdown days on loneliness.

The COVID-19 pandemic has had far-reaching consequences for all aspects of economic well-being, and a growing literature has used COVID lockdowns as an exogenous shock. For example, Clark & Lepinteur (2022) show that lockdown reduces life satisfaction in five European countries using individual fixed effects. Ravindran & Shah (2020) find a positive effect of COVID lockdown on domestic violence against women in India using DID analysis of aggregate data on the regional intensity of government-mandated lockdowns. Butterworth et al. (2022), using the Australian State of Victoria as the treated group and 2020 as the treatment period, show that mental health is reduced by lockdowns using dichotomous DID with individual fixed effects.[2]

Several previous studies examine the effect of COVID lockdown on loneliness. For example, Grimes (2022) uses aggregate and individual-level data from New Zealand and levels of lockdown DID with time fixed effects for the identification, and shows a rise in loneliness and life satisfaction associated with lockdowns. Caro et al. (2022) use a European dataset and a dynamic mixture model to estimate loneliness in subpopulations and finds that older people are less likely to feel lonely but are also more affected by lockdown measures, while young people living alone have high levels of loneliness but are unaffected by lockdowns. Also drawing on the HIILDA dataset, Schurer et al. (2022) use DID analysis to examine loneliness and eight other outcomes, with Melbourne as the treated group, Sydney as the control group, and 2020 as the treated period. A variation of the model also provides different lengths of exposure to lockdown: <40 days, 40-70 days, and 71-112 days. Their estimation shows that

[2] More studies have estimated the general COVID effects, as opposed to only the effect of lockdowns. For example, Lepinteur et al. (2022) use the German Socio-Economic Panel, find that COVID increases loneliness in women and it partially explains the gender gap in life satisfaction.

although loneliness among mothers increases by 0.27 of a SD, most vulnerable groups are not affected.

Our paper makes the following contributions. First, COVID lockdowns could potentially be associated with economic conditions, population health status, and political preferences. Our identification uses the number of lockdown days experienced by individuals up until the survey interview and generates a randomly assigned treatment intensity, free from the endogeneity previous studies may suffer from. Second, instead of estimating the effect of lockdowns, we asked a different research question regarding physical isolation and loneliness, using COVID lockdown as a natural experiment. This is reflected in an identification, treatment effect, and treated group that differs from previous studies: The number of lockdown days experienced by each respondent provides a precise measure of physical isolation at individual level. This design also enables us to use a nationally representative sample of treated and control groups, which is wider than some previous studies capture. Third, we specifically identify channels from COVID lockdowns other than physical isolation. For example, we take into account the effects of working from home and the frequency of social contacts. We show that by controlling for these channels, the effect of physical isolation because of the COVID lockdown does not impact loneliness. Fourth, we complement previous research on COVID effects by studying the most frequently discussed channel (i.e., physical isolation). Whereas a body of literature has shown that COVID has increased loneliness, the majority of previous studies have only speculated on potential mechanisms rather than directly testing it. We isolate the effect of physical isolation on loneliness and provide the first causal empirical evidence that physical isolation does not lead to loneliness. Our results will thus help policymakers and researchers to understand the determinants of loneliness.

2. Literature review

The COVID-19 pandemic has had far-reaching consequences in all aspects of daily life, with the restrictions imposed during the early phase of the pandemic leading to increased social isolation and loneliness (Teater et al., 2021). Pandemic conditions presented a major stressor on adults' well-being and loneliness (Heindinger & Richter, 2020), and due to the nature of the pandemic—which placed individuals at increased risk of sickness and fatality—protective measures, such as stay-at-home orders and lockdowns, may have been perceived as particularly isolating (Krendl & Perry, 2021).

2.1 Difference between Loneliness and Social Isolation

Although loneliness and social isolation are often used interchangeably, they are two separate, albeit interrelated, concepts. Loneliness is a subjective measure that refers to a discrepancy in individuals' desired and actual social relationships in both quality and quantity (de Jong Gierveld et al., 2006). It can be further divided into *emotional* and *social* loneliness, in which the former refers to the absence of a close emotional attachment and the latter to the absence of broader social network relationships (Weiss, 1973). Conversely, social isolation is an objective measure of an individual's lack of relationships that forms a continuum from social isolation to social participation (de Jong Gierveld et al., 2006). Social isolation can be measured through factors such as the size and structure of social networks; it can also be measured through the extent of social support received, the frequency and duration of interactions, or the level of social engagement with the community (Cornwell & Waite, 2009). Perceived social isolation is also discussed in the literature, but is commonly used as a synonym for social loneliness because it is a subjective measure of social contacts and support (Shankar et al., 2011).

Loneliness and social isolation are distinguished from one another to reflect the reality that the two concepts do not necessarily co-occur; individuals can experience one, both, or

neither (Russell et al., 2012). Individuals may be completely socially isolated—for instance, living alone and kilometres from their nearest neighbour—but experience no loneliness. Similarly, an individual may be surrounded by many types of relationships and social supports but feel lonely. Although the concepts differ, they are correlated (Benson et al., 2021; Coyle & Dugan, 2012). Nevertheless, it has traditionally been difficult to tease each out due to reverse causation and observed and unobserved confounders. In other words, those who are lonely may prefer to be alone. There may also be individual factors that are correlated with both loneliness and physical isolation.

Regarding the link between loneliness and social isolation, Leary et al. (2003) found that the frequency and enjoyment of solitary activities is more strongly related to a desire for solitude than a desire to spend time away from people; solitary activities can provide a respite from excessive social interaction, are beneficial for psychological well-being, and do not necessarily indicate loneliness. However, engaging in solitary activities has been found to suffer from the Goldilocks effect. This refers to individuals who need to engage in the right number of solitary activities for their well-being: Too many or too few social connections might result in negative well-being. Russell et al. (2012) also found this effect in adolescents' relationships, whereby loneliness increased the further an individual was from their desired level of relationships. This association exists both when an individual has fewer desired relationships and when they have more, and demonstrates that the association between loneliness and social isolation is nonlinear, since negative feelings increase the further an individual is from their desired level of social connections in either direction (Russell et al., 2012).

Interestingly, loneliness and social isolation are both commonly associated with the same health indicators. After controlling for the other, loneliness and social isolation separately have been found to be associated with a range of health concerns. Studies have investigated

the link between loneliness and social isolation, as well as with frailty (Davies et al., 2021; Gale et al., 2017); mortality (Lennartsson et al., 2022); physical activity (Schrempft et al., 2019); inflammation (Smith et al., 2020); cardiovascular events (Bu et al., 2020); sleep quality (Benson et al., 2021); mental health (Christiansen et al., 2021; Ge et al., 2017); and hearing loss (Shukla et al., 2020). While this list is not exhaustive, it helps illustrate the recent frequency of using both measures synonymously in a study. The range of studies that investigate the association of loneliness and social isolation with varying health indicators highlight the interrelatedness of the two concepts. As such, both must be considered together in research and when proposing interventions to mitigate risk (Holt-Lunstad et al., 2015). Holt-Lunstad et al., (2015) found that a large proportion of the empirical literature did not account for both loneliness and social isolation, and often only account for one concept or used a measure that combined the two, which reveals a weakness in their meta-analytic review. Although studies are now better at separating loneliness and social isolation measures, continuing to incorporate both is required to elucidate their association with each other and other variables. This also leads to a complicated interpretation because they rarely change independently of each other.

2.2 Loneliness and Social Isolation during COVID-19

During the pandemic, restrictions have been found to negatively affect feelings of both loneliness and social isolation, since the objective experience of social distancing and stay-at-home restrictions forced individuals worldwide to remain at home for unprecedented intervals. Consequently, feelings of isolation have increased: Individuals report feeling deprived and restricted in their daily activities (Gonçalves et al. 2022); having reduced life satisfaction, well-being, and connection with their community (Clair et al., 2021); and experiencing a decrease in network density and size (Kovacs et al., 2021). The nature of COVID-19 specifically

required that people isolate from each other, which increased the physical distance between individuals and their networks. This, in turn, has been found to also induce feelings of loneliness.

Kovacs et al. (2021) found that while loneliness increased, people with more than five social contacts in their core network and those who had long and frequent contact with them had a smaller increase in loneliness. This demonstrates the phenomenon of 'turtling up' in networks, whereby during stressful events individuals focus on the stronger ties in their network. This phenomenon was also found among young adults, because contact with friends and relationship quality increased over the pandemic and protected against loneliness (Juvonen et al., 2022). In New Zealand, higher socioeconomic status and greater social participation was also associated with less loneliness (Lay-Yee et al., 2021). With regard to activities during the pandemic, Pauly et al. (2022) found that spending more alone time than usual was associated with loneliness over their 10-day study period. This relates to what is already known about loneliness and the Goldilocks effect: When solitary time is unwarranted, loneliness increases. Negative behaviours such as consuming more alcohol and smoking cigarettes rose during the COVID-19 pandemic, with a lack of social contacts and loneliness being cited as the second and fifth highest reasons for the increase (Vanderbruggen et al., 2020).

Across age cohorts, cross-sectional analyses have found that loneliness and social isolation rose for every age group. However, loneliness and social isolation was the greatest among young adults (Clair et al., 2021; Juvonen et al., 2021; Lay-Yee et al., 2021; Teater et al., 2021), as well as depression and anxiety (Juvonen et al., 2021). Technology and internet usage were identified by respondents as the most frequent way social needs were met (Gonçalves et al., 2022; Teater et al., 2021), and mediated the effects of the pandemic (Juvonen et al., 2021). Specifically, across a sample of 18- to 70-year-olds, satisfaction with (not the frequency of) electronic contact was associated with lower loneliness, depression, and anxiety

(Juvonen et al., 2021). Importantly, while young adults are consistently highlighted as experiencing greater loneliness over the pandemic, they have also been shown to be adaptive; they have employed the widest range of technologies to maintain meaningful connections during the pandemic (Juvonen et al., 2022; Teater et al., 2021). Hence, COVID-19 restrictions have isolated people within their homes and away from their social networks for unprecedented intervals. As a result, life satisfaction and well-being have decreased alongside the rise in loneliness and social isolation across the population. However, closer ties with important social contacts have protected individuals against greater increases in both measures.

In this study, we provide a unique account of how the physical isolation imposed during lockdowns may have impacted loneliness in the general public. By exploiting variation in the number of days mandated due to COVID outbreaks, we examine how the number of days in lockdown may relate to loneliness. We also examine variation by individual characteristics to determine whether the relationship differs for different groups of adults.

3. DATA

3.1 Dataset and sample

Our data are from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, which is a nationally representative household panel study that collects demographic and socioeconomic information and covers well-being, the labour market, and family characteristics. It is conducted by the Melbourne Institute: Applied Economic & Social Research and funded by the Australian government through the Department of Social Services.

We limit the study period to the years 2018, 2019, and 2020. The sample is restricted to individuals who have repeated loneliness measures in the HILDA survey.[3] We observe

[3] We present results in which we restrict samples to individuals who had not moved between 2019 and 2020 (*N=1,739 excluded*) in Appendix I. The results are highly consistent.

17,124 individuals in the sample, with 13,946 in the treated group and 3,230 in the control group.

3.2 Key variables

The HILDA provides a general loneliness measure that asks, '*How much do you agree or disagree: I often feel very lonely*' (1=*strongly disagree* and 7= *strongly agree*). Other studies that use this variable to study loneliness in the Australian population include those by (Mund et al., 2020; Tani et al., 2020; Wister et al., 2016). Though this is a single-item measure, one recent paper validated the reliability of this question and that it is well equipped to measure loneliness (Newmyer et al., 2021). Figure 2 shows the loneliness measures by year, with mean = 2.69 and SD = 1.76. We will use the standardized measure for the purpose of cross-comparison with other studies on loneliness and economic well-being.[4]

3.2 Australian state lockdowns

The days each Australian state spent in lockdown between January 1, 2020, and February 17, 2021, were initially compiled through a general Google search, then a search of each state government's media release archives. The criteria for lockdown and lockdown duration were as follows: (1) only the days individuals were under legislatively enforced orders to stay home were included, and (2) during that period, individuals were only permitted to leave their home based on four essential categories: shopping for essentials, work or education that could not be done remotely, medical or compassionate reasons, and outdoor exercise. When individuals were permitted to undertake an activity that did not fall into one of these four categories, the lockdown was considered to have ended.

[4] We also present the ordered logit regression for baseline estimation in Table A2 in the Appendix, and the results are highly consistent with our main results.

Table A.1 summarizes lockdown days by the Greater Capital City Statistical Area (GCCSA), which separates state capitals from regional areas in the states. Notably, the most significant lockdown period during the study period is the second wave of lockdowns in Greater Melbourne, which lasted 111 days.

3.3 Treatment definition and treated and control groups

We merge the HILDA data with the lockdown measure by interview date. Lockdown days are defined as the number of lockdown days in the specific state in 2020 that the respondent had experienced up until the interview date. Interview dates for the HILDA 2020 wave range from August 3, 2020, to February 17, 2021. Therefore, all affected regions would have experienced at least the first wave of lockdowns in 2020. Figure 1 presents the maximum lockdown days experienced by HILDA respondents by region, which shows that treatment intensity various significantly.

We define the treatment of lockdown days starting from the 7^{th} day for two reasons: First, short-term lockdowns would not impact loneliness level, and second, empirically, this threshold enables us to count people in Adelaide and Western Australia as being in the control group. This provides more observations in the control group in order to conduct the parallel trends analysis necessary to validate our DID. We also conduct a sensitivity test using the raw lockdown days for the treatment variable in Section 6.2 and results do not change (see Table 9 Panel B).

The treated group is defined as respondents who live in lockdown states (i.e., lockdown days above 7 days). These states include Australian Capital Territory (ACT), Victoria (VIC), New South Wales (NSW), Queensland (QLD), and Tasmania (TAS). The control group is defined as respondents who live in lockdown-free states (i.e., lockdown days are equal to or less than 7 days). These states are Northern Territory (NT) and South Australia (SA), Western

Australia (WA). In our sample, the control group contains 19% of respondents and the treated group 81%. On average, the treated group experienced 53 days of lockdown in 2020 (SD = 25); with a maximum of 154 days in lockdown.

4. METHODOLOGY

4.1 Assumptions of difference-in-differences

A difference-in-differences analysis requires three assumptions. We list them below, along with our strategies for validating the assumptions.

1. Trends in the affected states and non-affected states would have been similar in the absence of the reform. To test this assumption, (1) we compare pre-COVID characteristics in affected and non-affected regions, (2) plot the average of loneliness in affected and non-affected regions over years, and (3) use an event study to test their preexisting trends in a regression.
2. Lockdown only affects treated states, not untreated states. To satisfy this condition, (1) we include year fixed effects to capture any common trends in the affected states and non-affected states and lockdown days to capture any additional effects on those who experienced lockdowns. (2) To prevent lockdown-induced interstate immigration[5] as well as economic shocks, we include population and income per capita at state-year level from Australian Bureau of Statistics in our robustness tests (Section 5.2).
3. No other factors could be systematically correlated with both the number of lockdown days and loneliness in the affected region. To address this concern, we (1) test the random assignment of lockdown days by regressing it against the three most 'suspicious factors' that could potentially correlate with individual characteristics (see Section 4.4)

[5] Interstate immigration was limited during lockdown periods because of strict border controls.

and (2) control for confounding factors in terms of household, health, work, social, COVID-19, and macro factors (Section 5.2).

4.2 Difference-in-differences with a continuous treatment

We estimate the impact of lockdowns on individual loneliness using a continuous treatment DID with individual, region, and year fixed effects. This yields richer variation in lockdown intensity than the dichotomous treatment:

$$Loneliness_{ist} = \tau_1 LLD_{ist} + W_{ist}\,\tau_2 + \alpha_i + d_t + s_r + \nu_{ist} \qquad \text{Eq 1}$$

where $Loneliness_{ist}$ is self-reported loneliness for individual *i* in state *s* and year *t* and LLD_{st} is the number of lockdown days (> 7 days) in state *s* and year *t* (see Section 2). Note that by definition, *LLD=0* for all respondents in waves 2018 and 2019, and only the treated group has a positive LLD in 2020. Therefore, LLD essentially acts as an interaction term of treatment and treated period. We also conduct the clustered wild bootstrap-t procedure (Cameron et al., 2008) to correct the bias for over-rejection of a null hypothesis from a small number of clusters.

Our interest is λ_1 and τ_1, which capture the treatment effect of the lockdown at state level on individuals' loneliness. To avoid a small coefficient, we scale the LLD by multiplying by 0.001. The LLD estimate captures, for every 100 days in lockdown, by how much of a SD loneliness would change.

4.3 Preexisting trends

We conduct three tests for preexisting differences between affected and non-affected regions. First, we compare pre-treated observables between treated and control groups. Table 2 presents pre-COVID balance tests, and shows that the two groups are not statistically

different across most observables. Affected states have slightly younger populations (difference=1.2 years); 2% fewer are married, and 1% more are de facto. In terms of labour market outcomes, affected states have 3% more full-time employers, 2% fewer not in the labour force, slightly more educated (7.5% of a SD), and higher annual income (3% of average income). In general, we view these differences are small in magnitude and control for these differences in our estimation.

Second, we plot average loneliness scores from 2018 to 2020 for states affected by lockdowns and states not affected. Figure 2 shows that the two groups started with a similar level of average loneliness in 2018, which slightly reduces in 2019—with the treated group reducing by more—before the loneliness level rises in 2020 in the treated group and decreases for the control group. However, the difference between the two groups falls within the 95% confidence interval, and thus there is no evidence of a prior trend. Note that this overall average does not account for observed and unobserved heterogeneity across individuals.

Third, we test whether there is a preexisting trend in loneliness between the affected and non-affected regions. We estimate the following equation:

$$Loneliness_{ist} = d_t * Treated_s + d_t + X_{ist}\gamma_2 + \alpha_i + e_{ist}, \qquad \text{Eq 2}$$

where $d_t * Treated_s$ is the interaction term that captures the additional time trend for the affected states after controlling for the overall time trend, d_t. If $d_t * Treated_s$ is insignificant, it provides evidence that there are no significant different trends in loneliness before the COVID-19 lockdown. Table 2 presents the results, which show that all interaction terms are not statistically significant using 2018 non-affected region as the base. Figure 3 further shows

the point estimates of interaction terms with 95% confidence intervals, with no significant trends between affected and non-affected regions.

4.4 Random assignment of lockdown days

What if the individuals who experienced more lockdown days are intrinsically different from those with fewer days or no lockdowns? We test the number of lockdown days endogenous to individuals' characteristics. We propose the three most 'suspicious' factors that are endogenous to individuals and may induce governments to carry out lockdowns: (1) income, (2) education, and (3) health conditions. In particular, the concern is that a population with a different level of income, education, or health could potentially induce a government to enforce more lockdown days.

Table 3 shows the regression of these suspicious factors as outcomes on lockdown days. It shows that the treatment variable is not significantly associated with equivalent household income, highest educational attainment, self-reported general health (1-5), and whether the individual has a chronic illness. This provides further evidence for the quasi-random design, whereby lockdown days until interview days are not endogenous to respondents' characteristics.

5 RESULTS

5.1 Baseline with individual fixed effects

Our primary interest is the number of lockdown days (i.e., λ_1 in the baseline model). If it is significant and positive, this indicates that the number of lockdown days increases the loneliness level. Our estimates do not support this hypothesis. Next, we add individual fixed effects to the estimation; this method compares loneliness within the same individual before

and after the lockdown. Table 5, column 1 presents lockdown estimates without individual controls (note that the treated dummy is eliminated by individual fixed effects), and the lockdown effect is small and positive but not statistically significant. After adding individual characteristics in column 2 and year fixed effects in column 3, the estimate of lockdown does not change materially. The point estimate suggests that for a 100-day lockdown, the loneliness level increases by 1% to 2% of a SD.

To provide more context for the effect size, we first benchmark this magnitude to being widowed (using married as the base) and find that widowhood increases loneliness by 48.2% - 49.2% of a SD. Second, we conduct a falsification test that uses our baseline model to estimate other factors in economic well-being: financial stress and mental health. Previously, studies have found that lockdowns increase financial stress (Adegboye et al., 2021) and decrease mental health (Butterworth et al., 2022). Table 5 shows that our identification captures 4.2% of a SD increase in financial stress significantly and 12.8% of a SD decrease in mental health significantly. Compared with these two benchmarks, we show the effect of lockdown on loneliness is thus statistically and empirically insignificant.

5.2 Concurrent effect

Our baseline estimation uses the cumulative loneliness experienced by an individual. We also examine whether the concurrent effect of lockdown affects loneliness—that is, whether people who are in lockdown when interviewed report higher levels of loneliness. In the sample, 18% of respondents in 2020 were interviewed during lockdown (2,293 in Melbourne and 9 in other regions). For this subsection only, we redefine the treatment variable as currently in lockdown=1 and 0 otherwise, and re-estimate the baseline estimation. The results are presented in Table 6, which shows that being in lockdown does not significantly increase loneliness.

Given that Greater Melbourne is the only region that experienced a significant lockdown period during the interview date range, we further plot the loneliness level in Melbourne after 1 month of lockdown (the earliest point the interview date can capture), 2 months of lockdown, the end of lockdown, 1 month out of lockdown, and 2 months out of lockdown. Figure 5 shows that there are barely any changes in loneliness at different time points for lockdown and that 95% confidence intervals are within the all-time average and within 1 SD range of the all-time average. This result shows that there is no significant during or after effects, and we do not have evidence that loneliness would have undergone transitory change in response to lockdown events. This result coincides with findings by Mund et al. (2020), who show that loneliness exhibits traits-like stability over time.

5.3 Exclusion restrictions

What if lockdown impacts factors other than physical isolation and, in turn, affects loneliness? We separately test the following aspects by adding each to the baseline estimation:

1. Social channel. (a) Get together with friends: '*How often do you get together socially with friends/relatives not living with you?*' (1=*Every day* to 7=*Less often than once every 3 months*) (reverse coded; mean = 4.3, SD = 1.5), (b) has access to the internet at home=1 (mean = 0.87, SD = 0.9).
2. Work channel. (a) Working from home=1 (mean = 0.18, SD = 0.39), (b) ANZSIC job industry (2-digit classification).
3. Household channel. (a) Type of dwelling (apartment, house, or townhouse), and (b) household composition (couple, with children, with others, or alone).
4. Health channel. (a) Individual health (using the 36-Item Short Form Health Survey—i.e., the SF-36, which ranges from 0 to 100, mean = 66.2, SD = 20.9), (b) have had COVID-19 (mean = 0.005, SD = 0.076 in year 2020).

5. COVID-19 cases and macroeconomic channel. (a) COVID-19 cases, (b) COVID-19 deaths, (c) COVID-19 cases in aged care services (both among residential care and in-home care) by states in 2020 from the Department of Health, (d) total gross income per capita in AUD, population at state-year level.

Table 7 presents the results, and shows that these confounders do not change the insignificant effects of lockdown.

6. Further results

6.1 Heterogeneous effects

We next examine whether the lockdown would affect different demographic and socioeconomic subgroups separately, given prior literature that suggests variation in loneliness by individual characteristics (Cohen-Mansfeld et al. 2016; de Jong Gierveld et al. 2015). We specifically examine the following factors: (1) living arrangements, (2) remoteness, (3) personality, (4) income, (5) age, (6) immigrant status, and (7) indigenous status.

Table 8 shows DID lockdown effects in these subgroups, and the results are statistically insignificant for most regressions. Although point estimates vary across subgroups, the overall effect size is very small, and the insignificant results provide further evidence that loneliness is not affected by physical isolation across demographic and socioeconomic groups.

Two exceptions are for extroverted people and young people (15-25 years old). The extroverted subsample has a marginally significant estimate (at the 10% level) and suggests that per 100-day lockdown increases loneliness by 6% of a SD. Young people experience 33.6% of a SD increased loneliness during lockdown at the 10% level. This result suggests that young and extroverted people might be at higher risk of developing loneliness in response to physical isolation, similar to previous findings on COVID lockdown (e.g., Bu et al., 2020; Entringer & Gosling, 2022; Hu & Gutman, 2021; Sampogna et al., 2021).

6.2 Other robustness checks

We test whether already lonely people are more likely to be affected. We conduct quantile regression, and the estimate of lockdown increases with loneliness level, but remains statistically insignificant (see Table 9 Panel A).

We conduct sensitivity analysis (1) using raw lockdown days; (2) limiting the sample to living alone, not having moved during the study period, and living in a major city, respectively; and (3) including the 10 previous waves (i.e., to 2010). The results are consistently insignificant throughout (see Table 9 Panel B)

Last, we conduct an attrition test by using self-completed questionnaire longitudinal weight, respondent's longitudinal weight, and inverse probability weight and find that results are insignificant across weighted estimations (see Table 9 Panel C).

7. CONCLUSION

Loneliness has received increased attention in recent years, and especially since the onset of COVID-19. We draw on the case of Australia, in which strict stay-at-home orders were imposed, and ongoing panel survey data that contain measures of residential location and loneliness to examine how variation in the number of days spent in lockdown are related to loneliness. We also exploit regional differences in the lockdowns imposed by state governments—due to location-specific outbreaks of COVID-19 cases—to examine the links between physical isolation and loneliness. Using a long-running survey dataset with a measure of loneliness starting in 2001, we were also able to adjust for individual characteristics that may confound this association, and also to examine trends in loneliness prior to COVID-19. Our results show that being in lockdown, as well as the number of days in lockdown, were unrelated to reported levels of loneliness. Our findings also demonstrate that physical isolation

and loneliness are different, and that while ‘being alone’ has been conflated with social isolation, they may be unique constructs.

Despite its contributions to the literature, our study is not without limitations. First, we were only able to capture the first year of the COVID-19 pandemic. COVID-19 and lockdowns continued to occur beyond the early parts of 2021; therefore, our study was not able to capture the longer-term effects of lockdown on loneliness. We are also unable to generalise our findings to other countries. For example, Australians have relatively advanced means for telecommunications, and the same result may not apply to countries in which people have limited means to communicate without in-person contact. Thus, future research that also examines how lockdowns and physical isolation may impact loneliness in other contexts would be helpful.

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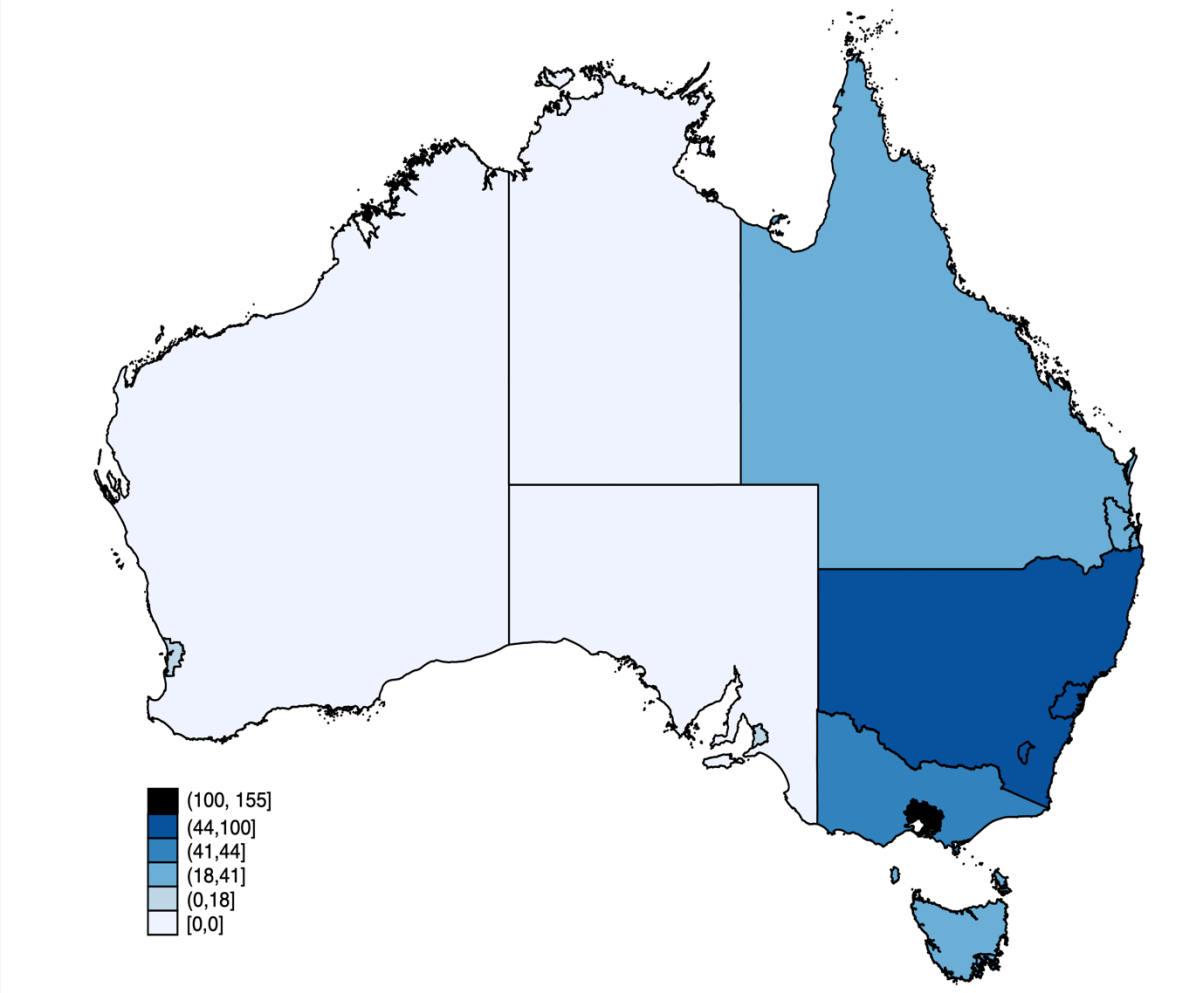
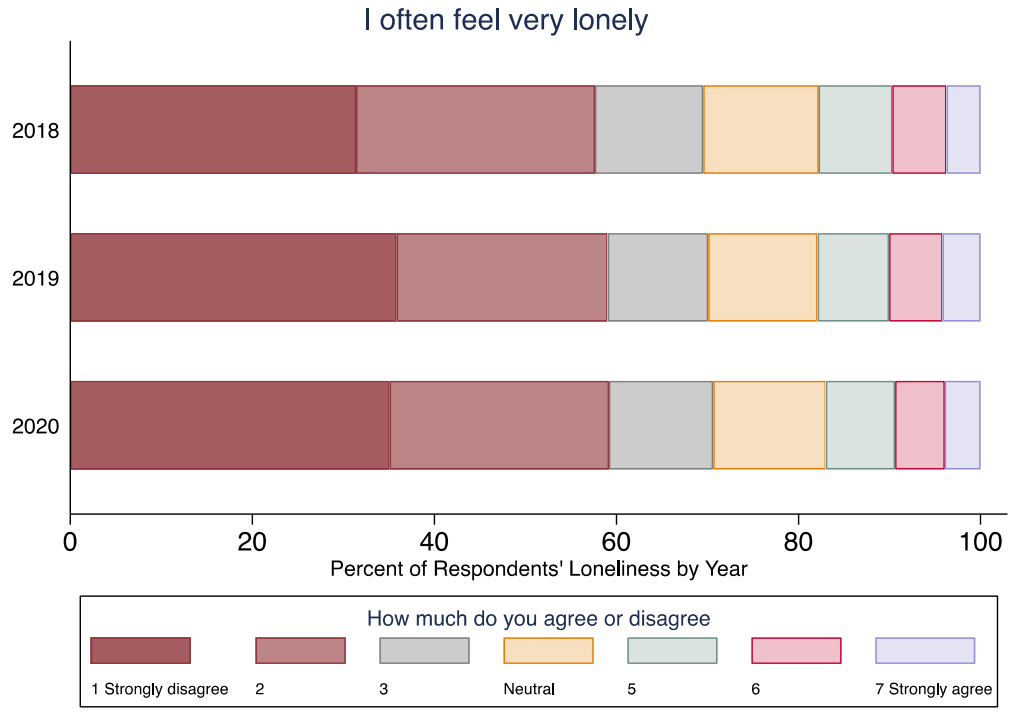
Figure 1. Maximum lockdown days experienced by HILDA respondents by region



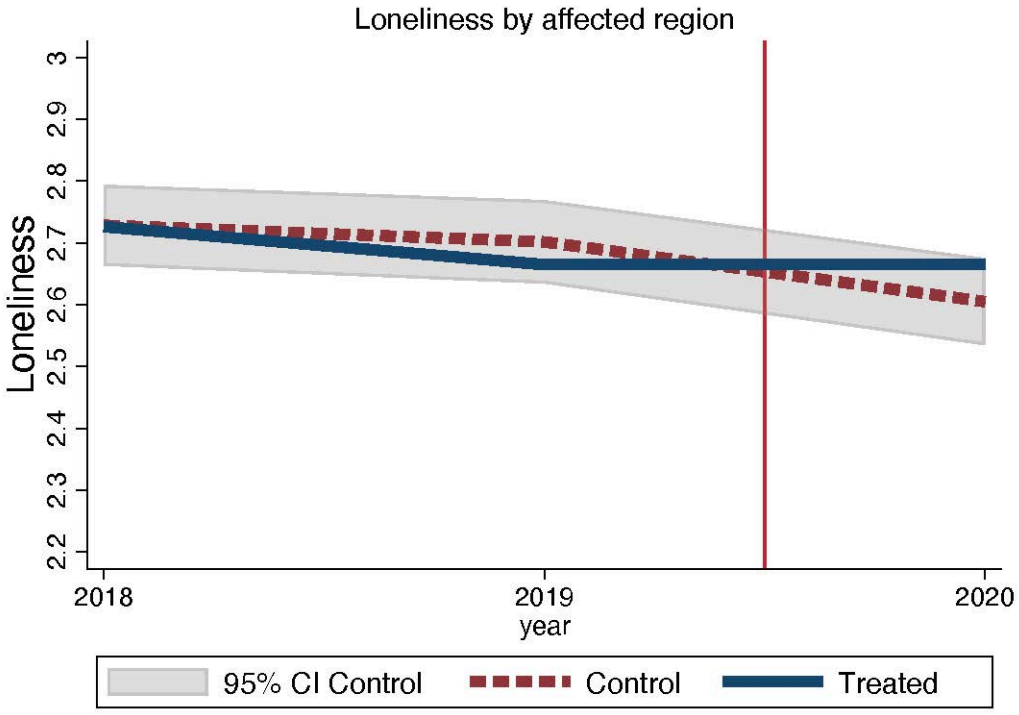
Source: Maximum lockdown days are obtained by merging lockdown days at Greater Capital City Statistical Area (GCCSA) and HILDA respondents' interview dates in 2020. Interview date range in 2020 is 3-Aug-2020 to 17-Feb-2021. Treatment definition: Number of lockdown days experienced by respondent in 2020 up until interview date.

Figure 2. Loneliness by year



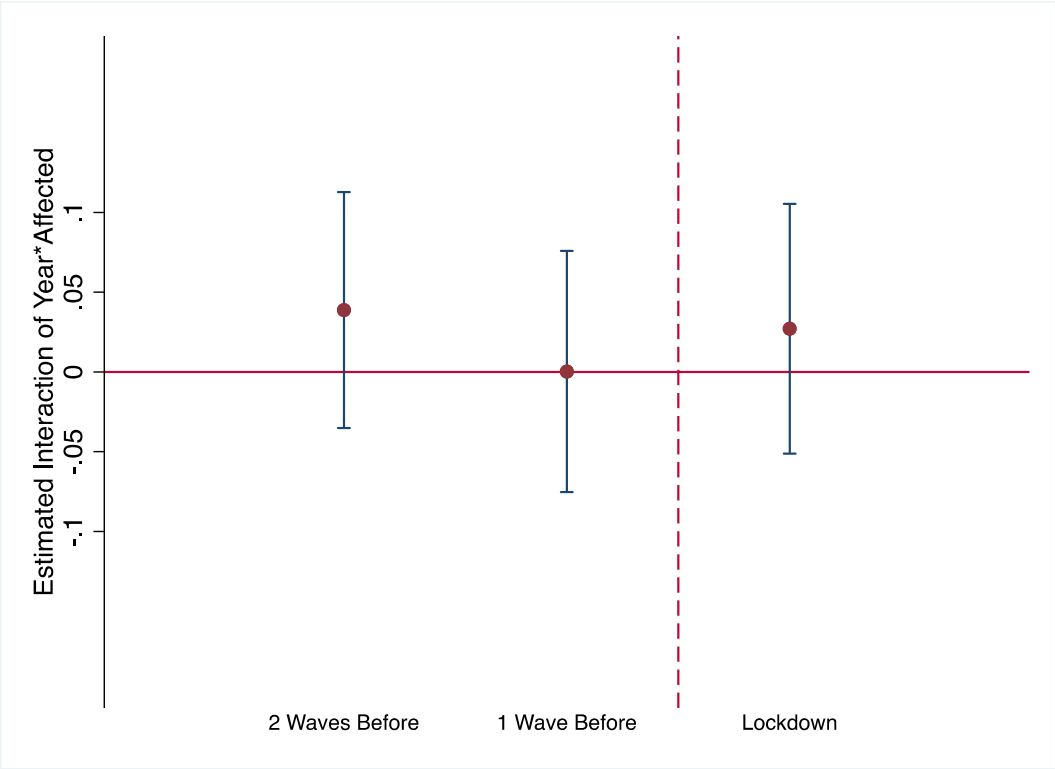
Source: HILDA 2018, 2019, and 2020 waves. Respondents with repeated loneliness measures. *N*=15,563.

Figure 3**.** Loneliness level by year and region affected by lockdown vs not affected



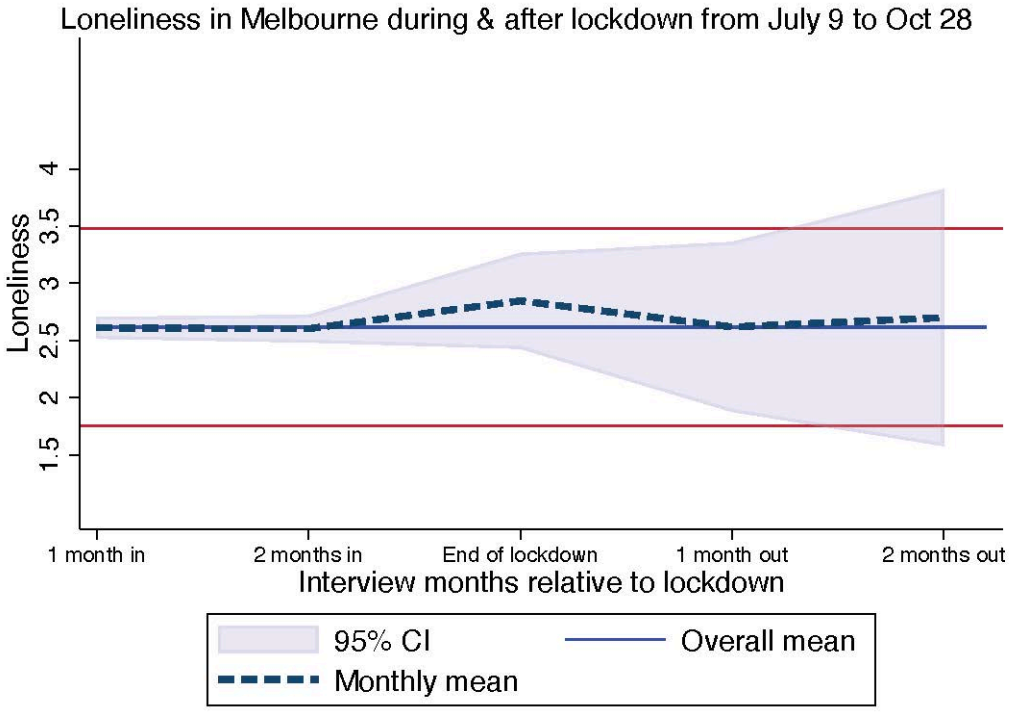
Note: HILDA 2018-2020 with repeated lockdown measures. The treated group is defined as respondents who live in lockdown states (i.e., in which the number of lockdown days is more than 7): ACT, VIC, NSW, QLD, and TAS. The control group is defined as respondents who live in lockdown-free states (i.e., lockdown days are equal to or less than 7): NT and SA, WA. *N*=15,563.

Figure 4. Event study



Note: Trend plots and differential changes over time in loneliness between treatment and control groups. Data are from HILDA 2018-2020 with repeated lockdown measures. The figure corresponds to the event study estimated using Equation (2) and results shown in Table 2. Point estimates are the corresponding coefficients of $d_t * Treated_s$. Vertical lines are 95% confidence intervals. Loneliness is standardised. The set of control variables is in Equation (1), including individual-year-region fixed effects. Sample size: 15,563. The figure shows that prior to the introduction of lockdowns, the time trends do not significantly differ between treated and control groups.

Figure 5. During and after lockdown and loneliness



Note: HILDA 2020 Melbourne sample. This uses the second lockdown in Melbourne from 09/07/2020 to 28/10/2020. HILDA interviews start on 3-Aug-2020, which captures as early as 1 month after commencement of second lockdown in Melbourne. *N*=2,241.

Table 1. Pre-lockdown summary statistics

	(1) Control		(2) Treated		(3) Difference	
	Mean	SD	Mean	SD	Mean	t-stat
Loneliness	0.02	1.00	0.01	0.99	0.01	(0.76)
Life satisfaction	0.00	0.98	0.05	0.94	-0.05***	(-3.40)
Relationship satisfaction	0.01	0.97	0.00	0.99	0.01	(0.47)
Parenting stress	0.04	1.04	0.05	1.01	-0.01	(-0.30)
Financial stress	-0.01	1.04	-0.03	0.98	0.02	(1.58)
Lockdown days	0.00	0.00	0.00	0.00	0.00	(.)
Living alone	0.15	0.36	0.16	0.36	-0.01	(-0.97)
Age	47.15	19.28	45.98	19.00	1.17***	(4.17)
Female	0.53	0.50	0.53	0.50	-0.01	(-0.94)
Married	0.50	0.50	0.48	0.50	0.02*	(2.13)
Defacto	0.15	0.36	0.17	0.37	-0.01*	(-2.07)
Separated	0.03	0.16	0.03	0.16	0.00	(0.11)
Divorced	0.07	0.25	0.06	0.24	0.01	(1.76)
Widowed	0.04	0.21	0.04	0.20	0.00	(0.12)
Never married	0.21	0.41	0.23	0.42	-0.01	(-1.92)
Indigenous Origin Status	0.03	0.17	0.04	0.19	-0.00	(-1.64)
Unemployed	0.04	0.19	0.03	0.18	0.00	(1.09)
Employed FT	0.40	0.49	0.43	0.50	-0.03***	(-4.30)
EmployedPT	0.22	0.42	0.21	0.41	0.01	(1.06)
NotinLabourForce	0.34	0.47	0.32	0.47	0.02**	(3.10)
Highest qualification	1.84	0.80	1.91	0.81	-0.07***	(-5.54)
Equivalent HH income	60885.08	39109.70	63181.20	42215.85	-2296.12***	(-3.95)
Observations	5740		25035		30775	

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Loneliness is standardised. The treated group is defined as respondents who live in lockdown states (i.e., in which the number of lockdown days is more than 7): ACT, VIC, NSW, QLD, and TAS. The control group is defined as respondents who live in lockdown-free states (i.e., in which the number of lockdown days is equal to or less than 7): NT and SA, WA. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 2. Event study

VARIABLES	(1) Loneliness
Year 2018* Affected	0.0388
	(0.0450)
Year 2019* Affected	0.000267
	(0.0459)
Year 2020* Affected	0.0271
	(0.0476)
Year 2019	-0.0128
	(0.0240)
Year 2020	-0.0308
	(0.0235)
Observations	42,176
Number of id	15,557
R-squared	0.004
Ind FE	Yes
Ind controls	Yes
State Year FE	Yes

Note: HILDA waves 2018-2019. Sample is limited to those who have repeated loneliness measures. Loneliness is standardised. The treated group is defined as respondents who live in lockdown states (i.e., in which the number of lockdown days is more than 7): ACT, VIC, NSW, QLD, and TAS. The control group is defined as respondents who live in lockdown-free states (i.e., in which lockdown days are equal to or less than 7): NT and SA, WA. Estimates correspond to Eq 2. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3. Test for random assignment of lockdown days (treatment).

VARIABLES	(1) Equivalent hh income	(2) Education>Uni	(4) Self-reported general health (1-5)	(5) Long-term health condition=1
Lockdown days	1,614	0.00540	0.0380	-0.0120
	(947.2)	(0.00290)	(0.0149)	(0.0107)
Observations	43,539	43,539	42,043	43,530
R-squared	0.018	0.018	0.003	0.003
Number of id	15,557	15,557	15,555	15,557
Ind FE	Yes	Yes	Yes	Yes
Ind controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Loneliness is standardised. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4. Baseline difference-in-differences estimates with three-way fixed effects.

VARIABLES	(1) Loneliness	(2) Loneliness	(3) Loneliness
Lockdown days	0.0139	0.0136	0.0211
	(0.0313)	(0.0321)	(0.0191)
	p =0.314	p =0.342	p =0.330
Widowed		0.482**	0.492**
		(0.0901)	(0.106)
		p =0.00	p =0.00
Observations	43,815	43,787	43,787
R-squared	0.000	0.003	0.004
Number of id	17,180	17,168	17,168
Ind FE	Yes	Yes	Yes
Ind controls	No	Yes	Yes
Year FE	No	No	Yes

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Loneliness is standardised. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. Standard errors clustered at region-year level in parentheses. p-values of wild-t are calculated using the wild bootstrap-*t* procedure. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. Falsification tests

VARIABLES	(1) Financial stress	(2) Mental health
Lockdown days	0.0416*	-0.128**
	(0.0126)	(0.0218)
Observations	41,025	41,275
R-squared	0.011	0.014
Number of id	15,522	15,535

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Financial stress is generated by principal component analysis that includes 7 questions regarding financial hardship and cashflow problems. Mental health is from the SF36 Mental Component Summary using factor analysis of 8 SF36 factors. Outcomes are standardised for easy comparison. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6. Concurrent effect

VARIABLES	(1) Loneliness	(2) Loneliness	(3) Loneliness
In lockdown	-0.00316	-0.00167	-0.00620
	(0.00896)	(0.0106)	(0.0143)
Observations	42,198	42,176	42,176
R-squared	0.000	0.003	0.004
Number of id	15,563	15,557	15,557
Ind FE	Yes	Yes	Yes
Ind controls	No	Yes	Yes
Year FE	No	No	Yes

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Loneliness is standardised. In lockdown=1 if an individual is in lockdown at the time of interview, 0 otherwise. In our sample, 18% of individuals in 2020 were interviewed during lockdown (mainly in Melbourne). Standard errors at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. Exclusion restrictions

Panel A: Household			Panel B: Health	
	(1)	(2)	(1)	(2)
Lockdown days	0.0205	0.0212	0.0277	0.0211
	(0.0143)	(0.0154)	(0.0138)	(0.0142)
Observations	42,175	42,176	41,862	42,173
R-squared	0.005	0.006	0.017	0.004
Number of id	15,557	15,557	15,554	15,557
Dwelling	Yes			
HH composition		Yes		
Have COVID			Yes	
General health				Yes
Panel C: Work			Panel D: Social	
	(1)	(2)	(1)	(2)
Lockdown days	0.0226	-0.0187	-0.00578	0.0209
	(0.0196)	(0.0211)	(0.0259)	(0.0186)
Observations	42,170	26,258	41,738	42,168
R-squared	0.004	0.011	0.009	0.004
Number of id	15,557	10,817	15,549	15,557
WFH	Yes			
Job industry		Yes		
Social			Yes	
Internet				Yes

Panel E: COVID & Macro					
	(1)	(2)	(3)	(4)	(5)
Lockdown days	0.0441	0.0355	0.0331	0.0275	0.0197
	(0.0482)	(0.0390)	(0.0377)	(0.0200)	(0.0189)
Observations	42,176	42,176	42,176	42,176	42,176
R-squared	0.004	0.004	0.004	0.004	0.004
Covid cases	Yes			15,557	15,557
Covid deaths		Yes			
Covid in aged care			Yes		
Population				Yes	
Income per capita					Yes

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. The following controls are added, respectively: Type of dwelling (apartment, house, or townhouse); Household composition (couple, with children, with others, or alone); Individual health (SF36); Have had COVID; Working from home=1 (mean=0.18, SD=0.39); ANZSIC job industry (2-digit classification); "*How often do you get together socially with friends/relatives not living with you?*" (1=*Every day* to 7=*Less often than once every 3 months*) (reverse coded; mean = 4.3, SD = 1.5); Has access to the internet at home= 1 (mean = 0.87, SD = 0.9). Statistics on COVID-19 cases, COVID-19 deaths, and COVID-19 cases in aged care services (both residential care and in-home care) by states in 2020 from the Department of Health. Total gross income per capita and population at state-year level are obtained from the Australian Bureau of Statistics. Loneliness is standardised. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8. Heterogeneous effects

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lockdown days	0.0173	0.0129	0.0183	0.0272	0.336*	-0.0168	0.0499	0.188
	(0.0157)	(0.0417)	(0.0157)	(0.0158)	(0.0836)	(0.0156)	(0.0224)	(0.229)
Living alone * Lockdown days	0.0302							
	(0.0337)							
Major city * Lockdown days		0.00824						
		(0.0423)						
Low income * Lockdown days			0.00865					
			(0.0196)					
Male * Lockdown days				-0.0135				
				(0.0205)				
Age 26-65 * Lockdown days					-0.365*			
					(0.0922)			
Age 65 above * Lockdown days					-0.368*			
					(0.0881)			
Extroverted * Lockdown days						0.0619*		
						(0.0174)		
English speaking.Immi * Lockdown days							-0.105	
							(0.0642)	
Non-English speaking.Immi i * Lockdown days							-0.129	
							(0.0499)	
Indigenous * Lockdown days								-0.168
								(0.230)
Observations	42,176	42,161	42,176	42,176	42,176	38,321	42,170	42,151
R-squared	0.005	0.004	0.004	0.004	0.007	0.005	0.005	0.004
Number of id	15,557	15,557	15,557	15,557	15,557	13,938	15,555	15,546

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Dependent variable is standardised loneliness at individual level. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. It interacts with the following dummy variables: living alone, living in a major city, household income is below median, age group (15-25, 26-65, and 65 and above), male, extroverted (more than median in the extroversion-introverion scale), immigrant (from an English or non-English-speaking country), and indigenous status, respectively. Standard errors clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9. Further results. Panel A: Quantile regression. Panel B: Sensitivity test. Panel C: Attrition Test

Panel A: Quantile regression					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Quantile=0.1	Quantile=0.25	Quantile=0.5	Quantile=0.75	Quantile=0.9
Lockdown days	-0.00648	0.00241	0.0195	0.0420	0.0523
	(0.146)	(0.111)	(0.145)	(0.292)	(0.366)
Observations	42,176	42,176	42,176	42,176	42,176
Ind FE	Yes	Yes	Yes	Yes	Yes
Ind controls	Yes	Yes	Yes	Yes	Yes
State Year FE	Yes	Yes	Yes	Yes	Yes

Panel B Sensitivity test					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Raw LDD	Living alone	Not moved sample	Major city	Sample 2010-2020
Lockdown days	0.000222	0.0499	0.0281	0.0202	0.0425
	(0.000195)	(0.0297)	(0.0200)	(0.0264)	(0.0230)
Observations	42,176	6,551	40,408	27,914	107,450
R-squared	0.004	0.007	0.003	0.005	0.010
Number of id	15,557	2,804	14,778	10,423	15,153
Ind FE	Yes	Yes	Yes	Yes	Yes
Ind controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Panel C Attrition test			
	(1)	(2)	(3)
VARIABLES	SCQ longitudinal weight	Responding person longitudinal weight	Inverse probability weight
Lockdown days	0.0243	0.0165	0.0225
	(0.00984)	(0.0114)	(0.0183)
Observations	37,020	39,366	35,147
R-squared	0.005	0.005	0.005
Number of id	13,028	14,201	15,385

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. All regressions control for time-variant personal characteristics, and individual-year-regional fixed effects. Panel A uses quantile regression with individual fixed effects. Panel B tests raw lockdown days (instead of days more than 7), multiplying by 0.01; samples of living alone, not moved, major cities, and using HILDA 2010-2020 waves. Panel C uses self-completed questionnaire longitudinal weight, responding person longitudinal weight, and inverse probability weight, where we calculate the probability of staying in the next wave based on current wave characteristics and inverse the probability to inflate the sample and make up for those who are more likely to drop out. Loneliness is standardised. Lockdown days are defined as the number of lockdown days more than 7 experienced by the individual in 2020 up until the interview date, scaled by multiplying by 0.01. Standard errors clustered at region-year level in parentheses. p-values of wild-t are calculated using the wild bootstrap-*t* procedure. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix I

Information sources to calculate lockdown days

The search words utilised in the search included, “lockdown”, “restriction”, “stay-at-home”, “stage three”, “stage four” and “essential reason”. The initial Google search produced 14 bouts of lockdowns in the January 2020 to February 2021 period to be considered across the States. These 14 bouts of lockdown were then checked against each State Governments’ media releases over the January 2020 to February 2021 period to determine the details of each bout of lockdown and ensure that the bouts included legislation that enforced leaving homes for activities that only fell under four essential categories. These State media release archives included ACT Government media releases (https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases), NSW Government Ministerial media releases (https://www.nsw.gov.au/media-releases), Northern Territory Government newsroom (https://newsroom.nt.gov.au/), the Queensland Cabinet and Ministerial Directory (https://statements.qld.gov.au/), Government of South Australia: COVID-19 latest news (https://www.covid-19.sa.gov.au/latest-news), Tasmania Government COVID-19 updates (https://www.premier.tas.gov.au/covid-19_updates), Premier of Victoria media centre (https://www.premier.vic.gov.au/media-centre) and Government of Western Australia media statements (https://www.mediastatements.wa.gov.au/). Legislative directions, as well as department of health and police services’ media releases were also utilised. These sources provided a detailed account of the freedom individuals lost or gained, as well as the exact date and time individuals they were imposed or lifted. This subsequent search of State Government media releases, utilising the same search terms, refined the details of each lockdown and excluded four bouts of lockdowns, three in the Northern Territory, South Australia and Western Australia in the March 2020 to May 2020 period and one in Queensland in the August 2020 to October 2020 period. This was due to these bouts of lockdown falling

outside the criteria for inclusion as they did not include the legislatively enforced ‘four essential categories’ to leave homes. This left 10 bouts of lockdowns to be included for the January 2020 to February 2021 period: one bout for the Australian Capital Territory, two within New South Wales, zero in the Northern Territory, two within Queensland, one within South Australia, one in Tasmania and three bouts of lockdown in Victoria. Bouts of lockdown lasted as little as three days, to as long as 112 days, however the mean of all lockdowns was 33.1 days.

Table A1. Lockdown days by region in the Period of 01/01/2020- 17/02/2021

ACT		Begun: 29/03/2020 Ended: 09/05/2020 **(41)**		
NSW	Greater Sydney	Begun: 31/03/2020 Ended: 15/05/2020 **(45)**		
	Regional	Begun: 31/03/2020 Ended: 15/05/2020 **(45)**	Begun: 19/12/2020 Ended: 09/01/2021 **(21)** [Northern Beaches LGA]	
NT				
QLD	Greater Brisbane	Begun: 30/03/2020 Ended: 02/05/2020 **(33)**	Begun: 08/01/2021 Ended: 11/01/2021 **(3)**	
	Regional	Begun: 30/03/2020 Ended: 02/05/2020 **(33)**		
SA	Greater Adelaide	Begun: 19/11/2020 Ended: 22/11/2020 **(3)**		

	Regional			
TAS		Begun: 31/03/2020 Ended: 11/05/2020 **(41)**		
VIC	Greater Melbourne	Begun: 31/03/2020 Ended: 13/05/2020 **(43)**	Begun: 09/07/2020 Ended: 28/10/2020 **(111)**	Begun: 12/02/2021 Ended: 18/02/2021 **(5)**
	Regional	Begun: 31/03/2020 Ended: 13/05/2020 **(43)**	Begun: 12/02/2021 Ended: 18/02/2021 **(5)**	
WA	Greater Perth	Begun: 31/01/2021 Ended: 05/02/2021 **(5)**		
	Regional	Begun: 31/01/2021 Ended: 05/02/2021 **(5)** [Peel & South-West regions]		

Sources: Various state Governments' media releases and statement.

Table A2. Ordered logit regression with individual fixed effects

VARIABLES	(1) Loneliness	(2) Loneliness	(3) Loneliness
Lockdown days	0.0466	0.0420	0.0715
	(0.0352)	(0.132)	(0.0844)
Observations	63,540	63,504	63,504
Ind FE	Yes	Yes	Yes
Ind controls	No	Yes	Yes
Year FE	No	No	Yes

Note: HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. HILDA waves 2018-2020. Sample is limited to those who have repeated loneliness measures. Loneliness measure is 1 to 7 on *How much do you agree or disagree: I often feel very lonely,* where 1 is for *strongly disagree* and 7 is for *strongly agree.* Lockdown days are defined as the number of lockdown days that is more than 7 days experienced by individual in 2020 up until interview date. It is scaled by multiplying by 0.01. Standard errors are clustered at region-year level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.