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The impact of COVID-19 shocks, precarity and mediating resources on the mental health of residents of share housing in Victoria, Australia

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Abstract

Background: Lockdown measures in response to COVID-19 have challenged people's mental health, especially among economically vulnerable households. The economic vulnerability of many share housing occupants (where individuals are unrelated adults and not in a romantic relationship) puts them most at risk of poor mental health outcomes. To date, little research has been undertaken to examine the experiences of this cohort.

Methods: We conducted a two-wave survey of occupants of share housing (n=586) in June and October 2020 during a period of population lockdown in Victoria, Australia. We measured household composition, housing and employment precarity, access to government support payments, household crowding, engagement with social networks and experience of COVID-19 shocks (job loss, living cost pressures and changing housing conditions). We conducted fixed effects ordered logit regression models to assess the mental health consequences of baseline precarity and COVID-related shocks, that is changing economic conditions throughout the lockdown period.

Results: People exposed to double precarity (precarity in both housing and employment) reported 2.4 times higher odds of mental health deterioration (OR 2.4, 95%CI 0.99-5.69). Those exposed to COVID-19 shocks also reported a 2.7 times higher odds of mental health deterioration (OR 2.7, 95%CI 1.53-4.85). Mediation analysis suggests that housing inadequacy explained around 14.7% of the total effect of double precarity on mental health while access to sufficient government financial support explained 7%.

Conclusions: Residents of group households characterised by pre-existing precarity were vulnerable to negative mental health effects of lockdowns. Access to sufficient government payments and adequate housing buffered this decline.

Strengths and limitations of this study

- The study focuses on an under-researched group; members of share households, where individuals are unrelated adults and not in a romantic relationship. This group are characterised by high levels of precarity and are disproportionately impacted by COVID-19 public health interventions.
- The paper offers a novel conceptual framework and custom-designed survey that investigates the impact of exposure to COVID-19 shocks and experiences of housing and employment precarity on mental health outcomes. It also considers the mediating impacts of access to social support, government payments and adequate housing.
- The small and highly targeted sample (n= 586) is not generalisable to the broader population

1. Introduction and Conceptual Framework

The emergence of the highly infectious coronavirus (COVID-19) has created a global health crisis with significant economic and social repercussions. Australia, like many other countries, responded with social distancing measures including limiting time outside of the home, broad work-from-home rules, temporary or permanent shut down of businesses and closure of schools and childcare. These measures effectively locked down households for long periods of time and have had well documented health, social and economic costs [1,2]. The most acute consequences have been felt by households who are vulnerable to both precarious employment (e.g., casual employees with no leave entitlements or unemployed people) and housing (e.g., people without formal leasing arrangements or living in highly unaffordable housing); that is, households prone to pre-existing double precarity. One particular cohort, occupants of share housing (where individuals are unrelated adults and not in a romantic relationship) are amongst the most vulnerable to being both precariously employed and housed during this time [3]. They are, therefore,

potentially amongst the most exposed to financial hardship arising from restrictive public health measures put in place to reduce COVID-19 transmission in communities.

This paper analyses the effects of housing and employment precarity on mental health for this cohort, while investigating the mediating effects of access to social, income and housing resources. Using the experiences of share housing residents during the 115 days of lockdown in Melbourne Australia, we seek to examine how lockdown restrictions, under the duress of 'double precarity' common amongst share housing households, impacted mental health, and how much support through social connections, sufficient government assistance or housing adequacy offered protection. We propose a conceptual framework (Figure 1) for understanding the set of relationships under consideration before presenting findings from two surveys conducted in Victoria, Australia in 2020.

Our conceptual framework is based on the following explanatory variables and mediator variables.

Explanatory variables: The double precarity of housing and employment insecurity

Despite the wealth of evidence on the impact of both employment and housing instability on mental health, these two forms of insecurity have largely been studied separately. This paper addresses this gap, focusing on housing precarity (defined as living with short-term rental contracts and/or unaffordable housing) and employment precarity (defined as casual employment contracts and unemployment). The impact of job loss and job insecurity on mental health outcomes has been well established [see, for example, 4,5]. Unemployment is both a consequence of, and risk factor for, reduced mental health [6]. Housing security and affordability is similarly recognized as an important determinant of health and wellbeing. Access to adequate and secure housing serves a protective function for mental health [7–9]. The converse is also true. Poor-quality housing and insecure tenancies all have a potentially negative impact on a person's health [10,11].

Mediator Variables: Resources of social support, government support and housing adequacy

Precarity in housing and employment triggered by pandemic containment measures is known to negatively impact mental health. Importantly, several factors mediate the impact of precariousness on mental health, including social support, government support and access to adequate housing.

- Social support: The presence of social ties and social support are often associated with improved mental and physical health, especially as a resource that buffers the harmful impacts of stress exposure [12,13], although correlations are culturally contingent [14].
- Government support: While research has documented the ability of government-provided payments to build the resilience of poor and vulnerable households to economic shocks [15], the connection to mental health outcomes is more tenuous. Previous research suggests that social welfare payments need to provide sufficient economic provisions while also alleviating the stigma and psychological impacts associated with receiving benefits to have a protective effect on mental health [16].
- Housing adequacy: Access to sufficient space and autonomy in a home is important for mental health as non-functioning or inadequate housing is associated with depressive mood [17]. Overcrowding in homes can lead to cognitive overload from excess sensory stimuli, a lack of opportunities for retreat and feelings of being surveilled [18]. Similarly, previous research has found associations between overcrowding and depression, withdrawal, aggression, and psychological distress [19]. Living in share housing has been associated with depressive disorders and anxiety, especially for unemployed people [20].

Drawing on this literature from health, housing and economics, we hypothesize several channels through which precarity and access to mediating resources impact upon each other and upon mental health, as illustrated in Figure 1.

INSERT FIGURE 1 HERE

2. Methods

2.1 Study context: Victoria, Australia

Victoria is the second most populous state in Australia. While the first positive case of the novel coronavirus was identified in Australia on 25 January 2020, the large-scale impacts of the pandemic were not substantially felt until mid-March 2020. On the 30th of March the Australian Government introduced the 'Job Keeper Payment' that aimed to help employers keep their staff on pay roll and the 'Job Seeker Payment' that served as an emergency CoronaVirus Supplement to existing social welfare payments, immediately doubling the income of many unemployed people [21]. The State of Victoria declared a State of Disaster on August 2nd, 2020, resulting in a night-time curfew, a 5km limit on distances residents could travel from their homes, restrictions of gatherings in public and private spaces, office and school closures and limitations on allowable time outside the house. These restrictions, occurring in the context of a global health pandemic and large-scale economic crisis, present a case study in the impact of simultaneous imposition of housing and employment stress. Further, the substantial government intervention in support payments offers the lens of a 'natural experiment' to examine their benefits in mediating the impacts of 'double precarity' and exposure to COVID-19.

2.2 Study cohort: members of share households

This study focuses on people living in share houses in Victoria, Australia. In this context, share housing usually takes the form of individual arrangements between a land lord and a group of tenants; occupants may know each other before moving in together or may begin and remain as relative strangers. People living in shared housing are a group characterized by high levels of precarity. They are more likely to be young, casually employed, living in informal arrangements and at risk of homelessness than the broader population [22]. Share housing is often considered as either a transitional housing form on the way to adulthood or a 'coping mechanism' for vulnerable households when other forms of family or state

support are unavailable [23]. Recent evidence suggests that this group are more likely to have lost their jobs or had hours reduced, more likely to be reliant on social welfare payments and more likely to have been born overseas than the general population [3].

2.3 Survey design and data collection

Data were collected through two waves of an online longitudinal survey, yielding 1,052 responses in June and 312 responses in October. Respondent recruitment occurred through multiple channels. For Wave One of the surveys, most responses (n=670) were derived from an online survey panel service that targeted a representative selection of share housing respondents currently living in Victoria. The remaining responses (n=382) were targeted through targeted facebook and instagram advertisements, twitter and facebook messages posted by the University of Melbourne, Tenants Union of Victoria, and Victorian Legal Aid and posts on facebook groups aimed at international students and share houses across Victoria. Wave Two re-surveyed the original respondents, either via the online panel company or through automated follow-up emails to Wave One participants. In the empirical analysis, we only keep responses for people who appear in both survey waves, which allows us to have a panel of 586 individuals (293 x 2 waves). See Appendix Table A1 for the full survey.

2.4 Patient and Public Involvement

Neither patients nor the public were involved in the design, or conduct, or reporting or dissemination of our research. Survey respondents were emailed a copy of research findings if they indicated a desire to receive findings when completing the survey.

2.5 Empirical strategy

To investigate the relationship between vulnerability, exposure to COVID-19 and mental health, we proceed in two steps.

We start by analysing the relationship between precarity and respondents' socio-economic characteristics using the following regression setup:

$$Precarity_i = \alpha + \gamma X_i + \partial_c + \theta_s + u_i \quad (1)$$

We define socio-economic precarity ($Precarity_i$) as a two-dimensional index reflecting its interaction between employment and housing dimensions for respondent *i*. This is computed as the sum of the probability of the following conditions, and ranges between 0 and 2:

1. Probability of housing precarity: defined as living in unaffordable housing (paying more than 30% of income on housing costs) and/or renting with a lease of 6 months or shorter.
2. Probability of employment precarity: defined as being casually employed or unemployed.

X_i includes a vector of individual characteristics including gender, age, being low income (weekly income lower than AUD$650), having low education (having completed Year 12 or below), being a migrant (namely a temporary visa holder or refugee); ∂_c represents country of birth fixed effects and θ_s denotes sector of employment fixed effects. Given that $Precarity_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model.

Next, we investigate the effect of *Precarity*$_i$, combined with exposure to COVID-19 shocks, to calculate whether either or both affected mental health. Exposure to COVID-19 shocks (*Covid shock*$_i$) is measured by a respondent *i*'s reported impact of COVID-19 in the form of: (i) changing housing conditions (people moving in or out); (ii) decreased earnings; (iii) financial hardship (inability to cover housing and other living costs). We code *Covid shock*$_i$ as a dummy variable equal to one if an individual had experienced at least one of the above-mentioned shocks. We find that 74% of the respondents in our sample experienced at least one shock.

We investigate the relationship between mental health, precarity and COVID-19 shocks, using the following regression:

$$Mental\ health\ worse_i = \alpha + \beta_1 Precarity_i + \beta_2 Covid\ shock_i + \gamma X_i + \partial_c + \theta_s + u_i \quad (2)$$

The dependent variable *Mental health worse*$_i$ is computed as the sum of the probability of a worsening in mental health in wave 1 and/or wave 2 of the survey. Given that *Mental health worse*$_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model.

Finally, to provide insights on plausible mediating factors that may mediate the negative relationship between precarity and health outcomes, we assess the role played by:

(i) Sufficient government support (*Gov support*$_i$) targeted to mitigate negative COVID-19 effects, measured as respondents' sufficiency of support derived from accessing the packages offered by the government to assist financially those affected by COVID-19. Specifically, we assign a dummy variable equal to one for each respondent answering "somewhat agree" or "strongly agree" to the question "The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months".

(ii) Social support (*Social support*$_i$), measured as the presence of community or family networks used as risk-coping mechanisms and their frequency of access during the pandemic.

(iii) Housing inadequacy (*Housing inadequacy*$_i$), computed as a multidimensional index drawing on perceptions of privacy, use of space and overcrowding, modified from Campagna [24]:

We undertake a mediation analysis to examine the extent to which the association between precarity and a worsening in mental health occurs directly, and the extent to which it occurs through housing inadequacy and lack of social support.

Following VanderWeele [25], we utilize the following regression setup:

$$\mathbb{E}(M|\ Precarity_i=a,\ X_i=c)= \beta_0 +\beta_1\ a +\beta_2{}'\ c \qquad (3)$$

$$\mathbb{E}(Mental\ health\ worse_i|Precarity_i=a,\ M=m,\ X_i=c)= \theta_0 +\theta_1\ a+\theta_2\ m +\theta_3{}'\ c \qquad (4)$$

where M represents either *Social support*$_i$, *Gov support*$_i$, or *Housing inadequacy*$_i$ and X_i is a vector including the above-mentioned set of controls as well as an indicator of exposure to COVID-19 shocks (*Covid shock*$_i$).

This approach allows us to compute: (i) the natural direct effect (NDE), capturing how much precarity would affect mental health if we were to disable the relationship between precarity and the mediators; (ii) the natural indirect effect (NIE), which can be conceived as the effect on mental health of the mediator, keeping *Precarity*$_i$ fixed; (iii) The total effect (TE) representing the sum of NIE and NDE, which can be defined as how much mental health would change overall for a change in precarity, accounting for the mediators' effect.

3. Results

Our sample of members of group households predominantly comprised young people. The average age was 34 years with just over half being female, and one fifth being migrants. The majority (65%) experienced pre-existing housing precarity, more than one third experienced pre-existing employment

precarity and 28.5% experienced both - confirming that this cohort of group housing residents is precariously placed.

In terms of experience of 'COVID-19 shocks', three quarters reported a shock, and this decreased slightly by the second wave of data collection. Nearly one fifth of group housing residents reported a worsening of their mental health with COVID-19, with this rising by 2 percentage points in Wave 2.

Around one third of survey respondents indicated they had received sufficient government supports to make a substantial difference to their financial security. This decreased in subsequent waves of data collection by nearly 9%. Most people (65%) reported adequate social support, and this increased slightly over time. Around 30% of the respondents reported living in inadequate housing conditions. See Appendix Table A2 for expanded summary statistics.

The odds of experiencing double precarity was strongly patterned by socio-demographic characteristics. Notably, residents of group housing who were migrants to Australia reported three times greater odds of double precarity (3.2 95%CI 0.95-10.70). The odds of reporting worse mental health decreased with age (OR 0.97 95%CI 0.94-1.00) and were greater for women (OR 1.13 95%CI 0.60-2.10). The results of the Brant test (reported in Appendix Table A3) confirm that the proportional odds and parallel lines assumption of the ordered logit model predicting double precarity are met.

The results in table 1 indicate that double precarity was associated with respondents reporting worsening mental health (OR 2.4 95%CI 0.99-5.69). This relationship is largely driven by housing precarity (OR 2.4 95%CI 0.98-5.69) while employment precarity is not significantly related to reporting a deterioration in mental health. Exposure to COVID-19 shocks was strongly correlated with worsening mental health, with residents exposed to COVID-19 shocks reporting a 2.7-fold odds of deteriorating mental health (OR 2.7, 95%CI 1.53-4.85).

Table 1: The relationship between mental health, precarity and COVID-19 exposure

	Odds Ratio	Lower Confidence Interval	Upper Confidence Interval
Double precarity (a)	2.385	0.987	5.687
Housing precarity (a)	2.358	0.978	5.688
Employment precarity (a)	0.441	0.111	1.759
COVID-related shocks (b)	2.732	1.538	4.850

a) Adjusted for age, sex, migrant status, education level, COVID shock.
b) Adjusted for age, sex, migrant status, education level, double precarity

Notes: Odd ratios of regression equation (2). Full results are reported in Appendix Table A4.

When analysing the plausible channels underlying our results in Table 2, we find that precarity is positively associated with worsening mental health, as shown by the TCE estimates. The NDE coefficients, capturing how much precarity would affect mental health if we were to nullify the relationship between precarity and the mediators, confirms that precarity has a direct effect on worsening mental health when testing for any mediator (cols. I-III). Turning to the NIE, we find that much of the precarity-mental health association is mediated by inadequate housing (col. I) and by access to government support, both of which affect the relationship significantly. Specifically, inadequate housing explains around 14.7% of the TCE, while government support around 7.8% of the TCE, thus reducing the effect of precarity on mental health. Social support mitigates the negative relationship between precarity and mental health (has a negative sign), but the indirect effect is not statistically significant. Hence, these results indicate that housing inadequacy has a negative mediating effect on mental health, exacerbating the effect of precarity, while

access to government support played a positive mediating role, thus weakening the effect of precarity on mental health.

Table 2: Mediating factors

	Inadequate housing	Social support	Government support
Total Causal Effect (TCE)	0.075**	0.074**	0.078***
	(0.027)	(0.027)	(0.032)
Natural Direct Effect (NDE)	0.064**	0.073***	0.084***
	(0.027)	(0.027)	(0.027)
Natural Indirect Effect (NDE)	0.011**	-0.003	-0.006*
	(0.005)	(0.003)	(0.003)
Estimated proportion of effect explained (%)	14.76	4.05	7.84

Notes: This table shows the total causal effect (TCE), natural direct effect (NDE) and natural indirect effect (NIE) of change in precarity on mental health with mediation through inadequate housing, social support and government support (N=586).

4. Discussion

There is a strong association between experiencing precarity, exposure to COVID-19 shocks and deterioration of mental health during COVID-19 lockdowns in 2020. Specifically, experiencing a COVID-19 shock, such as moving homes or changing household occupants, losing income or experiencing financial hardship, is associated with a 2.7-fold increase in the odds of deteriorating mental health. Similarly, experiencing double precarity is associated with 2.4 times higher odds of reporting worsening mental

health. Occupants of share housing are highly likely to have experienced pre-existing employment and housing precarity, as well as COVID-19-induced shocks.

A novel contribution of this paper relates to our examination of the mediating impacts of housing adequacy, sufficient government support and social support. The finding that much of the precarity-mental health association is mediated by inadequate housing is significant. It correlates with existing findings that link overcrowding with depression and heightened stress levels [24] and longitudinal analysis that has found that changes in severe overcrowding and individual deprivation may reduce distress irrespective of other factors [26]. It also highlights the intersecting role of mental health and housing in the context of pandemic-induced stay-at-home rules. Particularly within share households, where occupant relationships range from close friendships to being strangers, access to adequate housing space and quality has a direct mental health impact. This has implications for public health policy that seeks to address both increased risk of viral spread in overcrowded housing and increased stress associated with an inability to experience privacy and retreat from others.

We find that accessing government support payments had a protective impact on mental health, but only if respondents indicated that this support was "sufficient to make a substantial difference to my financial security over the next 3 months". While 62.7% of respondents indicated that they had accessed some form of government assistance, only 38% indicated that it was sufficient to impact their financial security. This finding aligns with prior research that found that unreliable or insufficient welfare payments have little impact on mental health [16] while suggesting that substantial increases to unemployment welfare payments (JobSeeker) and the employee support payment (JobKeeper) had a significant impact on mental health for some. This finding is particularly important given the substantially higher rates of pre-existing precarity experienced by migrants, a group that was excluded from JobKeeper and JobSeeker payments. While research has often identified the protective impact of welfare payments on financial resilience following a disaster [27,28], this finding is a rare contribution to the literature on the impact of welfare

payments on mental health. In contrast, we find that social networks do mediate the relationship between precarity and mental health reduction, but not to a statistically significant degree. This may be partially explained by the reduced capacity for physical contact between social networks during lock-down conditions. It may also reflect the fact that those experiencing significant mental health decreases were more likely to reach out to their social support networks to access support.

A limitation of this study is the small sample size. This study deliberately targeted a specific cohort, rather than attempting a cross-sectional analysis of the population. While results are not generalisable to the broader population they do represent the circumstances of people in group housing – an under researched yet precarious cohort. Similarly, the timing of survey waves, at 5 months apart, is short and does not capture longer-term mental health impacts. This time frame was targeted to gather insights within the context of rapidly changing pandemic conditions. While this study provides insights into correlations between various elements, it does not establish causal links.

This research advances our understanding of the relationship between mental health, COVID-19 shocks and the double precarity of housing and employment insecurity. It also highlights the intersecting mediating effects of housing adequacy, receipt of adequate government payments and social support. Given that COVID-19 lock downs, with associated economic insecurity and increased time spent under stay-at-home rules, appear likely to be an on-going experience for many, it is essential that we understand how vulnerability and supporting resources interact with mental health. In this context, access to adequate and affordable housing are likely to become more constrained and more important than ever. Our analysis points to the importance of employment and housing security for mental health and also highlights the psychological impacts of overcrowded housing in the context of a pandemic. Future research should continue to track this vulnerable group, especially as mental health challenges and economic insecurity, particularly for migrants and young people, continues to be exacerbated by the pandemic.

Research Ethics Approval: Human Participants

This research project has been approved by the Human Research Ethics Committee of The University of Melbourne. The Ethics ID Number is 2056957.1

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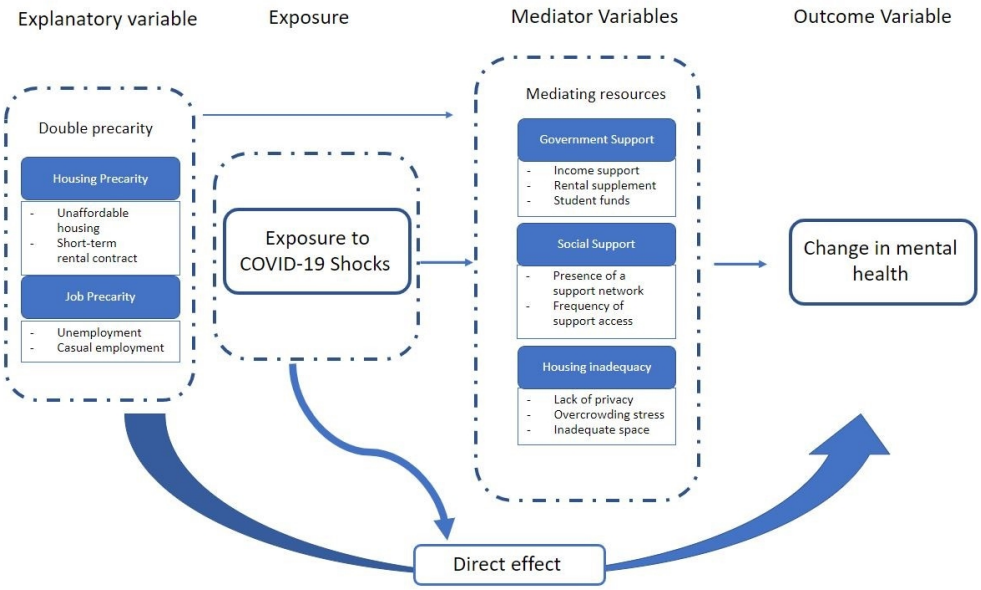

Figure 1. Conceptual framework linking double precarity, exposure to COVID-19 shocks, mediating resources and mental health impacts

316x193mm (96 x 96 DPI)

Appendix Figures and Tables

Appendix Table A.1 Summary of the Survey Instrument

Q	Field	Question	Measures/ Answers	Survey logic
1	Housing Situation – screening question	What is your housing situation?	I currently live in a share house/ I have previously lived in a share house in 2020, but no longer do now/ Neither of the above	Selecting 'Neither of the above' terminated the survey
2	Location – screening question	Where do you live?	I currently live in Victoria/ I have lived in Victoria in 2020, but do not live there anymore/ I have not lived in Victoria at any point in 2020	Selecting 'I have not lived in Victoria at any point in 2020' terminated the survey
3	Location	What is your current postcode?	Drop down menu	
4	Age	What year were you born?	Drop down menu	
5	Country of origin	What is your country of birth?	Drop down menu with top 20 most common countries of origin in Australia then 'other'	
6	Gender	What is your gender	Male/ female/ non-binary/ prefer not to say	
7	Citizenship	Which of the following best describes you?	Citizen of Australia or New Zealand/ Permanent resident of Australia/ Visa Holder	
8	Visa Purpose	What is the primary purpose of your stay in Australia?	Skilled work/ Holiday/ Working holiday/ Study/ Joining family/ Humanitarian protection	Question only shown to those who selected 'Visa holder' in Q7
9	Indigeneity	Are you of Aboriginal or Torres Strait Islander origin?	Aboriginal/ Torres Strait Islander/ Aboriginal and Torres Strait Islander/ Not Aboriginal or Torres Strait Islander	Only shown to those who selected 'Citizen of Australia or New Zealand' in Q7
10	Education	What is your highest level of education?	Year 10 or below/ Year 11 or equivalent/ Year 12 or equivalent/ Trade or Apprenticeship/ Other TAFE or technical certificate/ Diploma/ Bachelor degree/ Postgraduate degree/ prefer not to say	
11	Employment status	What is your current employment status	Working 35 hours or more per week / Working less than 35 hours per week and happy with hours/ Working less than 35	Only shown to those who indicated they

			hours a week but want more hours / Not working, looking for work / Not working, not looking for work / Prefer not to say	were currently working in Q10
12	Industry of employment	Which of the following industries best describes your main job?	Accommodation and Food Services / Administrative and Support Services / Agriculture, Forestry and Fishing /Arts and Recreation Services / Construction / Education and Training/ Electricity, Gas, Water and Waste Services / Financial and Insurance Services / Health Care and Social Assistance / Information Media and Telecommunication / Manufacturing / Mining/ Professional, Scientific and Technical Services / Public Administration and Safety/ Rental, Hiring and Real Estate Services / Retail Trade / Transport, Postal and Warehousing/ Wholesale Trade	
13	Employment Change	Has your work situation changed since COVID-19 was declared as a pandemic?	Yes/ No	
14	Employment Change	What has changed?	My hours have reduced /My hours have increased / My employment has been permanently terminated or temporarily paused/ Other	Only shown to those that selected 'yes' in Q13
15	Employment contract	What kind of employment contract do you have in your main job?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated they were currently working in Q10
16	Employment Status	What kind of employment contract did you have in your main job prior to COVID-19 disruptions?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated that their 'employment has been permanently terminated or temporarily paused' in Q14
17	Salary	Would you find it easier to calculate your average weekly take-home pay (post-tax) or your annual salary (pre tax)?	Weekly take-home pay (after tax)/ Annual salary (before tax)	
18	Salary	What is your average weekly take-home pay (after tax)? (include	Drop down menu of income brackets	Shown to those that selected

		salary, any government payments, dividends and additional income like child support)		'weekly take-home pay' in Q17
19	Salary	What is your annual salary (before tax)? (include salary, any government payments, dividends and additional income like child support)	Drop down menu of income brackets	Shown to those that selected 'annual salary' in Q17
20	Work expectations	How likely do you think it is that you will lose all or most of your work by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are currently working in Q10
21	Work expectations	How likely do you think it is that you will gain employment by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are not currently working in Q10
22	Living expenses	In the last 12 months, how difficult was it for you to meet your necessary cost of living expenses like housing, electricity, water, health care, food, clothing or transport?	5 point Likert scale from 'extremely easy' to 'extremely difficult'	
23	Financial hardship	Have you done any of the following in the last 12 months?	No/ Yes, since March 2020/ Yes, prior to March 2020 for Sought assistance from a charity organization/ Pawned or sold anything because you needed cash/ Went without meals to afford other necessities/ Could not pay the mortgage or rent on time/ Used afterpay	
24	Savings	What is the approximate balance of your total savings?	Less than $500/ $500 - $2,999/ $3,000 - $4,999 / $5,000 - $10,000/ More than $10,000	
25	Debt	What is your current level of debt?	I have more debts than I can pay back/ I have debts that I am just managing to pay back / I have debts that I am managing to pay back comfortably / I have no debts	

26	Change in financial situation	Since COVID-19, has your financial situation	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
27	Life satisfaction	How satisfied are you with your life in general?	5 point Likert scale from 'extremely satisfied' to 'extremely dissatisfied'	
28	Mental health	Overall, would you say your mental health is	5 point Likert scale from 'excellent' to 'terrible'	
29	General health	Overall, would you say your general health is	5 point Likert scale from 'excellent' to 'terrible'	
30	Mental health change	Since COVID-19 isolation rules were introduced, would you say that your mental health has	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
31	Housing change	Have your living arrangements changed since COVID-19?	Nothing has changed / I have moved back in with family/ I have moved in with my partner/ I have moved into a (different) shared living arrangement / Additional occupants have moved in (more people now live in my home)/ Occupants have left (less people now live in my home)/ Other (please describe)	
32	Reason for housing change	Why did you make this change?	Open text	
33	Occupants	How many people live in your home? (include yourself and everyone who spends most nights of the week staying in your home)	Drop down menu 2 – 8+	
34	Tenure	What is your current housing situation?	Living in a short-term rental (e.g. no lease or a lease of less than 6 months)/ Living in a rental property with a lease of 6 months or more / Living in a home that I own/ Living with parents/ Other	
35	Landlord	I rent from	A landlord or real estate agent/ A flatmate/ A family I know/ A family I don't know/ Other	Shown to those that selected 'lease than 6 months' or 'lease of 6 months or more' in Q34
36	Housing cost	What is your personal weekly rent or mortgage payment	Drop down menu in $100 increments	

37	Bedrooms	How many bedrooms are there in your home?	Drop down menu of 0 – 5+	
38	Housing crowding stress	In the past month, how often have you	5 points from 'all the time to 'never' for Felt nervous and stressed about how crowded your home is/ felt concerned about your ability to effectively use your home to do the things you need to do (ie work, sleep, enjoy free time/ been angry because you didn't have enough privacy or personal space for yourself at home	
39	Housemate relations	Since COVID-19 isolation rules were introduced, would you say that your relationships with other members of your household have	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
40	Legal rights	How confident do you feel about knowing and protecting your legal rights as a renter?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
41	Future housing costs	How confident are you that you will be able to meet your housing costs over the next 6 months?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
42	Access to support	Please indicate if you have accessed any of the following resources in response to COVID-19 (please select all that apply)	Government support/ The COVID-19 rent relief grant / International Students Emergency Relief Fund/ Financial support from family or friends / Financial support from an employer/ Financial support from a housemate / Financial support from a religious group or charity/ Accessed personal savings/ Accessed superannuation/ Took out a personal loan/ Sought mortgage payment relief/ Other	
43	Effectiveness of support	The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months	5 point Likert scale from 'strongly agree' to 'strongly disagree'	Shown to those that received support in Q42
44	Social support	Do you have a support network (family, friends, community) that can	Yes/ no	

		help you in situations of financial hardship?		
45	Social support	The following people/ organisations have worked very hard to support me during COVID-19	5 points from 'strongly agree' to 'strongly disagree' for me/ my family/ my work place/ the government/ my friends/ charities/ community groups	
46	Social support	How often have you felt you had access to the following support over the last 3 months? This support could be given in-person or virtually	5 points from 'all the time to 'never' for Someone you can count on to listen to you when you need to talk/ Someone to give you information to help you understand a situation/ Someone to help with daily chores if you were sick/ Someone to have a good time with	
47	Rental negotiation	Have you attempted to renegotiate your rent in response to COVID-19?	No / Yes, and rent was reduced / Yes, but rent was not reduced/ Negotiations are still in progress	
48	Rental negotiation	Why didn't you attempt to renegotiation your rent?	I don't need to/ I don't know how or don't feel comfortable doing it / I don't qualify / I am worried I will be forced to leave if I do/ Other	Shown to those that selected 'no' in Q47
49	Rental negotiation	Can you please explain the outcome of this negotiation?	Text input	
50	Open ended	Is there anything else you would like people to know about the experiences of residents of share houses during COVID-19?	Text input	

Appendix Table A2: Summary statistics, sample mean by survey wave.

	Baseline (June 2020)	Follow-up (October 2020)
Age (average years, range)	34, 19-74	
Female (%)	55.67	
Migrant (%)	21.33	
Low Education (%)	16.00	
Mental health worsening (%)	18.33	+2
Number of people in the household (average number, range)	3, 2-6	3, 2-7
Pre-existing social conditions:		
Housing precarity (%) (paying more than 30% of income on housing costs and/or renting in the informal market).	65.17	
Employment precarity (%) (casually employed or unemployed)	35.50	
Double precarity (%) (experiencing both housing and employment precarity simultaneously)	28.50	
Changing social conditions:		
Covid shocks (%) (people moving in or out of household, decreased earnings, inability to cover housing and other living costs)	74.00	-4.33
Housing inadequacy (%) (feeling stressed about overcrowding, concerned about ability to use the house, angry about lack of privacy)		31.33
Accessed government support (%)	67.33	-9.33
Sufficiency of government support (%)	37.67	-8.67
Social support (%)	64.66	+1.34
N	293	293

Appendix Table A3: The relationship between individual characteristics and precarity

	Outcome variable: *Double Precarity$_i$*					
	I	II	III	IV	V	VI
Female	1.148	1.153	0.98	1.153	0.998	1.127
	(0.248)	(0.249)	(0.218)	(0.190)	(0.271)	(0.358)
Migrant	6.804***	7.289***	3.356***	3.003***	2.241	3.197*
	(2.027)	(2.192)	(1.154)	(1.150)	(1.101)	(1.970)
Age	0.957***	0.952***	0.953***	0.956***	0.957**	0.968*
	(0.011)	(0.011)	(0.010)	(0.007)	(0.019)	(0.017)
Low education		1.996**		2.139***	0.823	1.084
		(0.579)		(0.531)	(0.297)	(0.626)
Low income			7.423***			
			(1.700)			
Country of birth FE	N	N	N	Y	N	Y
Sector employed FE	N	N	N	N	Y	Y
N	586	586	586	586	422	422
Brant test	0.340	0.206	0.823	0.206	0.206	0.206

Notes: Ordered logit regressions, odd ratios reported. *Double Precarity$_i$* (job + housing precarity) ranges between 0 and 2. Standard errors clustered at the sector of employment level. Given that the low education and low income dummy variables are likely to be collinear, we control only for one of them (low education) when we add country of birth and sector of employment fixed effects (cols IV-VI).

Appendix Table A4: The relationship between mental health, precarity and COVID-19 exposure

	Outcome variable: *Mental health worse*$_i$				
	I	II	III	IV	V
Double precarity		2.360*	2.385**		
		(1.043)	(1.059)		
Housing precarity				2.358*	
				(1.059)	
Job precarity					0.441
					(0.331)
Exposure to	2.747***		2.732***	2.732***	2.746***
COVID shocks	(0.750)		(0.800)	(0.800)	(0.750)
Sector employed FE	Y		Y	Y	Y
N	538		538	538	538
Brant test	0.397		0.656	0.397	0.250

Notes: Ordered logit regressions, odd ratios reported. *Mental health worse*$_i$ (worsening of mental health in wave 1 and/or 2) ranges between 0 and 2. All regressions control for: gender, migrant status and age. Standard errors clustered at the sector of employment level.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	5 and 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3 – 4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6 – 8*
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	13
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3 – 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6 – 9
		(*b*) Describe any methods used to examine subgroups and interactions	6 – 9
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10 and appendix
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*10 - 11*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10 - 11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of COVID-19 shocks, precarity and mediating resources on the mental health of residents of share housing in Victoria, Australia: an analysis of data from a two-wave survey

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Title: The impact of COVID-19 shocks, precarity and mediating resources on the mental health of residents of share housing in Victoria, Australia

Abstract

Objectives: Lockdown measures in response to COVID-19 have challenged people's mental health, especially among economically vulnerable households. The objective of this study is to investigate the impact of exposure to COVID-19-shocks (defined as job loss, living cost pressures and changing housing conditions throughout the lockdown period) and double precarity (defined as precarity in housing and employment) on mental health outcomes for members of share households as well as the mediating effects of a range of resources.

Design: We conducted a two-wave survey of occupants of share housing in June and October 2020 during a prolonged period of population lockdown. We conducted fixed effects ordered logit regression models to assess the mental health consequences of baseline precarity and COVID-related shocks.

Setting: The State of Victoria, Australia

Participants: We surveyed 293 occupants of share houses (mean age 34 SD 11.5, 56% female). Members of share houses (where individuals are unrelated adults and not in a romantic relationship) are more likely to be young, casually employed, immigrants and low-income.

Primary and secondary outcome measures: We measured household composition, housing and employment precarity, access to government support payments, household crowding, engagement with social networks and experience of COVID-19 shocks. We used a self-reported measure of mental health.

Results: Those exposed to COVID-19 shocks reported a 2.7 times higher odds of mental health deterioration (OR 2.7, 95%CI 1.53-4.85). People exposed to double precarity (precarity in both housing and employment) reported 2.4 times higher odds of mental health deterioration (OR 2.4, 95%CI 0.99-5.69). Mediation analysis suggests that housing inadequacy explained 14.7% of the total effect of double precarity on mental health while lack of access to sufficient government financial support explained 7%.

Conclusions: Residents of group households characterised by pre-existing precarity were vulnerable to negative mental health effects of lockdowns. Access to sufficient government payments and adequate housing buffered this negative effect.

Strengths and limitations of this study

- Our use of mediation analysis enables novel examination of the protective role of housing adequacy, government payments and social support for tenant's mental health during COVID-related shocks.
- We survey respondents at two time points – allowing examination of change within people in response to economic shocks.
- The small and highly targeted sample (n= 293) is not generalisable to the broader population.
- Our observational study describes relationships but does not establish causality.

1. Introduction

The emergence of the highly infectious coronavirus (COVID-19) has created a global health crisis with significant economic and social repercussions. Australia, like many other countries, responded with social distancing measures including limiting time outside of the home, broad work-from-home rules, temporary or permanent shut down of businesses and closure of schools and childcare. These measures effectively locked down households for long periods of time and have had well documented health, social and economic costs [1,2]. The most acute consequences have been felt by households who are vulnerable to both precarious employment (e.g., casual employees with no leave entitlements or unemployed people) and housing (e.g., people without formal leasing arrangements or living in highly unaffordable housing); that is, households prone to pre-existing double precarity. One particular cohort, occupants of share housing (where individuals are unrelated adults and not in a romantic relationship) are amongst the most

vulnerable to being both precariously employed and housed during this time [3]. They are, therefore, potentially amongst the most exposed to financial hardship arising from restrictive public health measures put in place to reduce COVID-19 transmission in communities.

This study was conducted in Victoria, the second most populous state in Australia. While the first positive case of the novel coronavirus was identified in Australia on 25 January 2020, the large-scale impacts of the pandemic were not substantially felt until mid-March 2020. On the 30th of March the Australian Government introduced the 'Job Keeper Payment' that aimed to help employers keep their staff on pay roll and the 'Job Seeker Payment' that served as an emergency CoronaVirus Supplement to existing social welfare payments, immediately doubling the income of many unemployed people [4]. The State of Victoria declared a State of Disaster on August 2nd, 2020, resulting in a night-time curfew, a 5km limit on distances residents could travel from their homes, restrictions of gatherings in public and private spaces, office and school closures and limitations on allowable time outside the house. These restrictions, occurring in the context of a global health pandemic and large-scale economic crisis, present a case study in the impact of simultaneous imposition of housing and employment stress. Further, the substantial government intervention in support payments offers the lens of a 'natural experiment' to examine their benefits in mediating the impacts of 'double precarity' and exposure to COVID-19.

This paper analyses the effects of housing and employment precarity on mental health for this cohort, while investigating the mediating effects of access to social, income and housing resources. Using the experiences of share housing residents during the 115 days of lockdown in Melbourne Australia, we seek to examine how lockdown restrictions, under the duress of 'double precarity' common amongst share housing households, impacted mental health, and how much support through social connections, sufficient government assistance or housing adequacy offered protection. We propose a conceptual framework (Figure 1) for understanding the set of relationships under consideration before presenting findings from two surveys conducted in Victoria, Australia in 2020.

2. Methods

2.1 Study cohort: members of share households

This study focuses on people living in share houses in Victoria, Australia. In Australia, share housing usually takes the form of individual arrangements between a land lord and a group of tenants; occupants may know each other before moving in together or may begin and remain as relative strangers. People living in shared housing are a group characterized by high levels of precarity. They are more likely to be young, casually employed, living in informal arrangements and at risk of homelessness than the broader population [5]. In Victoria, the median share household spends 23% of gross household income on housing costs, compared to 14% across all household types [6]. Similarly, 36% of members of share households are not Australian citizens, compared to 12% of the broader population of Victoria [7]. Share housing is often considered as either a transitional housing form on the way to adulthood or a 'coping mechanism' for vulnerable households when other forms of family or state support are unavailable [8] or where occupants are unable to provide income and rental history documents [9]. Recent evidence suggests that this group are more likely to have lost their jobs or had hours reduced, more likely to be reliant on social welfare payments and more likely to have been born overseas than the general population [3].

2.2 Conceptual Framework

Our conceptual framework is based on the following explanatory variables and mediator variables.

Explanatory variables: The double precarity of housing and employment insecurity and exposure to COVID-19 shocks

Despite the wealth of evidence on the impact of both employment and housing instability on mental health, these two forms of insecurity have largely been studied separately. Similarly, evidence is still emerging about the 'shocks' experienced by individuals and households impacted by COVID-19. This paper addresses this gap, focusing on:

- housing precarity: defined as living with short-term rental contracts and/or unaffordable housing. Housing security and affordability is similarly recognized as an important determinant of health and wellbeing. Access to adequate and secure housing serves a protective function for mental health [10–12]. Further, poor-quality housing and insecure tenancies all have a potentially negative impact on a person's health [13,14].
- Employment precarity: defined as casual employment contracts and unemployment. The impact of job loss and job insecurity on mental health outcomes has been well established [see, for example, 15,16]. Unemployment is both a consequence of, and risk factor for, reduced mental health [17].
- Exposure to COVID-19 shocks: defined as job loss, living cost pressures and changing housing conditions throughout the lockdown period. Emerging research has identified higher exposure to these types of shocks amoung the casually employed, migrants and young people [3].

Mediator Variables: Resources of social support, government support and housing adequacy

Precarity in housing and employment triggered by pandemic containment measures is known to negatively impact mental health. Importantly, several factors mediate the impact of precariousness on mental health, including social support, government support and access to adequate housing.

- Social support: The presence of social ties and social support are often associated with improved mental and physical health, especially as a resource that buffers the harmful impacts of stress exposure [18,19]. For example, social support has been shown to mitigate financial hardship via monetary transfers and interpersonal loans in some cases [20].

- Government support: While research has documented the ability of government-provided payments to build the resilience of poor and vulnerable households to economic shocks [21], the connection to mental health outcomes is more tenuous. Previous research suggests that social welfare payments need to provide sufficient economic provisions while also alleviating the stigma and psychological impacts associated with receiving benefits to have a protective effect on mental health [22].
- Housing adequacy: Access to sufficient space and autonomy in a home is important for mental health as non-functioning or inadequate housing is associated with depressive mood [23]. Overcrowding in homes can lead to cognitive overload from excess sensory stimuli, a lack of opportunities for retreat and feelings of being surveilled [24]. Similarly, previous research has found associations between overcrowding and depression, withdrawal, aggression, and psychological distress [25]. Living in share housing has been associated with depressive disorders and anxiety, especially for unemployed people [26].

Drawing on this literature from health, housing and economics, we hypothesize several channels through which precarity and access to mediating resources impact upon each other and upon mental health, as illustrated in Figure 1.

INSERT FIGURE 1 HERE

2.3 Survey design and data collection

Data were collected through two waves of an online longitudinal survey, yielding 1,052 valid responses in June and 293 valid responses in October. The purpose of a longitudinal design was to test changes in mental health over time, in a period characterised by high levels of COVID19 shock for many. The survey was open to anyone who had lived in a share household in Victoria at any point between June 2020 and

October 2020 and screening questions were used to exclude those who didn't meet these criteria. The first page of the online survey contained an informed consent statement and participants acknowledged consent by clicking 'start' on the survey. The survey instrument was designed using a variety of standardized demographic, housing, health and financial resilience questions derived from large Australian surveys such as the Household, Income, Labour Dynamics in Australia (HILDA) survey and the Australian Bureau of Statistics Census. See Appendix Table A1 for the full survey.

Respondent recruitment occurred through multiple channels. For Wave One of the surveys, most responses (n=670) were derived from an online survey panel service that targeted a representative selection of share housing respondents currently living in Victoria. The remaining responses (n=382) were targeted through targeted facebook and instagram advertisements, twitter and facebook messages posted by the University of Melbourne, Tenants Union of Victoria, and Victorian Legal Aid and posts on facebook groups aimed at international students and share houses across Victoria. Wave Two re-surveyed the original respondents, either via an anonymized process managed by the online panel company or through follow-up emails to Wave One participants automated using the survey program Qualtrics. In the empirical analysis, we only keep responses for people who appear in both survey waves, which allows us to have a panel of 293 individuals in two time periods. Despite the relatively high attrition rate, a comparison of means between the included and the excluded participants did not point to any statistically significant difference between the two groups, based on most observable characteristics.

Unlike cross-sectional surveys, this panel survey set-up enables the analysis of individual-level dynamics that are not biased by self-selection, by observing the same individuals repeatedly at two different times of the COVID pandemic. Self-selection would arise due to potential unobservable confounders correlated with both outcomes (mental health) and explanatory variables (double precarity), such as lower motivation or worse work-performance.

2.4 Patient and Public Involvement

Neither patients nor the public were involved in the design, or conduct, or reporting or dissemination of our research. Survey respondents were emailed a copy of research findings if they indicated a desire to receive findings when completing the survey.

2.5 Empirical strategy

To investigate the relationship between vulnerability, exposure to COVID-19 and mental health, we proceed in two steps.

We start by analysing the relationship between precarity and respondents' socio-economic characteristics using the following regression setup:

$$Precarity_i = \alpha + \gamma X_i + \partial_c + \theta_s + u_i \quad (1)$$

We define socio-economic precarity ($Precarity_i$) as a two-dimensional index reflecting its interaction between employment and housing dimensions for respondent *i*. This is computed as the sum of the probability of the following conditions, and ranges between 0 and 2:

1. Probability of housing precarity: defined as living in unaffordable housing (paying more than 30% of income on housing costs) and/or renting with a lease of 6 months or shorter.
2. Probability of employment precarity: defined as being casually employed or unemployed.

X_i includes a vector of individual characteristics including gender, age, being low income (weekly income lower than AUD$650), having low education (having completed Year 12 or below), being a migrant (namely a temporary visa holder or refugee); ∂_c represents country of birth fixed effects and θ_s denotes sector of employment fixed effects. Given that *Precarity*$_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model.

Next, we investigate the effect of *Precarity*$_i$, combined with exposure to COVID-19 shocks, to calculate whether either or both affected mental health. Exposure to COVID-19 shocks (*Covid shock*$_i$) is measured by a respondent *i*'s reported impact of COVID-19 in the form of: (i) changing housing conditions (people moving in or out); (ii) decreased earnings; (iii) financial hardship (inability to cover housing and other living costs). We code *Covid shock*$_i$ as a dummy variable equal to one if an individual had experienced at least one of the above-mentioned shocks.

We investigate the relationship between mental health, precarity and COVID-19 shocks, using the following regression:

$$Mental\ health\ worse_i = \alpha + \beta_1 Precarity_i + \beta_2 Covid\ shock_i + \gamma X_i + \partial_c + \theta_s + u_i \quad (2)$$

The dependent variable *Mental health worse*$_i$ is computed as the sum of the probability of a worsening in mental health in wave 1 and/or wave 2 of the survey. Our measure of mental health was self-reported. Respondents were asked in both waves of the survey "Since COVID-19 isolation rules were introduced, would you say that your mental health became: much better, better, did not change, worse, much worse". We generated a dummy variable equal to 1 if respondents answered worse or much worse in each wave. Given that *Mental health worse*$_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model. Regressions (1) and (2) cannot establish a causal relationship between outcomes and explanatory variables, and should be interpreted as correlations.

Finally, to provide insights on plausible mediating factors that may mediate the negative relationship between precarity and health outcomes, we assess the role played by:

(i) Sufficient government support (*Gov support*$_i$) targeted to mitigate negative COVID-19 effects, measured as respondents' self-evaluated sufficiency of support derived from accessing the packages offered by the government to assist financially those affected by COVID-19. Specifically, we assign a dummy variable equal to one for each respondent answering "somewhat agree" or "strongly agree" to the question "The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months".

(ii) Social support (*Social support*$_i$), measured as the presence of community or family networks used as risk-coping mechanisms and their frequency of access during the pandemic, modified from [27].

(iii) Housing inadequacy (*Housing inadequacy*$_i$), computed as a multidimensional index drawing on perceptions of privacy, use of space and overcrowding, modified from Campagna [28]:

We undertake a mediation analysis to examine the extent to which the association between precarity and a worsening in mental health occurs directly, and the extent to which it occurs through housing inadequacy and lack of social support.

Following VanderWeele [29], we utilize the following regression setup:

$$\mathbb{E}(M|\ Precarity_i=a,\ X_i=c)= \beta_0 +\beta_1\, a +\beta_2{}'\, c \qquad (3)$$

$$\mathbb{E}(Mental\ health\ worse_i|Precarity_i=a,\ M=m,\ X_i=c)= \theta_0 +\theta_1\, a+\theta_2\, m +\theta_3{}'\, c \qquad (4)$$

where M represents either *Social support*$_i$, *Gov support*$_i$, *Housing inadequacy*$_i$ or *Covid shock*$_i$, and X_i is a vector including the above-mentioned set of controls as well as an indicator of exposure to COVID-19 shocks (when M is not *Covid shock*$_i$).

This approach allows us to compute: (i) the natural direct effect (NDE), capturing how much precarity would affect mental health if we were to disable the relationship between precarity and the mediators; (ii) the natural indirect effect (NIE), which can be conceived as the effect on mental health of the mediator, keeping $Precarity_i$ fixed; (iii) The total effect (TE) representing the sum of NIE and NDE, which can be defined as how much mental health would change overall for a change in precarity, accounting for the mediators' effect.

3. Results

Our sample of members of group households predominantly comprised young people. The average age was 34 years with just over half being female, and one fifth being migrants. The majority (65%) experienced pre-existing housing precarity, more than one third experienced pre-existing employment precarity and 28.5% experienced both - confirming that this cohort of group housing residents is precariously placed.

In terms of experience of 'COVID-19 shocks', three quarters reported a shock, and this decreased slightly by the second wave of data collection. Nearly one fifth of group housing residents reported a worsening of their mental health with COVID-19, with this rising by 2 percentage points in Wave 2.

38% of survey respondents indicated they had received sufficient government supports to make a substantial difference to their financial security. This decreased in the second wave of the survey by nearly 9%. Most people (65%) reported adequate social support, and this increased slightly over time. 31% of the respondents reported living in inadequate housing conditions. See Appendix Table A2 for expanded summary statistics.

The odds of experiencing double precarity was strongly patterned by socio-demographic characteristics. Notably, residents of group housing who were migrants to Australia reported three times greater odds of double precarity (3.2 95%CI 0.95-10.70). The odds of reporting worse mental health decreased with age (OR 0.97 95%CI 0.94-1.00) and were greater for low income earners (OR 7.42 95%CI 4.74-11.63). The results of the Brant test (reported in Appendix Table A3) confirm that the proportional odds and parallel lines assumption of the ordered logit model predicting double precarity are met.

The results in table 1 indicate that exposure to COVID-19 shocks was strongly correlated with worsening mental health, with residents exposed to COVID-19 shocks reporting a 2.7-fold odds of deteriorating mental health (OR 2.7, 95%CI 1.53-4.85). Double precarity was also associated with respondents reporting worsening mental health (OR 2.4 95%CI 0.99-5.69). This relationship is largely driven by housing precarity (OR 2.4 95%CI 0.98-5.69) while employment precarity is not significantly related to reporting a deterioration in mental health.

Table 1: The relationship between mental health, precarity and COVID-19 exposure

	Odds Ratio	Lower Confidence Interval	Upper Confidence Interval	P value
COVID-related shocks (b)	2.732	1.538	4.850	0.001
Double precarity (a)	2.385	0.987	5.687	0.050
Housing precarity (a)	2.358	0.978	5.688	0.050
Employment precarity (a)	0.441	0.111	1.759	0.246

a) Adjusted for age, sex, migrant status, education level, COVID shock.
b) Adjusted for age, sex, migrant status, education level, double precarity

Notes: Odd ratios of regression equation (2). Full results are reported in Appendix Table A4.

When analysing the plausible channels underlying our results in Table 2, we find that precarity is positively associated with worsening mental health, as shown by the TCE estimates. The NDE coefficients, capturing how much precarity would affect mental health if we were to nullify the relationship between precarity

and the mediators, confirms that precarity has a direct effect on worsening mental health when testing for any mediator (cols. I-IV). Turning to the NIE, we find that much of the precarity-mental health association is mediated by inadequate housing, access to government support and exposure to COVID-19 shocks, all of which affect the relationship significantly. Specifically, inadequate housing explains 14.7% of the TCE, and access to government support 7.8% of the TCE, thus reducing the effect of precarity on mental health, and covid shocks 27.78% of the TCE. Social support mitigates the negative relationship between precarity and mental health (has a negative sign), but the indirect effect is not statistically significant. Hence, these results indicate that housing inadequacy and exposure to COVID-19 shocks have a negative mediating effect on mental health, exacerbating the effect of precarity, while access to government support played a positive mediating role, thus weakening the effect of precarity on mental health.

Table 2: The effect of mediating factors and exposure to Covid shocks on the relation between double precarity and mental health decline

	Inadequate housing	Social support	Government support	Covid Shock
Total Causal Effect (TCE)	0.075**	0.074**	0.078***	0.090***
	(0.027)	(0.027)	(0.032)	(0.029)
Natural Direct Effect (NDE)	0.064**	0.073***	0.084***	0.065**
	(0.027)	(0.027)	(0.027)	(0.316)
Natural Indirect Effect (NIE)	0.011**	-0.003	-0.006*	0.025***
	(0.005)	(0.003)	(0.003)	(0.089)
Estimated proportion of effect explained (%)	14.76	4.05	7.84	27.78

Notes: This table shows the total causal effect (TCE), natural direct effect (NDE) and natural indirect effect (NIE) of precarity on change in mental health with mediation through inadequate housing, social support, government support and exposure to COVID-19 shocks (N=586).

4. Discussion

There is a strong association between experiencing precarity, exposure to COVID-19 shocks and deterioration of mental health during COVID-19 lockdowns in 2020 for members of share households. Specifically, experiencing a COVID-19 shock, such as moving homes or changing household occupants, losing income or experiencing financial hardship, is associated with a 2.7-fold increase in the odds of deteriorating mental health. Similarly, experiencing double precarity is associated with 2.4 times higher odds of reporting worsening mental health. Occupants of share housing are highly likely to have experienced pre-existing employment and housing precarity, as well as COVID-19-induced shocks.

A novel contribution of this paper relates to our examination of the mediating impacts of housing adequacy, sufficient government support and social support. The finding that much of the precarity-mental health association is mediated by inadequate housing is significant. It correlates with existing findings that link overcrowding with depression and heightened stress levels [28] and longitudinal analysis that has found that changes in severe overcrowding and individual deprivation may reduce distress irrespective of other factors [30]. It also highlights the intersecting role of mental health and housing in the context of pandemic-induced stay-at-home rules. Particularly within share households, where occupant relationships range from close friendships to being strangers, access to adequate housing space and quality has a direct mental health impact. This has implications for public health policy that seeks to address both increased risk of viral spread in overcrowded housing and increased stress associated with an inability to experience privacy and retreat from others.

We find that accessing government support payments had a protective impact on mental health, but only if respondents indicated that this support was “sufficient to make a substantial difference to my financial security over the next 3 months”. While 62.7% of respondents indicated that they had accessed some form of government assistance, only 38% indicated that it was sufficient to impact their financial security.

This finding aligns with prior research that found that unreliable or insufficient welfare payments have little impact on mental health [22] while suggesting that substantial increases to unemployment welfare payments (JobSeeker) and the employee support payment (JobKeeper) had a significant impact on mental health for some. This finding is particularly important given the substantially higher rates of pre-existing precarity experienced by migrants, a group that was excluded from JobKeeper and JobSeeker payments. While research has often identified the protective impact of welfare payments on financial resilience following a disaster [31,32], this finding is a rare contribution to the literature on the impact of welfare payments on mental health. In contrast, we find that social networks do mediate the relationship between precarity and mental health reduction, but not to a statistically significant degree. This may be partially explained by the reduced capacity for physical contact between social networks during lock-down conditions. It may also reflect the fact that those experiencing significant mental health decreases were more likely to reach out to their social support networks to access support.

Our study has several important strengths. It is one of the first studies to examine the mediating role of housing, government support and social conditions in ameliorating the negative mental health effects of a shock, such as COVID lockdowns, on members of group households. This economically vulnerable cohorts characterised by less secure housing tenure is often under-represented in national surveys and overlooked in research. Our paper offers a custom-designed survey of this small and highly targeted sample at two time points. We have reduced the impact of self-selection bias by using multiple dissemination channels and commissioning an online panel with a broad audience of panel members. Our study has several important limitations that should be noted. First, due to its targeted nature, our small sample size is small and there was a high level of attrition between Wave One and Two. However, we have repeated measures for 293 respondents which allows us to examine change in economic circumstances and mental health over time. The timing of survey waves, at 5 months apart, is short and does not capture longer-term mental health impacts. This time frame was targeted to gather insights

within the context of rapidly changing pandemic conditions. Finally, while this study provides insights into correlations between various elements, it does not establish causal links.

This research advances our understanding of the relationship between mental health, COVID-19 shocks and the double precarity of housing and employment insecurity. It also highlights the intersecting mediating effects of housing adequacy, receipt of adequate government payments and social support. Given that COVID-19 lock downs, with associated economic insecurity and increased time spent under stay-at-home rules, appear likely to be an on-going experience for many, it is essential that we understand how vulnerability and supporting resources interact with mental health. In this context, access to adequate and affordable housing are likely to become more constrained and more important than ever. Our analysis points to the importance of employment and housing security for mental health and also highlights the psychological impacts of overcrowded housing in the context of a pandemic. Future research should continue to track this vulnerable group, especially as mental health challenges and economic insecurity, particularly for migrants and young people, continues to be exacerbated by the pandemic.

Research Ethics Approval: Human Participants

This research project has been approved by the Human Research Ethics Committee of The University of Melbourne. The Ethics ID Number is 2056957.1. In line with this ethics approval, all participants provided informed consent to be involved in the study.

Data availability statement

No additional data available

Contributors:

KR obtained grant funding for this project. KR, LP and RB were responsible for the design and concept of this project and KR provided oversight for the study. LP was responsible for the analysis of the study data and KR, LP and RB provided interpretation of data, All authors were responsible for the writing and revision of the manuscript. All authors are study guarantors. All authors reviewed and agreed the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Competing interests:

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/disclosure-of-interest/ and declare: support from the University of Melbourne's Hallmark Research Initiative for Affordable Housing; *no other relationships or activities that could appear to have influenced the submitted work.*

Figure legends

Figure 1: Conceptual Framework

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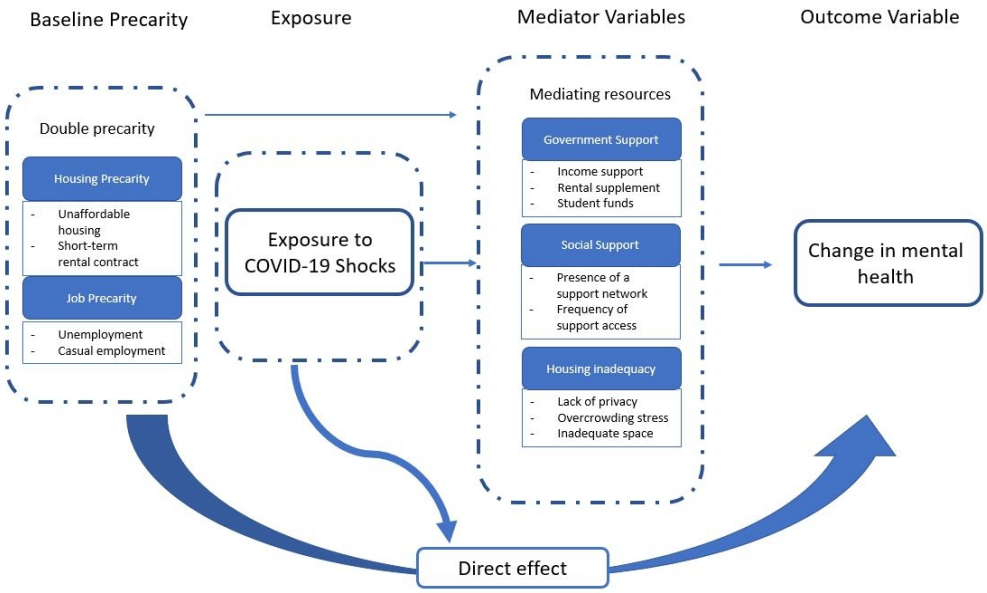

Figure One: Conceptual Framework

93x58mm (300 x 300 DPI)

Appendix Figures and Tables

Appendix Table A.1 Summary of the Survey Instrument

Q	Field	Question	Measures/ Answers	Survey logic
1	Housing Situation – screening question	What is your housing situation?	I currently live in a share house/ I have previously lived in a share house in 2020, but no longer do now/ Neither of the above	Selecting 'Neither of the above' terminated the survey
2	Location – screening question	Where do you live?	I currently live in Victoria/ I have lived in Victoria in 2020, but do not live there anymore/ I have not lived in Victoria at any point in 2020	Selecting 'I have not lived in Victoria at any point in 2020' terminated the survey
3	Location	What is your current postcode?	Drop down menu	
4	Age	What year were you born?	Drop down menu	
5	Country of origin	What is your country of birth?	Drop down menu with top 20 most common countries of origin in Australia then 'other'	
6	Gender	What is your gender	Male/ female/ non-binary/ prefer not to say	
7	Citizenship	Which of the following best describes you?	Citizen of Australia or New Zealand/ Permanent resident of Australia/ Visa Holder	
8	Visa Purpose	What is the primary purpose of your stay in Australia?	Skilled work/ Holiday/ Working holiday/ Study/ Joining family/ Humanitarian protection	Question only shown to those who selected 'Visa holder' in Q7
9	Indigeneity	Are you of Aboriginal or Torres Strait Islander origin?	Aboriginal/ Torres Strait Islander/ Aboriginal and Torres Strait Islander/ Not Aboriginal or Torres Strait Islander	Only shown to those who selected 'Citizen of Australia or New Zealand' in Q7
10	Education	What is your highest level of education?	Year 10 or below/ Year 11 or equivalent/ Year 12 or equivalent/ Trade or Apprenticeship/ Other TAFE or technical certificate/ Diploma/ Bachelor degree/ Postgraduate degree/ prefer not to say	
11	Employment status	What is your current employment status	Working 35 hours or more per week / Working less than 35 hours per week and happy with hours/ Working less than 35	Only shown to those who indicated they

			hours a week but want more hours / Not working, looking for work / Not working, not looking for work / Prefer not to say	were currently working in Q10
12	Industry of employment	Which of the following industries best describes your main job?	Accommodation and Food Services / Administrative and Support Services / Agriculture, Forestry and Fishing /Arts and Recreation Services / Construction / Education and Training/ Electricity, Gas, Water and Waste Services / Financial and Insurance Services / Health Care and Social Assistance / Information Media and Telecommunication / Manufacturing / Mining/ Professional, Scientific and Technical Services / Public Administration and Safety/ Rental, Hiring and Real Estate Services / Retail Trade / Transport, Postal and Warehousing/ Wholesale Trade	
13	Employment Change	Has your work situation changed since COVID-19 was declared as a pandemic?	Yes/ No	
14	Employment Change	What has changed?	My hours have reduced /My hours have increased / My employment has been permanently terminated or temporarily paused/ Other	Only shown to those that selected 'yes' in Q13
15	Employment contract	What kind of employment contract do you have in your main job?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated they were currently working in Q10
16	Employment Status	What kind of employment contract did you have in your main job prior to COVID-19 disruptions?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated that their 'employment has been permanently terminated or temporarily paused' in Q14
17	Salary	Would you find it easier to calculate your average weekly take-home pay (post-tax) or your annual salary (pre tax)?	Weekly take-home pay (after tax)/ Annual salary (before tax)	
18	Salary	What is your average weekly take-home pay (after tax)? (include	Drop down menu of income brackets	Shown to those that selected

		salary, any government payments, dividends and additional income like child support)		'weekly take-home pay' in Q17
19	Salary	What is your annual salary (before tax)? (include salary, any government payments, dividends and additional income like child support)	Drop down menu of income brackets	Shown to those that selected 'annual salary' in Q17
20	Work expectations	How likely do you think it is that you will lose all or most of your work by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are currently working in Q10
21	Work expectations	How likely do you think it is that you will gain employment by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are not currently working in Q10
22	Living expenses	In the last 12 months, how difficult was it for you to meet your necessary cost of living expenses like housing, electricity, water, health care, food, clothing or transport?	5 point Likert scale from 'extremely easy' to 'extremely difficult'	
23	Financial hardship	Have you done any of the following in the last 12 months?	No/ Yes, since March 2020/ Yes, prior to March 2020 for Sought assistance from a charity organization/ Pawned or sold anything because you needed cash/ Went without meals to afford other necessities/ Could not pay the mortgage or rent on time/ Used afterpay	
24	Savings	What is the approximate balance of your total savings?	Less than $500/ $500 - $2,999/ $3,000 - $4,999 / $5,000 - $10,000/ More than $10,000	
25	Debt	What is your current level of debt?	I have more debts than I can pay back/ I have debts that I am just managing to pay back / I have debts that I am managing to pay back comfortably / I have no debts	

26	Change in financial situation	Since COVID-19, has your financial situation	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
27	Life satisfaction	How satisfied are you with your life in general?	5 point Likert scale from 'extremely satisfied' to 'extremely dissatisfied'	
28	Mental health	Overall, would you say your mental health is	5 point Likert scale from 'excellent' to 'terrible'	
29	General health	Overall, would you say your general health is	5 point Likert scale from 'excellent' to 'terrible'	
30	Mental health change	Since COVID-19 isolation rules were introduced, would you say that your mental health has	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
31	Housing change	Have your living arrangements changed since COVID-19?	Nothing has changed / I have moved back in with family/ I have moved in with my partner/ I have moved into a (different) shared living arrangement / Additional occupants have moved in (more people now live in my home)/ Occupants have left (less people now live in my home)/ Other (please describe)	
32	Reason for housing change	Why did you make this change?	Open text	
33	Occupants	How many people live in your home? (include yourself and everyone who spends most nights of the week staying in your home)	Drop down menu 2 – 8+	
34	Tenure	What is your current housing situation?	Living in a short-term rental (e.g. no lease or a lease of less than 6 months)/ Living in a rental property with a lease of 6 months or more / Living in a home that I own/ Living with parents/ Other	
35	Landlord	I rent from	A landlord or real estate agent/ A flatmate/ A family I know/ A family I don't know/ Other	Shown to those that selected 'lease than 6 months' or 'lease of 6 months or more' in Q34
36	Housing cost	What is your personal weekly rent or mortgage payment	Drop down menu in $100 increments	

37	Bedrooms	How many bedrooms are there in your home?	Drop down menu of 0 – 5+	
38	Housing crowding stress	In the past month, how often have you	5 points from 'all the time to 'never' for Felt nervous and stressed about how crowded your home is/ felt concerned about your ability to effectively use your home to do the things you need to do (ie work, sleep, enjoy free time/ been angry because you didn't have enough privacy or personal space for yourself at home	
39	Housemate relations	Since COVID-19 isolation rules were introduced, would you say that your relationships with other members of your household have	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
40	Legal rights	How confident do you feel about knowing and protecting your legal rights as a renter?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
41	Future housing costs	How confident are you that you will be able to meet your housing costs over the next 6 months?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
42	Access to support	Please indicate if you have accessed any of the following resources in response to COVID-19 (please select all that apply)	Government support/ The COVID-19 rent relief grant / International Students Emergency Relief Fund/ Financial support from family or friends / Financial support from an employer/ Financial support from a housemate / Financial support from a religious group or charity/ Accessed personal savings/ Accessed superannuation/ Took out a personal loan/ Sought mortgage payment relief/ Other	
43	Effectiveness of support	The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months	5 point Likert scale from 'strongly agree' to 'strongly disagree'	Shown to those that received support in Q42
44	Social support	Do you have a support network (family, friends, community) that can	Yes/ no	

		help you in situations of financial hardship?		
45	Social support	The following people/ organisations have worked very hard to support me during COVID-19	5 points from 'strongly agree' to 'strongly disagree' for me/ my family/ my work place/ the government/ my friends/ charities/ community groups	
46	Social support	How often have you felt you had access to the following support over the last 3 months? This support could be given in-person or virtually	5 points from 'all the time to 'never' for Someone you can count on to listen to you when you need to talk/ Someone to give you information to help you understand a situation/ Someone to help with daily chores if you were sick/ Someone to have a good time with	
47	Rental negotiation	Have you attempted to renegotiate your rent in response to COVID-19?	No / Yes, and rent was reduced / Yes, but rent was not reduced/ Negotiations are still in progress	
48	Rental negotiation	Why didn't you attempt to renegotiation your rent?	I don't need to/ I don't know how or don't feel comfortable doing it / I don't qualify / I am worried I will be forced to leave if I do/ Other	Shown to those that selected 'no' in Q47
49	Rental negotiation	Can you please explain the outcome of this negotiation?	Text input	
50	Open ended	Is there anything else you would like people to know about the experiences of residents of share houses during COVID-19?	Text input	

Appendix Table A2: Summary statistics, sample mean by survey wave.

	Baseline (June 2020)	Follow-up (October 2020)
Age (average years, range)	34, 19-74	
Female (%)	55.67	
Migrant (%)	21.33	
Low Education (%)	16.00	
Mental health worsening (%)	18.33	+2
Number of people in the household (average number, range)	3, 2-6	3, 2-7
Pre-existing social conditions:		
Housing precarity (%) (paying more than 30% of income on housing costs and/or renting in the informal market).	65.17	
Employment precarity (%) (casually employed or unemployed)	35.50	
Double precarity (%) (experiencing both housing and employment precarity simultaneously)	28.50	
Changing social conditions:		
Covid shocks (%) (people moving in or out of household, decreased earnings, inability to cover housing and other living costs)	74.00	-4.33
Housing inadequacy (%) (feeling stressed about overcrowding, concerned about ability to use the house, angry about lack of privacy)		31.33
Accessed government support (%)	67.33	-9.33
Sufficiency of government support (%)	37.67	-8.67
Social support (%)	64.66	+1.34
N	293	293

Appendix Table A3: The relationship between individual characteristics and precarity

	Outcome variable: *Double Precarity*$_i$					
	I	II	III	IV	V	VI
Female	1.148	1.153	0.98	1.153	0.998	1.127
	(0.248)	(0.249)	(0.218)	(0.190)	(0.271)	(0.358)
Migrant	6.804***	7.289***	3.356***	3.003***	2.241	3.197*
	(2.027)	(2.192)	(1.154)	(1.150)	(1.101)	(1.970)
Age	0.957***	0.952***	0.953***	0.956***	0.957**	0.968*
	(0.011)	(0.011)	(0.010)	(0.007)	(0.019)	(0.017)
Low education		1.996**		2.139***	0.823	1.084
		(0.579)		(0.531)	(0.297)	(0.626)
Low income			7.423***			
			(1.700)			
Country of birth FE	N	N	N	Y	N	Y
Sector employed FE	N	N	N	N	Y	Y
N	586	586	586	586	422	422
Brant test	0.340	0.206	0.823	0.206	0.206	0.206

Notes: Ordered logit regressions, odd ratios reported. The outcome variable, *Double Precarity*$_i$ (job + housing precarity) ranges between 0 and 2. The explanatory variables are indicated in the first column. Standard errors clustered at the sector of employment level. Given that the low education and low income dummy variables are likely to be collinear, we control only for one of them (low education) when we add country of birth and sector of employment fixed effects (FE), cols IV-VI.

Appendix Table A4: The relationship between mental health, precarity and COVID-19 exposure

	Outcome variable: *Mental health worse$_i$*				
	I	II	III	IV	V
Double precarity		2.360*	2.385**		
		(1.043)	(1.059)		
Housing precarity				2.358*	
				(1.059)	
Job precarity					0.441
					(0.331)
Exposure to	2.747***		2.732***	2.732***	2.746***
COVID shocks	(0.750)		(0.800)	(0.800)	(0.750)
Sector employed FE	Y		Y	Y	Y
N	538		538	538	538
Brant test	0.397		0.656	0.397	0.250

Notes: Ordered logit regressions, odd ratios reported. The outcome variable, *Mental health worse$_i$* (worsening of mental health in wave 1 and/or 2) ranges between 0 and 2. The explanatory variables are indicated in the first column. All regressions control for: gender, migrant status and age. Standard errors clustered at the sector of employment level. FE stands for fixed effects.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	5 and 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3 – 4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6 – 8*
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	13
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3 – 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6 – 9
		(*b*) Describe any methods used to examine subgroups and interactions	6 – 9
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10 and appendix
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*10 - 11*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10 - 11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of COVID-19 shocks, precarity and mediating resources on the mental health of residents of share housing in Victoria, Australia: an analysis of data from a two-wave survey

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The impact of COVID-19 shocks, precarity and mediating resources on the mental health of residents of share housing in Victoria, Australia: an analysis of data from a two-wave survey

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Keywords: Mental health; COVID-19; Housing; Employment; Health inequalities

Word Count: 3,450

Abstract

Objectives: COVID-19 lockdown measures have challenged people's mental health, especially among economically vulnerable households. The objective of this study was to investigate the impact of exposure to COVID-19-shocks (defined as job loss, living cost pressures and changing housing conditions throughout the lockdown period) and double precarity (defined as precarity in housing and employment) on mental health outcomes for members of share households as well as the mediating effects of a range of resources.

Design: We conducted a two-wave survey of occupants of share housing in June and October 2020 during a prolonged period of population lockdown. Research design involved fixed effects ordered logit regression models to assess the mental health consequences of baseline precarity and COVID-related shocks.

Setting: Victoria, Australia.

Participants: We surveyed 293 occupants of share houses (mean age 34 SD 11.5, 56% female). Members of share houses (where individuals are unrelated adults and not in a romantic relationship) are more likely to be young, casually employed, visa-holders and low-income.

Outcome measures: We measured household composition, housing and employment precarity, access to government support, household crowding, social networks and COVID-19 shocks. We used a self-reported measure of mental health.

Results: Those exposed to COVID-19 shocks reported a 2.7 times higher odds of mental health deterioration (OR 2.7, 95%CI 1.53-4.85). People exposed to double precarity (precarity in both housing and employment) reported 2.4 times higher odds of mental health deterioration (OR 2.4, 95%CI 0.99-5.69). Housing inadequacy and lack of access to sufficient government payments explained 14.7% and 7% of the total effect of double precarity on mental health, respectively.

Conclusions: Results indicate that residents of group households characterised by pre-existing precarity were vulnerable to negative mental health effects during lockdown. Access to sufficient government payments and adequate housing buffered this negative effect.

Strengths and limitations of this study

- Our use of mediation analysis enables novel examination of the protective role of housing adequacy, government payments and social support for tenant's mental health during COVID-related shocks.
- We survey respondents at two time points – allowing examination of change within people in response to economic shocks.
- The small and highly targeted sample (n= 293) is not generalisable to the broader population.
- Our observational study describes relationships but does not establish causality.

1. Introduction

The emergence of the highly infectious coronavirus (COVID-19) has created a global health crisis with significant economic and social repercussions. Australia, like many other countries, responded with social distancing measures including limiting time outside of the home, broad work-from-home rules, temporary or permanent shut down of businesses and closure of schools and childcare [1]. Measures in Australia and internationally effectively locked down households for long periods of time, with well-documented impacts on mental health across populations [2,3] and broader health, social and economic implications [4–6]. The most acute consequences have been felt by households who are vulnerable to both precarious employment (e.g., casual employees with no leave entitlements or unemployed people) and housing (e.g., people without formal leasing arrangements or living in highly unaffordable housing); that is, households prone to pre-existing double precarity [7–9].

The relevance of housing and employment precarity for mental health is evident beyond the impacts of COVID-19 and is well established in extant literature. Access to adequate and secure housing serves a protective function for mental health [10–12] and poor-quality housing and insecure tenancies have a potentially negative impact on a person's health [13,14]. Similarly, the impact of job loss and job insecurity on mental health outcomes has been well established [see, for example, 15,16]. Unemployment is both a consequence of, and risk factor for, reduced mental health [17]. One particular cohort, occupants of share housing (where individuals are unrelated adults and not in a romantic relationship) are particularly likely to fit these demographics and be amongst the most vulnerable to being both precariously employed and housed during this time [1]. They are, therefore, potentially amongst the most exposed to financial hardship arising from restrictive public health measures put in place to reduce COVID-19 transmission in communities.

This paper analyses the effects of housing and employment precarity on mental health for this cohort, while investigating the mediating effects of access to social, income and housing resources. Using the experiences of share housing residents during the 115 days of lockdown in 2020 in Victoria Australia, we seek to examine how lockdown restrictions, under the duress of 'double precarity' common amongst share housing households, impacted mental health, and how much support through social connections, sufficient government assistance or housing adequacy offered protection. We propose a conceptual framework (Figure 1) for understanding the set of relationships under consideration before presenting findings from two surveys conducted in Victoria, Australia in 2020.

2. Methods

2.1 Study cohort: members of share households

This study focuses on people living in share houses in Victoria, Australia. We define share houses as households occupied by two or more unrelated adults who are not in a romantic relationship. In Australia, share housing usually takes the form of individual arrangements between a land lord and a group of tenants; occupants may know each other before moving in together or may begin and remain as relative strangers living in informal arrangements. People living in shared housing are a group characterized by high levels of precarity. They are more likely to be young, casually employed, living in informal arrangements and at risk of homelessness than the broader population [18]. In Victoria, the median share household spends 23% of gross household income on housing costs, compared to 14% across all household types [19]. 17% of temporary visa-holders in Australia were living in a share household at the 2016 census, compared to 4% of the broader population [20]. Share housing is often considered as either a transitional housing form on the way to adulthood or a 'coping mechanism' for vulnerable households when other forms of family or state support are unavailable [21] or where occupants are unable to provide income and rental history documents [22]. Recent evidence suggests that this group are more likely to

have lost their jobs or had hours reduced, more likely to be reliant on social welfare payments and more likely to have been born overseas than the general population [1].

2.2 Study Context

This study was conducted in Victoria, the second most populous State in Australia. The study surveys, occurring in June and October of 2020, coincided with a time of considerable disruption to social, economic and health systems in Victoria. While the first positive case of the novel coronavirus was identified in Australia on 25 January 2020, the large-scale impacts of the pandemic were not substantially felt until mid-March 2020. On the 30th of March the Australian Government introduced the 'Job Keeper Payment' that aimed to help employers keep their staff on pay roll and the 'Job Seeker Payment' that served as an emergency CoronaVirus Supplement to existing social welfare payments, immediately doubling the income of many unemployed people [23]. The State of Victoria declared a State of Disaster on August 2nd, 2020, resulting in a night-time curfew, a 5km limit on distances residents could travel from their homes, restrictions of gatherings in public and private spaces, office and school closures and limitations on allowable time outside the house [24]. These restrictions, occurring in the context of a global health pandemic and large-scale economic crisis, present a case study in the impact of simultaneous imposition of housing and employment stress. Further, the substantial government intervention in support payments offers the lens of a 'natural experiment' to examine their benefits in mediating the impacts of 'double precarity' and exposure to COVID-19.

2.3 Conceptual Framework

Our conceptual framework is based on the following explanatory variables and mediator variables.

2.2.1 Explanatory variables: The double precarity of housing and employment insecurity and exposure to COVID-19 shocks

Despite the wealth of evidence on the impact of both employment and housing instability on mental health, these two forms of insecurity have largely been studied separately [25]. Similarly, evidence is still emerging about the 'shocks' experienced by individuals and households impacted by COVID-19. This paper addresses this gap, focusing on:

- housing precarity: defined as living with short-term rental contracts and/or unaffordable housing.
- Employment precarity: defined as casual employment contracts and unemployment.
- Double precarity: the combination of both housing and employment precarity
- Exposure to COVID-19 shocks: defined as job loss, living cost pressures and changing housing conditions throughout the lockdown period.

2.2.2 Mediator Variables: Resources of social support, government support and housing adequacy

Precarity in housing and employment triggered by pandemic containment measures is known to negatively impact mental health. Importantly, several factors mediate the impact of precariousness on mental health, including social support, government support and access to adequate housing.

- Social support: Defined as the presence of social ties and frequency of access to emotional and pragmatic support. Social support is often associated with improved mental and physical health, especially as a resource that buffers the harmful impacts of stress exposure [26,27]. For example, social support has been shown to mitigate financial hardship via monetary transfers and interpersonal loans in some cases [28].

- Government support: While research has documented the ability of government-provided payments to build the resilience of poor and vulnerable households to economic shocks [29], the connection to mental health outcomes is more tenuous. Previous research suggests that social welfare payments need to provide sufficient economic provisions while also alleviating the stigma and psychological impacts associated with receiving benefits to have a protective effect on mental health [30].
- Housing adequacy: Access to sufficient space and autonomy in a home is important for mental health as non-functioning or inadequate housing is associated with depressive mood [31]. Overcrowding in homes can lead to cognitive overload from excess sensory stimuli, a lack of opportunities for retreat and feelings of being surveilled [32]. Similarly, previous research has found associations between overcrowding and depression, withdrawal, aggression, and psychological distress [33]. Living in share housing has been associated with depressive disorders and anxiety, especially for unemployed people [34].

Drawing on this literature from health, housing and economics, we hypothesize several channels through which precarity and access to mediating resources impact upon each other and upon mental health, as illustrated in Figure 1.

INSERT FIGURE 1 HERE

2.4 Survey design and data collection

Data were collected through two waves of an online longitudinal survey, yielding 1,052 valid responses in June and 293 valid responses in October. The purpose of a longitudinal design was to test changes in mental health over time, in a period characterised by high levels of COVID19 shock for many. The survey

was open to anyone who had lived in a share household in Victoria at any point between June 2020 and October 2020 and screening questions were used to exclude those who didn't meet these criteria. The first page of the online survey contained an informed consent statement and participants acknowledged consent by clicking 'start' on the survey. The survey instrument was designed using a variety of standardized demographic, housing, health and financial resilience questions derived from large Australian surveys such as the Household, Income, Labour Dynamics in Australia (HILDA) survey and the Australian Bureau of Statistics Census. See Appendix Table A1 for the full survey.

Respondent recruitment occurred through multiple channels. For Wave One of the surveys, most responses (n=670) were derived from an online survey panel service that targeted a representative selection of share housing respondents currently living in Victoria. The remaining responses (n=382) were targeted through targeted Facebook and Instagram advertisements, Twitter and Facebook messages posted by the University of Melbourne, Tenants Union of Victoria, and Victorian Legal Aid and posts on Facebook groups aimed at international students and share houses across Victoria. Wave Two re-surveyed the original respondents, either via an anonymized process managed by the online panel company or through follow-up emails to Wave One participants automated using the survey program Qualtrics. In the empirical analysis, we only keep responses for people who appear in both survey waves, which allows us to have a panel of 293 individuals in two time periods. Respondents of the survey are not directly representative of occupants of share houses across all metrics. Compared to share household occupants across Australia, respondents are less likely to report year 12 as their highest level of education than (16% vs 39%), are more likely to be female (55% vs 45%) but are of similar age (median age 35). Despite the relatively high attrition rate, a comparison of means between the included and the excluded participants did not point to any statistically significant difference between the two waves, based on most observable characteristics.

Unlike cross-sectional surveys, this panel survey set-up enables the analysis of individual-level dynamics that are not biased by self-selection, by observing the same individuals repeatedly at two different times of the COVID pandemic. Self-selection would arise due to potential unobservable confounders correlated with both outcomes (mental health) and explanatory variables (double precarity), such as lower motivation or worse work-performance.

2.5 Patient and Public Involvement

Neither patients nor the public were involved in the design, or conduct, or reporting or dissemination of our research. Survey respondents were emailed a copy of research findings if they indicated a desire to receive findings when completing the survey.

2.6 Empirical strategy

To investigate the relationship between vulnerability, exposure to COVID-19 and mental health, we proceed in two steps.

We start by analysing the relationship between precarity and respondents' socio-economic characteristics using the following regression setup:

$$Precarity_i = \alpha + \gamma X_i + \partial_c + \theta_s + u_i \quad (1)$$

We define socio-economic precarity ($Precarity_i$) as a two-dimensional index reflecting its interaction between employment and housing dimensions for respondent *i*. This is computed as the sum of the probability of the following conditions, and ranges between 0 and 2:

1. Probability of housing precarity: defined as living in unaffordable housing (paying more than 30% of income on housing costs) and/or renting with a lease of 6 months or shorter.
2. Probability of employment precarity: defined as being casually employed or unemployed.

X_i includes a vector of individual characteristics including gender, age, being low income (weekly income lower than AUD$650), having low education (having completed Year 12 or below), being a migrant (namely a temporary visa holder or refugee); ∂_c represents country of birth fixed effects and θ_s denotes sector of employment fixed effects. Given that $Precarity_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model.

Next, we investigate the effect of Precarityi, combined with exposure to COVID-19 shocks, to calculate whether either or both affected mental health. Exposure to COVID-19 shocks (Covid shocki) is measured by a respondent i's reported impact of COVID-19 in the form of: (i) changing housing conditions (people moving in or out); (ii) decreased earnings; (iii) financial hardship (inability to cover housing and other living costs). We code Covid $shock_i$ as a dummy variable equal to one if an individual had experienced at least one of the above-mentioned shocks. Therefore, the coefficient of Covid $shock_i$ captures the effect of being exposed to covid shocks (relative to not having experienced any).

We investigate the relationship between mental health, precarity and COVID-19 shocks, using the following regression:

$$Mental\ health\ worse_i = \alpha + \beta_1 Precarity_i + \beta_2 Covid\ shock_i + \gamma X_i + \partial_c + \theta_s + u_i \quad (2)$$

The dependent variable $Mental\ health\ worse_i$ is computed as the sum of the probability of a worsening in mental health in wave 1 and/or wave 2 of the survey. Our measure of mental health was self-reported. Respondents were asked in both waves of the survey "Since COVID-19 isolation rules were introduced, would you say that your mental health became: much better, better, did not change, worse, much worse".

We generated a dummy variable equal to 1 if respondents answered worse or much worse in each wave. Given that *Mental health worse*$_i$ is an ordinal variable, we estimate this regression's coefficients using an ordered logit model. Regressions (1) and (2) cannot establish a causal relationship between outcomes and explanatory variables, and should be interpreted as correlations.

Finally, to provide insights on plausible mediating factors that may mediate the negative relationship between precarity and health outcomes, we assess the role played by:

(i) Sufficient government support (*Gov support*$_i$) targeted to mitigate negative COVID-19 effects, measured as respondents' self-evaluated sufficiency of support derived from accessing the packages offered by the government to assist financially those affected by COVID-19. Specifically, we assign a dummy variable equal to one for each respondent answering "somewhat agree" or "strongly agree" to the question "The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months".

(ii) Social support (*Social support*$_i$), measured as the presence of community or family networks used as risk-coping mechanisms and their frequency of access during the pandemic, modified from [35].

(iii) Housing inadequacy (*Housing inadequacy*$_i$), computed as a multidimensional index drawing on perceptions of privacy, use of space and overcrowding, modified from Campagna [36]:

We undertake a mediation analysis to examine the extent to which the association between precarity and a worsening in mental health occurs directly, and the extent to which it occurs through housing inadequacy and lack of social support.

Following VanderWeele [37], we utilize the following regression setup:

$$\mathbb{E}(M|\ Precarity_i=a,\ X_i=c)= \beta_0 +\beta_1\, a +\beta_2{}'\, c \qquad (3)$$

$$\mathbb{E}(Mental\ health\ worse_i|Precarity_i=a,\ M=m,\ X_i=c)= \theta_0 +\theta_1\, a+\theta_2\, m +\theta_3{}'\, c \qquad (4)$$

where M represents either *Social support*$_i$, *Gov support*$_i$, *Housing inadequacy*$_i$ or *Covid shock*$_i$, and X_i is a vector including the above-mentioned set of controls as well as an indicator of exposure to COVID-19 shocks (when M is not *Covid shock*$_i$).

This approach allows us to compute: (i) the natural direct effect (NDE), capturing how much precarity would affect mental health if we were to disable the relationship between precarity and the mediators; (ii) the natural indirect effect (NIE), which can be conceived as the effect on mental health of the mediator, keeping *Precarity*$_i$ fixed; (iii) The total effect (TE) representing the sum of NIE and NDE, which can be defined as how much mental health would change overall for a change in precarity, accounting for the mediators' effect.

3. Results

Our sample of members of group households predominantly comprised young people. The average age was 34 years with 55% being female, and one fifth being temporary visa-holders. The majority (65%) experienced pre-existing housing precarity, 35.5% experienced pre-existing employment precarity and 28.5% experienced both - confirming that this cohort of group housing residents is precariously placed.

In terms of experience of 'COVID-19 shocks', three quarters reported a shock, and this decreased slightly by the second wave of data collection. 18.3% of group housing residents reported a worsening of their mental health with COVID-19, with this rising by 2 percentage points in Wave 2.

38% of survey respondents indicated they had received sufficient government supports to make a substantial difference to their financial security. This decreased in the second wave of the survey by 9.3%. Most people (65%) reported adequate social support, and this increased slightly over time. 31% of the

respondents reported living in inadequate housing conditions. See Appendix Table A2 for expanded summary statistics.

The odds of experiencing double precarity was strongly patterned by socio-demographic characteristics. Notably, residents of group housing who were temporary visa-holders in Australia reported three times greater odds of double precarity (3.2 95%CI 0.95-10.70) than those who were not temporary visa-holders. The odds of reporting worse mental health decreased with age (OR 0.97 95%CI 0.94-1.00) and were greater for low income earners (OR 7.42 95%CI 4.74-11.63). The results of the Brant test (reported in Appendix Table A3) confirm that the proportional odds and parallel lines assumption of the ordered logit model predicting double precarity are met.

The results in table 1 indicate that exposure to COVID-19 shocks was strongly correlated with worsening mental health, with residents exposed to COVID-19 shocks reporting a 2.7-fold higher odds of deteriorating mental health (OR 2.7, 95%CI 1.53-4.85) than those who did not experience COVID-19 shocks. Experiencing double precarity was also associated with 2.4 times higher odds of reporting worsening mental health (OR 2.4 95%CI 0.99-5.69) than those who did not experience double precarity. This relationship is largely driven by housing precarity (OR 2.4 95%CI 0.98-5.69) while employment precarity is not significantly related to reporting a deterioration in mental health.

Table 1: The relationship between mental health, precarity and COVID-19 exposure

	Odds Ratio*	Lower Confidence Interval	Upper Confidence Interval	P value
COVID-related shocks (b)	2.732	1.538	4.850	0.001
Double precarity (a)	2.385	0.987	5.687	0.050
Housing precarity (a)	2.358	0.978	5.688	0.050
Employment precarity (a)	0.441	0.111	1.759	0.246

a) Adjusted for age, sex, migrant status, education level, COVID shock.
b) Adjusted for age, sex, migrant status, education level, double precarity

Notes: Odd ratios of regression equation (2), calculated as exp(β). Full results are reported in Appendix Table A4.

When analysing the plausible channels underlying our results in Table 2, we find that precarity is positively associated with worsening mental health, as shown by the TCE estimates. The NDE coefficients, capturing how much precarity would affect mental health if we were to nullify the relationship between precarity and the mediators, confirms that precarity has a direct effect on worsening mental health when testing for any mediator (cols. I-IV). Turning to the NIE, we find that much of the precarity-mental health association is mediated by inadequate housing, access to government support and exposure to COVID-19 shocks, all of which affect the relationship significantly. Specifically, inadequate housing explains 14.7% of the TCE, and access to government support 7.8% of the TCE, thus reducing the effect of precarity on mental health, and covid shocks 27.78% of the TCE. Social support mitigates the negative relationship between precarity and mental health (has a negative sign), but the indirect effect is not statistically significant. Hence, these results indicate that housing inadequacy and exposure to COVID-19 shocks have a negative mediating effect on mental health, exacerbating the effect of precarity, while access to government support played a positive mediating role, thus weakening the effect of precarity on mental health.

Table 2: The effect of mediating factors and exposure to Covid shocks on the relation between double precarity and mental health decline

	Inadequate housing	Social support	Government support	Covid Shock
Total Causal Effect (TCE)	0.075**	0.074**	0.078***	0.090***
	(0.027)	(0.027)	(0.032)	(0.029)
Natural Direct Effect (NDE)	0.064**	0.073***	0.084***	0.065**
	(0.027)	(0.027)	(0.027)	(0.316)
Natural Indirect Effect (NIE)	0.011**	-0.003	-0.006*	0.025***
	(0.005)	(0.003)	(0.003)	(0.089)

Estimated proportion of effect explained (%)	14.76	4.05	7.84	27.78

Notes: This table shows the total causal effect (TCE), natural direct effect (NDE) and natural indirect effect (NIE) of precarity on change in mental health with mediation through inadequate housing, social support, government support and exposure to COVID-19 shocks (N=586).

4. Discussion

There is a strong association between experiencing precarity, exposure to COVID-19 shocks and deterioration of mental health during COVID-19 lockdowns in 2020 for members of share households. Specifically, experiencing a COVID-19 shock, such as moving homes or changing household occupants, losing income or experiencing financial hardship, is associated with a 2.7-fold increase in the odds of deteriorating mental health. Similarly, experiencing double precarity is associated with 2.4 times higher odds of reporting worsening mental health, compared to those without this experience. Occupants of share housing are highly likely to have experienced pre-existing employment and housing precarity, as well as COVID-19-induced shocks.

A novel contribution of this paper relates to our examination of the mediating impacts of housing adequacy, sufficient government support and social support. The finding that much of the precarity-mental health association is mediated by inadequate housing is significant. It correlates with existing findings that link overcrowding with depression and heightened stress levels [36] and longitudinal analysis that has found that changes in severe overcrowding and individual deprivation may reduce distress irrespective of other factors [38]. It also highlights the intersecting role of mental health and housing in the context of pandemic-induced stay-at-home rules. Particularly within share households, where occupant relationships range from close friendships to being strangers, access to adequate housing space and quality has a direct mental health impact. This has implications for public health policy that seeks to

address both increased risk of viral spread in overcrowded housing and increased stress associated with an inability to experience privacy and retreat from others.

We find that accessing government support payments had a protective impact on mental health, but only if respondents indicated that this support was "sufficient to make a substantial difference to my financial security over the next 3 months". While 62.7% of respondents indicated that they had accessed some form of government assistance, only 38% indicated that it was sufficient to impact their financial security. This finding aligns with prior research that found that unreliable or insufficient welfare payments have little impact on mental health [30] while suggesting that substantial increases to unemployment welfare payments (JobSeeker) and the employee support payment (JobKeeper) had a significant impact on mental health for some. This finding is particularly important given the substantially higher rates of pre-existing precarity experienced by visa-holders, a group that was excluded from JobKeeper and JobSeeker payments. While research has often identified the protective impact of welfare payments on financial resilience following a disaster [39,40], this finding is a rare contribution to the literature on the impact of welfare payments on mental health. In contrast, we find that social networks do mediate the relationship between precarity and mental health reduction, but not to a statistically significant degree. This may be partially explained by the reduced capacity for physical contact between social networks during lock-down conditions. It may also reflect the fact that those experiencing significant mental health decreases were more likely to reach out to their social support networks to access support.

Our study has several important strengths. It is one of the first studies to examine the mediating role of housing, government support and social conditions in ameliorating the negative mental health effects of a shock, such as COVID lockdowns, on members of group households. This economically vulnerable cohorts characterised by less secure housing tenure is often under-represented in national surveys and overlooked in research. Our paper offers a custom-designed survey of this small and highly targeted sample at two time points. We have reduced the impact of self-selection bias by using multiple

dissemination channels and commissioning an online panel with a broad audience of panel members. Our study has several important limitations that should be noted. First, due to its targeted nature, our sample size is small and is not representative of share housing occupants across Australia. Similarly, there was a high level of attrition between Wave One and Two. This is partially a reflection of the cohort and time period. Higher stress levels, high mobility, a migration background, unemployment or poor health status are all attributes associated with higher likelihoods of attrition [41,42]; all elements present in the current study. Similarly, we draw on self-reported mental health assessments rather than using a validated instrument. However, we have repeated measures for 293 respondents which allows us to examine change in economic circumstances and mental health over time. The timing of survey waves, at 5 months apart, is short and does not capture longer-term mental health impacts. This time frame was targeted to gather insights within the context of rapidly changing pandemic conditions. Finally, while this study provides insights into correlations between various elements, it does not establish causal links.

This research advances our understanding of the relationship between mental health, COVID-19 shocks and the double precarity of housing and employment insecurity. It also highlights the intersecting mediating effects of housing adequacy, receipt of adequate government payments and social support. Given that COVID-19 lock downs, with associated economic insecurity and increased time spent under stay-at-home rules, appear likely to be an on-going experience for many, it is essential that we understand how vulnerability and supporting resources interact with mental health. In this context, access to adequate and affordable housing are likely to become more constrained and more important than ever. Our analysis points to the importance of employment and housing security for mental health and also highlights the psychological impacts of overcrowded housing in the context of a pandemic. Future research should continue to track this vulnerable group, especially as mental health challenges

and economic insecurity, particularly for visa-holders and young people, continues to be exacerbated by the pandemic.

Contributors

KR obtained grant funding for this project. KR, LP and RB were responsible for the design and concept of this project and KR provided oversight for the study. LP was responsible for the analysis of the study data and KR, LP and RB provided interpretation of data. All authors were responsible for the writing and revision of the manuscript. All authors are study guarantors. All authors reviewed and agreed the final manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/disclosure-of-interest/ and declare: support from the University of Melbourne's Hallmark Research Initiative for Affordable Housing; *no other relationships or activities that could appear to have influenced the submitted work.*

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Ethics approval

This research project has been approved by the Human Research Ethics Committee of The University of Melbourne. The Ethics ID Number is 2056957.1. In line with this ethics approval, all participants provided informed consent to be involved in the study.

Data availability statement

No additional data available.

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Figure titles

Figure 1: Conceptual framework

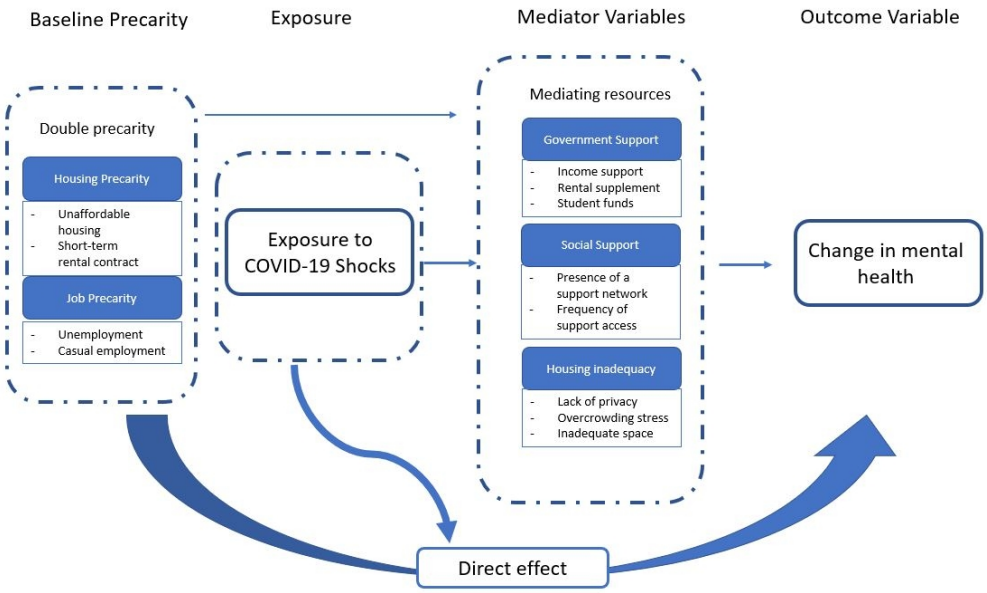

Figure One: Conceptual Framework

93x58mm (300 x 300 DPI)

Appendix Figures and Tables

Appendix Table A.1 Summary of the Survey Instrument

Q	Field	Question	Measures/ Answers	Survey logic
1	Housing Situation – screening question	What is your housing situation?	I currently live in a share house/ I have previously lived in a share house in 2020, but no longer do now/ Neither of the above	Selecting 'Neither of the above' terminated the survey
2	Location – screening question	Where do you live?	I currently live in Victoria/ I have lived in Victoria in 2020, but do not live there anymore/ I have not lived in Victoria at any point in 2020	Selecting 'I have not lived in Victoria at any point in 2020' terminated the survey
3	Location	What is your current postcode?	Drop down menu	
4	Age	What year were you born?	Drop down menu	
5	Country of origin	What is your country of birth?	Drop down menu with top 20 most common countries of origin in Australia then 'other'	
6	Gender	What is your gender	Male/ female/ non-binary/ prefer not to say	
7	Citizenship	Which of the following best describes you?	Citizen of Australia or New Zealand/ Permanent resident of Australia/ Visa Holder	
8	Visa Purpose	What is the primary purpose of your stay in Australia?	Skilled work/ Holiday/ Working holiday/ Study/ Joining family/ Humanitarian protection	Question only shown to those who selected 'Visa holder' in Q7
9	Indigeneity	Are you of Aboriginal or Torres Strait Islander origin?	Aboriginal/ Torres Strait Islander/ Aboriginal and Torres Strait Islander/ Not Aboriginal or Torres Strait Islander	Only shown to those who selected 'Citizen of Australia or New Zealand' in Q7
10	Education	What is your highest level of education?	Year 10 or below/ Year 11 or equivalent/ Year 12 or equivalent/ Trade or Apprenticeship/ Other TAFE or technical certificate/ Diploma/ Bachelor degree/ Postgraduate degree/ prefer not to say	
11	Employment status	What is your current employment status	Working 35 hours or more per week / Working less than 35 hours per week and happy with hours/ Working less than 35	Only shown to those who indicated they

			hours a week but want more hours / Not working, looking for work / Not working, not looking for work / Prefer not to say	were currently working in Q10
12	Industry of employment	Which of the following industries best describes your main job?	Accommodation and Food Services / Administrative and Support Services / Agriculture, Forestry and Fishing /Arts and Recreation Services / Construction / Education and Training/ Electricity, Gas, Water and Waste Services / Financial and Insurance Services / Health Care and Social Assistance / Information Media and Telecommunication / Manufacturing / Mining/ Professional, Scientific and Technical Services / Public Administration and Safety/ Rental, Hiring and Real Estate Services / Retail Trade / Transport, Postal and Warehousing/ Wholesale Trade	
13	Employment Change	Has your work situation changed since COVID-19 was declared as a pandemic?	Yes/ No	
14	Employment Change	What has changed?	My hours have reduced /My hours have increased / My employment has been permanently terminated or temporarily paused/ Other	Only shown to those that selected 'yes' in Q13
15	Employment contract	What kind of employment contract do you have in your main job?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated they were currently working in Q10
16	Employment Status	What kind of employment contract did you have in your main job prior to COVID-19 disruptions?	Permanent (employed on an on-going basis) or fixed term with a contract of at least 2 years / Fixed term with a contract of less than 2 years / Casual / Self-employed/ Prefer not to say	Only shown to those who indicated that their 'employment has been permanently terminated or temporarily paused' in Q14
17	Salary	Would you find it easier to calculate your average weekly take-home pay (post-tax) or your annual salary (pre tax)?	Weekly take-home pay (after tax)/ Annual salary (before tax)	
18	Salary	What is your average weekly take-home pay (after tax)? (include	Drop down menu of income brackets	Shown to those that selected

		salary, any government payments, dividends and additional income like child support)		'weekly take-home pay' in Q17
19	Salary	What is your annual salary (before tax)? (include salary, any government payments, dividends and additional income like child support)	Drop down menu of income brackets	Shown to those that selected 'annual salary' in Q17
20	Work expectations	How likely do you think it is that you will lose all or most of your work by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are currently working in Q10
21	Work expectations	How likely do you think it is that you will gain employment by October 2020?	5 point Likert scale from 'extremely likely' to 'extremely unlikely'	Shown to those that indicated they are not currently working in Q10
22	Living expenses	In the last 12 months, how difficult was it for you to meet your necessary cost of living expenses like housing, electricity, water, health care, food, clothing or transport?	5 point Likert scale from 'extremely easy' to 'extremely difficult'	
23	Financial hardship	Have you done any of the following in the last 12 months?	No/ Yes, since March 2020/ Yes, prior to March 2020 for Sought assistance from a charity organization/ Pawned or sold anything because you needed cash/ Went without meals to afford other necessities/ Could not pay the mortgage or rent on time/ Used afterpay	
24	Savings	What is the approximate balance of your total savings?	Less than $500/ $500 - $2,999/ $3,000 - $4,999 / $5,000 - $10,000/ More than $10,000	
25	Debt	What is your current level of debt?	I have more debts than I can pay back/ I have debts that I am just managing to pay back / I have debts that I am managing to pay back comfortably / I have no debts	

26	Change in financial situation	Since COVID-19, has your financial situation	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
27	Life satisfaction	How satisfied are you with your life in general?	5 point Likert scale from 'extremely satisfied' to 'extremely dissatisfied'	
28	Mental health	Overall, would you say your mental health is	5 point Likert scale from 'excellent' to 'terrible'	
29	General health	Overall, would you say your general health is	5 point Likert scale from 'excellent' to 'terrible'	
30	Mental health change	Since COVID-19 isolation rules were introduced, would you say that your mental health has	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
31	Housing change	Have your living arrangements changed since COVID-19?	Nothing has changed / I have moved back in with family/ I have moved in with my partner/ I have moved into a (different) shared living arrangement / Additional occupants have moved in (more people now live in my home)/ Occupants have left (less people now live in my home)/ Other (please describe)	
32	Reason for housing change	Why did you make this change?	Open text	
33	Occupants	How many people live in your home? (include yourself and everyone who spends most nights of the week staying in your home)	Drop down menu 2 – 8+	
34	Tenure	What is your current housing situation?	Living in a short-term rental (e.g. no lease or a lease of less than 6 months)/ Living in a rental property with a lease of 6 months or more / Living in a home that I own/ Living with parents/ Other	
35	Landlord	I rent from	A landlord or real estate agent/ A flatmate/ A family I know/ A family I don't know/ Other	Shown to those that selected 'lease than 6 months' or 'lease of 6 months or more' in Q34
36	Housing cost	What is your personal weekly rent or mortgage payment	Drop down menu in $100 increments	

37	Bedrooms	How many bedrooms are there in your home?	Drop down menu of 0 – 5+	
38	Housing crowding stress	In the past month, how often have you	5 points from 'all the time to 'never' for Felt nervous and stressed about how crowded your home is/ felt concerned about your ability to effectively use your home to do the things you need to do (ie work, sleep, enjoy free time/ been angry because you didn't have enough privacy or personal space for yourself at home	
39	Housemate relations	Since COVID-19 isolation rules were introduced, would you say that your relationships with other members of your household have	5 point Likert scale from 'become dramatically better' to 'become dramatically worse'	
40	Legal rights	How confident do you feel about knowing and protecting your legal rights as a renter?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
41	Future housing costs	How confident are you that you will be able to meet your housing costs over the next 6 months?	5 point Likert scale from 'extremely confident' to 'not at all confident'	
42	Access to support	Please indicate if you have accessed any of the following resources in response to COVID-19 (please select all that apply)	Government support/ The COVID-19 rent relief grant / International Students Emergency Relief Fund/ Financial support from family or friends / Financial support from an employer/ Financial support from a housemate / Financial support from a religious group or charity/ Accessed personal savings/ Accessed superannuation/ Took out a personal loan/ Sought mortgage payment relief/ Other	
43	Effectiveness of support	The resources I have accessed in response to COVID-19 are sufficient to make a substantial difference to my financial security over the next 3 months	5 point Likert scale from 'strongly agree' to 'strongly disagree'	Shown to those that received support in Q42
44	Social support	Do you have a support network (family, friends, community) that can	Yes/ no	

		help you in situations of financial hardship?		
45	Social support	The following people/ organisations have worked very hard to support me during COVID-19	5 points from 'strongly agree' to 'strongly disagree' for me/ my family/ my work place/ the government/ my friends/ charities/ community groups	
46	Social support	How often have you felt you had access to the following support over the last 3 months? This support could be given in-person or virtually	5 points from 'all the time to 'never' for Someone you can count on to listen to you when you need to talk/ Someone to give you information to help you understand a situation/ Someone to help with daily chores if you were sick/ Someone to have a good time with	
47	Rental negotiation	Have you attempted to renegotiate your rent in response to COVID-19?	No / Yes, and rent was reduced / Yes, but rent was not reduced/ Negotiations are still in progress	
48	Rental negotiation	Why didn't you attempt to renegotiation your rent?	I don't need to/ I don't know how or don't feel comfortable doing it / I don't qualify / I am worried I will be forced to leave if I do/ Other	Shown to those that selected 'no' in Q47
49	Rental negotiation	Can you please explain the outcome of this negotiation?	Text input	
50	Open ended	Is there anything else you would like people to know about the experiences of residents of share houses during COVID-19?	Text input	

Appendix Table A2: Summary statistics, sample mean by survey wave.

	Baseline (June 2020)	Follow-up (October 2020)	Median in Australian share houses
Age (average years, range)	34, 19-74		35
Female (%)	55.67		45
Migrant (%)	21.33		39
Low Education (%)	16.00		
Median Weekly Income	$650		$760
Mental health worsening (%)	18.33	+2	
Number of people in the household (average number, range)	3, 2-6	3, 2-7	
<u>Pre-existing social conditions:</u>			
Housing precarity (%) (paying more than 30% of income on housing costs and/or renting in the informal market).	65.17		
Employment precarity (%) (casually employed or unemployed)	35.50		
Double precarity (%) (experiencing both housing and employment precarity simultaneously)	28.50		
<u>Changing social conditions:</u>			
Covid shocks (%) (people moving in or out of household, decreased earnings, inability to cover housing and other living costs)	74.00	-4.33	
Housing inadequacy (%) (feeling stressed about overcrowding, concerned about ability to use the house, angry about lack of privacy)		31.33	
Accessed government support (%)	67.33	-9.33	
Sufficiency of government support (%)	37.67	-8.67	
Social support (%)	64.66	+1.34	
N	293	293	

Appendix Table A3: The relationship between individual characteristics and precarity

	Outcome variable: *Double Precarity*$_i$					
	I	II	III	IV	V	VI
Female	1.148	1.153	0.98	1.153	0.998	1.127
	(0.248)	(0.249)	(0.218)	(0.190)	(0.271)	(0.358)
Migrant	6.804***	7.289***	3.356***	3.003***	2.241	3.197*
	(2.027)	(2.192)	(1.154)	(1.150)	(1.101)	(1.970)
Age	0.957***	0.952***	0.953***	0.956***	0.957**	0.968*
	(0.011)	(0.011)	(0.010)	(0.007)	(0.019)	(0.017)
Low education		1.996**		2.139***	0.823	1.084
		(0.579)		(0.531)	(0.297)	(0.626)
Low income			7.423***			
			(1.700)			
Country of birth FE	N	N	N	Y	N	Y
Sector employed FE	N	N	N	N	Y	Y
N	586	586	586	586	422	422
Brant test	0.340	0.206	0.823	0.206	0.206	0.206

Notes: Ordered logit regressions, odd ratios reported. The outcome variable, *Double Precarity*$_i$ (job + housing precarity) ranges between 0 and 2. The explanatory variables are indicated in the first column. Standard errors clustered at the sector of employment level. Given that the low education and low income dummy variables are likely to be collinear, we control only for one of them (low education) when we add country of birth and sector of employment fixed effects (FE), cols IV-VI.

Appendix Table A4: The relationship between mental health, precarity and COVID-19 exposure

	Outcome variable: *Mental health worse$_i$*				
	I	II	III	IV	V
Double precarity		2.360*	2.385**		
		(1.043)	(1.059)		
Housing precarity				2.358*	
				(1.059)	
Job precarity					0.441
					(0.331)
Exposure to	2.747***		2.732***	2.732***	2.746***
COVID shocks	(0.750)		(0.800)	(0.800)	(0.750)
Sector employed FE	Y		Y	Y	Y
N	538		538	538	538
Brant test	0.397		0.656	0.397	0.250

Notes: Ordered logit regressions, odd ratios reported. The outcome variable, *Mental health worse$_i$* (worsening of mental health in wave 1 and/or 2) ranges between 0 and 2. The explanatory variables are indicated in the first column. All regressions control for: gender, migrant status and age. Standard errors clustered at the sector of employment level. FE stands for fixed effects.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	5 and 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	2 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3 – 4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6 – 8*
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	13
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3 – 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6 – 9
		(*b*) Describe any methods used to examine subgroups and interactions	6 – 9
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10 and appendix
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*10 - 11*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10 - 11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.