RESEARCH ARTICLE

International Journal of Geriatric Psychiatry **WILEY**

The longitudinal psychological, physical activity, and financial impact of a COVID-19 lockdown on older adults in Singapore: The PIONEER-COVID population-based study

Ester Pei Xuan Lee[1] | Ryan Eyn Kidd Man[1,2,3] | Tau Liang Alfred Gan[1] | Eva K. Fenwick[1] | Amudha Aravindhan[1] | Kam Chun Ho[1,4] | Sharon Cohan Sung[3,5] | Tien Yin Wong[1,2,3] | Cyrus Su Hui Ho[6] | Preeti Gupta[1] | Ecosse L. Lamoureux[1,2,3,7]

[1]Singapore Eye Research Institute, Singapore

[2]Singapore National Eye Centre, Singapore

[3]Duke-NUS Medical School, Singapore

[4]School of Optometry and Vision Science, University of New South Wales Sydney, Kensington, New South Wales, Australia

[5]Department of Developmental Psychiatry, Institute of Mental Health, Singapore

[6]Department of Psychological Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

[7]Ophthalmology Eye and Ear Hospital, The University of Melbourne, Melbourne, Victoria, Australia

Correspondence
Ecosse L. Lamoureux, Singapore Eye Research Institute, Singapore.
Email: ecosse.lamoureux@duke-nus.edu.sg

Abstract

Background: Several countries have implemented 'lockdown' measures to curb the spread of the coronavirus disease 2019 (COVID-19).

Aims: To examine the psychological, physical activity (PA), and financial impact of a 2-month COVID-19 lockdown on older adults aged ≥60 years in Singapore, and to identify factors associated with adverse lockdown-related outcomes.

Method: We interviewed 496 community-dwelling adults (mean age [standard deviation]: 73.8 [7.6] years; 54.8% female) during the lockdown who had previously participated in a population-based epidemiological study. Validated questionnaires were utilised to assess loneliness and depressive symptoms at both timepoints, while inhouse questionnaires were used to assess PA and financial difficulty during lockdown. Multivariable regression models determined the lockdown-related change in loneliness and depression scores, and the factors associated with adverse outcomes.

Results: Loneliness increased significantly during the lockdown period ($p < 0.001$) while depressive symptoms decreased ($p = 0.022$). Decreased PA, greater financial problems, male gender, Indian ethnicity, living alone, having a greater body mass index and perceived susceptibility to COVID-19 were all associated with worsening loneliness scores. A total of 36.9% and 19.6% participants reported decreased PA and had financial problems during the lockdown, respectively. Unemployment was associated with decreased PA, while self-employed individuals, cleaners, retail workers and smokers had greater odds of experiencing financial difficulty.

Conclusion: Despite a decrease in depressive symptoms, our population of older Asians reported a significant increase in loneliness and decreased PA, with one-fifth experiencing financial problems during lockdown. Our data suggest that more targeted public health efforts are needed to reduce repercussions of future lockdowns.

KEYWORDS
COVID-19, depression, financial problems, lockdown, loneliness, older adults, physical activity

Key points

- Loneliness increased significantly during the lockdown period compared to pre-lockdown while depressive symptoms decreased significantly.
- One in three older adults reported a decrease in physical activity during the lockdown.
- One-fifth of our sample experienced financial problems.
- During future lockdowns, more public health efforts are needed to enable older adults to stay socially connected and physically active on top of providing financial support.

1 | INTRODUCTION

Ever since the coronavirus disease 2019 (COVID-19) outbreak was declared a pandemic by the World Health Organisation in March 2020, countries around the world have been adopting unprecedented measures to curb the spread of the disease, with many going into various stages of 'lockdowns'.[1] Singapore, a multicultural Asian city-state, also implemented a lockdown, albeit less strict compared to other countries.[2] The lockdown comprised measures including stay-home orders, social distancing decrees, travel restrictions, and all workplace closures except for essential services from 7 April to 2 June 2020, and was successful in reducing the number of community cases.[3] While social distancing measures and travel restrictions remained in place after the lockdown ended, these are being gradually reduced over time.[3]

Nonetheless, psychological consequences, including loneliness and depression, from the implementation of these stringent lockdown measures have been reported globally.[4] For instance, reports showed significantly greater rates of both depression and anxiety during the initial week of a government-mandated partial lockdown in Vietnam.[5,6] In particular, older adults (i.e., those aged ≥65 years) have been identified as a vulnerable group necessitating high-quality mental health outcomes research on the impact of such strict preventative measures during COVID-19.[7] Due to the established deleterious impact of loneliness and depression on numerous health outcomes such as mental health and overall well-being, many research groups have attempted to document the cross-sectional and longitudinal mental health changes in this older population during the COVID-19 pandemic.[8-10] However, the absence of comparative pre-COVID-19 baseline information makes assessing the true impact of lockdown periods difficult. Findings relating to the impact of lockdown on depression have also been inconsistent.[11,12]

Furthermore, our understanding of how physical activity (PA) and financial situations have been affected by COVID-19 lockdowns is also limited. Yamada and colleagues, for example, found a decrease in PA in older adults during a COVID-19 lockdown in Japan,[13] which is problematic as reduced PA may also be associated with detrimental physical and mental health.[14] Moreover, the various COVID-19 lockdowns globally have led to widespread job furloughs and lay-offs,[15] but the associated consequent financial impact has not been comprehensively documented on an individual level.

Finally, many of the studies have been conducted in Western populations, with few in Asia.[12] Studies in Asia also mainly concentrated on middle-income countries such as China,[16] with few done in high-income Asian countries. This is important as there may be cultural differences in how older adults cope with and, consequently, are affected by the lockdown.

1.1 | Aims

To address these gaps, we examined the self-reported psychological (loneliness and depression), PA, and financial impact of the Singapore lockdown in a multi-ethnic sample of older Asian adults aged ≥60 years using data from an ongoing population-based study conducted before the lockdown and a sub-study conducted during the lockdown. We hypothesised that the lockdown would be associated with significant and substantial decrements in mental health, PA and financial outcomes in this aged population. We additionally aimed to identify the sociodemographic, clinical and psychological factors associated with these adverse lockdown-related outcomes in this population. Our findings may enable Singapore and other developed countries to be better prepared for lockdowns due to similar disease outbreaks in the future.

2 | METHODS

2.1 | Study design and population

The PopulatiON HEalth and Eye Disease PRofile in Elderly Singaporeans (PIONEER) study is an ongoing population-based and epidemiological study of older Asian adults of Chinese, Malay, or Indian ethnicity, aged 60 years and older living across Singapore, approved by the SingHealth Centralized Institutional Review Board (CIRB; #2016/3089). The study commenced in December 2017 and details of the PIONEER study design and methodology have been described previously.[17] Prior to the start of the lockdown on 7 April 2020, a total of 1029 participants had completed both clinical and questionnaire assessments.

The PIONEER-COVID-19 study is a sub-study of PIONEER, conducted between 13 May and 9 June 2020. Individuals who had previously passed the 6-Item Cognitive Impairment Test (6-CIT)[18] during PIONEER assessments and consented to be contacted for future research were invited to participate in this sub-study via telephone by trained research personnel. We included individuals

without severe cognitive, hearing, or speech impairment that would compromise study procedures, not diagnosed with COVID-19 and resided in Singapore during the lockdown. A total of 668 individuals were contacted and, if they accepted to participate, verbal consent was obtained from all participants. The 6-CIT was repeated if 6 months had passed since the participant completed the baseline PIONEER assessment. The study protocol, in the form of questionnaires, was then administered over the phone in the participant's preferred language (English, Mandarin, Malay, or Tamil) by trained interviewers. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human participants were approved by the SingHealth CIRB (#2020/2350).

Of the 665 eligible participants that consented to participate, 496 participants (75.0%) completed all study measures.

2.2 | Measures

2.2.1 | Loneliness

Loneliness was measured using a three-item scale, scored on a three-point scale from 1 (hardly ever) to 3 (often), at both timepoints.[19] Participants rated how often they felt they lacked companionship, were left out and felt isolated from others. For the PIONEER-COVID-19 study, the item stems were modified slightly so as to ensure participant responses were specific to the lockdown (e.g., 'Since the start of the lockdown, how often do you feel that you lack companionship?').

We utilised Rasch analysis[20] to assess the psychometric properties of the loneliness scale using the Andrich rating scale model[20] with Winsteps software (version 4.5.0). Rasch analysis transforms the ordinal questionnaire responses to interval-level estimates of person measures, which are expressed in log of the odds units, or logits. To generate valid pre-during person measures for the loneliness scale, questionnaire data were anchored to item measures and structure calibrations at baseline.[21] This approach reduces distortion of the estimated person measures and ensures that the same scale with identical measurement properties is used to test participants over time.[21] Higher Rasch-transformed scores reflect greater loneliness; a 1-logit increase in loneliness is equivalent to approximately 0.7-point increase in raw scores. We defined a clinically important worsening of loneliness as an increase in Rasch-transformed loneliness scores by 0.5 standard deviation (SD) compared to baseline.[22]

2.2.2 | Depression

The Patient Health Questionnaire (PHQ)-9,[23] a nine-item scale that measures the severity of depressive symptoms, was administered at both timepoints. Items were rated on a 4-point scale indicating the frequency the participant experienced a depressive symptom over the last 2 weeks, ranging from 0 (not at all) to 3 (nearly every day). We utilised the Singapore established cut-off (PHQ-9 score $\geq$ 6) to indicate presence of depression in our analyses[24] and all responses were summed to produce an overall score, with higher scores indicating greater severity of depressive symptoms. An increase in PHQ-9 scores measured during the lockdown by 0.5 SD indicated a clinically important worsening of depression.[22]

2.2.3 | Change in physical activity

Change in PA was measured using a single item asking how the participant's PA had changed since the lockdown, with choice options of 'decreased', 'no change' and 'increased'. Because of the small number of participants reporting an increase in PA (n = 48), we combined this category with 'no change in PA' in statistical analyses.

2.2.4 | Financial impact

The Economic Hardship Questionnaire (EHQ),[25] a 12-item scale, was adapted to examine the financial impact on participants during the lockdown, with two items excluded since these activities could not be undertaken due to the lockdown measures. Participants also described their household's financial position during the lockdown from 0 (no problems) to 2 (major problems). Due to the small number of participants reporting major financial problems (n = 18), we combined 'minor' and 'major' problems in statistical analyses. Participants also indicated how their household income had changed during lockdown from 1 (increased a lot) to 5 (decreased a lot). Responses for this item were recoded as 'increased', 'no change' and 'decreased'. Lastly, eight items assessed changes in lifestyle in the participants' household due to the financial constraints associated with the lockdown. Individual item scores were used in analyses.

2.2.5 | Other covariables

Standardised questionnaires that formed part of the PIONEER study were used to obtain information about sociodemographic variables (age, gender, ethnicity, education, type of housing, living arrangement, occupation, income, smoking status, and alcohol usage), clinical variables (self-reported diabetes, hypertension, hyperlipidaemia, and cardiovascular disease) and lifetime history of mental disorders. Body mass index (BMI) was calculated using height and weight measurements while chronic kidney disease (CKD) was based on the glomerular filtration rate estimated from collected blood samples (eGFR < 60 ml/min/1.73 m^2).[26] The Brief Resilience Scale (BRS)[27] was also administered to measure resilience. The BRS comprises six items on a five-point scale from 'strongly disagree' to 'strongly agree'.

Responses from all items were summed to produce an overall score, with higher scores indicating higher resilience.

During the PIONEER-COVID-19 assessment, participants also responded if they had experienced any major stressful life events over the last 6 months which were not related to COVID-19 such as hospitalisation and death of family member. To measure the perception of susceptibility to COVID-19, participants were asked to rate how likely they were to contract COVID-19 in the next 3 months on a five-point scale (very unlikely, unlikely, likely, very likely, and refused to answer). Finally, the elapsed time between baseline (pre-lockdown) and follow-up (during lockdown) assessments was recorded.

2.3 | Statistical analysis

All statistical analyses were performed using Stata (Version 15, StataCorp). Loneliness and depression were examined using a longitudinal design. Paired T-tests and the McNemar test were used to determine if there was a significant difference between the means and prevalence rates of loneliness and depression before and during the lockdown, respectively. Next, unadjusted and adjusted multivariable logistic regression analyses were conducted to identify factors associated with a clinical worsening of loneliness and depression. Multivariable linear regression analyses, adjusted for age, gender, and factors that were significantly associated with clinical worsening of the exposures in unadjusted analyses, were then conducted to determine the difference between the means of loneliness and depression before and during the lockdown. Sensitivity analyses were also conducted to examine whether the mean change in each psychological outcome differed between participants who completed the baseline PIONEER assessment less than a year from the lockdown assessment versus those who completed the assessment more than a year ago.

Change in PA and financial impact were examined using a cross-sectional design. We utilised proportions to describe participant responses to the individual PA and EHQ items. Unadjusted and adjusted logistic regression models were conducted to identify factors associated with decreased PA and having financial problems. Variables were included as covariates in multivariable linear regression models if they had a $p < 0.10$ in unadjusted models. Two-sided p values of <0.05 were considered statistically significant. Cohen's d was calculated as an estimated effect size.

3 | RESULTS

Of the 496 participants (mean age 73.8 years [SD = 7.6]), over half were female (54.8%), most were of Chinese (61.3%) ethnicity, and majority had received more than 6 years of formal education (64.1%). They were either working (34.1%) or not working (65.9%) and their monthly household income varied from less than $1000 (41.2%) to ≥$1000 (58.8%). More details of participants' characteristics are reported in Table 1.

3.1 | Impact of lockdown and associated risk factors on:

3.1.1 | Loneliness

The mean loneliness score was significantly higher during lockdown than pre-lockdown (−3.02 vs. −3.78; $p < 0.001$). This increase remained even after multivariable adjustments (age, gender, ethnicity, living alone, BMI, hypertension, perception of susceptibility, pre-lockdown loneliness score, change in PA, and household's financial position; adjusted mean difference = 0.76, $p < 0.001$, medium effect size [0.56]). Our sensitivity analyses found that although participants who completed the baseline assessment more than a year ago experienced a larger mean change in loneliness score than those who completed the baseline assessment less than a year ago, the between-group difference was not statistically significant (0.58 vs. 0.89, $p = 0.178$).

The proportion of participants experiencing a clinically important worsening of loneliness was 34.1% ($n = 169$). Factors associated with clinically important worsening of loneliness in unadjusted analyses are reported in Table S1. In multivariable models (Table 2), males ($OR_{adj} = 1.59$, $p = 0.039$), Indians (compared with Chinese; $OR_{adj} = 2.08$, $p = 0.005$); and individuals who were living alone ($OR_{adj} = 2.79$, $p = 0.016$), with higher BMI (per unit increase; $OR_{adj} = 1.06$, $p = 0.033$), and reported higher perceived susceptibility to COVID-19 (per point increase; $OR_{adj} = 1.54$, $p = 0.006$) had increased odds of having a clinically important worsening in loneliness scores. Participants with lower pre-lockdown loneliness scores ($OR_{adj} = 1.72$ per logit decrease, $p < 0.001$), decreased PA (compared with no change or increased; $OR_{adj} = 1.66$, $p = 0.025$) and financial problems ($OR_{adj} = 1.98$, $p = 0.012$) also had increased odds of having a clinically important worsening in loneliness scores in adjusted models.

3.1.2 | Depression

The mean depression score was significantly lower during the lockdown than in pre-lockdown (0.64 vs. 0.95; $p = 0.011$). After adjusting for covariables, the mean depression score remained significantly lower during the lockdown compared to pre-lockdown (adjusted mean difference = −0.33, $p = 0.022$, small effect size [0.13]). As shown by our sensitivity analyses, participants who completed the baseline assessment less than a year ago experienced a larger mean reduction in depression score than those who completed the baseline assessment more than a year ago, although the between-group difference was not statistically significant (−0.41 vs. −0.22, $p = 0.497$). Similarly, the prevalence of depression during the lockdown (2.22%) was also significantly lower than pre-lockdown (4.84%; $p = 0.024$).

The proportion of participants who experienced a clinically important worsening of depressive symptoms was 11.3% ($n = 56$). Factors associated with clinically important worsening of depression in unadjusted analyses are reported in Table S1. In adjusted models,

TABLE 1 Participants' sociodemographic and clinical characteristics

Characteristic	n (%) or M ± SD
Age	
60–64	71 (14.3)
65–69	108 (21.8)
70–74	125 (25.2)
75–79	76 (15.3)
80 and above	116 (23.4)
Gender, female	272 (54.8)
Ethnicity	
Chinese	304 (61.3)
Malay	48 (9.7)
Indian	144 (29.0)
Highest education level	
Primary or lower	178 (35.9)
Secondary or higher	318 (64.1)
Type of housing	
HDB 1-2 rooms	39 (7.9)
HDB 3-5 rooms	365 (73.6)
Private	92 (18.5)
Living alone (yes)	38 (7.8)
Occupation	
Unemployed, homemaker, or retired	297 (65.9)
White-collar, administrative, or clerical	46 (10.2)
Production, technical, or mechanical	57 (12.6)
Self-employed or others	51 (11.3)
Income	
<S$1000	136 (41.2)
S$1000 to <$2000	49 (14.8)
S$2000 to <$5000	79 (23.9)
S$5000 and above	66 (20.0)
Smoking status	
Never	377 (76.0)
Past or current	119 (24.0)
Alcohol use	
Never	405 (81.7)
Past or current	91 (18.3)
BMI	25.4 ± 4.6
Diabetes	153 (30.8)
Hypertension	429 (86.5)
Hyperlipidaemia	333 (71.2)

(Continues)

TABLE 1 (Continued)

Characteristic	n (%) or M ± SD
Cardiovascular disease	109 (22.0)
Chronic kidney disease	67 (15.5)
Presence of life event not due to COVID-19	35 (7.1)
Lifetime history of mental disorders	7 (1.4)
Resilience	3.1 ± 0.4
Perception of susceptibility	1.7 ± 0.7
Time since pre-lockdown assessment	
≤1 year	197 (39.7)
>1 year	299 (60.3)
Loneliness rasch-transformed score during lockdown	−3.02 ± 2.08
Depression score during lockdown	0.64 ± 1.49
Change in physical activity	
Decreased	183 (36.9)
No change or increased	313 (63.1)
Household's financial position during lockdown	
No problems	399 (80.4)
Minor or major problems	97 (19.6)

Abbreviations: BMI, body mass index; COVID-19, coronavirus disease 2019; HDB, Housing & Development Board; M, mean; n, number; SD, standard deviation.

having CKD (OR_{adj} = 2.48, p = 0.026) and reporting financial problems (OR_{adj} = 2.41, p = 0.015) increased the odds of having a clinically important worsening of depressive symptoms.

3.1.3 | Physical activity

In our sample, 36.9% of participants reported a decrease in PA, 53.4% reported no change, and 9.7% had increased in their PA since the lockdown. Factors associated with decreased PA in unadjusted analyses are reported in Table S2. In multivariable models adjusted for age, gender, and occupation (Table 3), participants who were not working (unemployed, homemaker, or retired) were more likely to report a decrease in PA compared to those with production, technical, or mechanical jobs (OR_{adj} = 2.22, p = 0.033).

3.1.4 | Financial problems

In our sample, 80.4% reported no problems, 15.9% had minor problems, and 3.6% had major problems with their household's financial position during the lockdown. Most reported no change in household income since the lockdown (70.4%), while 28.6% experienced a decrease, and a minority reported an increase (1.0%). Factors associated with financial problems in unadjusted analyses are reported in

TABLE 2 Factors associated with a clinically important worsening of loneliness and depression in multivariable linear regression models

Characteristic	Loneliness Adjusted[a] OR [95% CI]	Depression Adjusted[b] OR [95% CI]
Age	1.02 (0.99–1.05)	0.98 (0.94–1.03)
Gender		
Male	1.59 (1.02–2.44)*	1.27 (0.66–2.44)
Female	REF	REF
Ethnicity		
Chinese	REF	REF
Malay	1.53 (0.73–3.18)	1.63 (0.59–4.51)
Indian	2.08 (1.25–3.44)**	1.91 (0.94–3.87)
Living alone	2.79 (1.21–6.43)*	-
BMI (per unit increase)	1.06 (1.00–1.11)*	-
Hypertension (yes)	1.61 (0.79–3.30)	-
Chronic kidney disease (yes)	-	2.48 (1.11–5.54)*
Perception of susceptibility (per point increase)	1.54 (1.13–2.11)**	1.53 (0.98–2.39)
Pre-lockdown loneliness score (per logit decrease)	1.72 (1.32–2.22)***	-
Pre-lockdown depression score	-	0.67 (0.44–1.02)
Change in physical activity		
No change or increased	REF	-
Decreased	1.66 (1.07–2.59)*	-
Household's financial position		
No problems	REF	REF
Minor or major problems	1.98 (1.17–3.38)*	2.41 (1.18–4.91)*

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

[a]Model included age, gender, ethnicity, living alone, BMI, hypertension, perception of susceptibility, pre-lockdown loneliness score, change in physical activity and household's financial position.

[b]Model included age, gender, ethnicity, chronic kidney disease, perception of susceptibility, pre-lockdown depression score and household's financial position.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Table S2. Multivariable analyses showed that individuals who were self-employed or had occupations not classified as white-collar, administrative, clerical, production, technical, or mechanical (e.g., cleaners, service and sales workers; $\beta_{adj} = 3.57$, $p < 0.001$) and smokers ($\beta_{adj} = 2.00$, $p = 0.036$) were more likely to report having financial problems (Table 3).

Common lifestyle changes made due to financial constraints included (Table 4): cutting back on charitable contributions (22.3%), changing food shopping or eating habits to save money (11.5%) and reducing household utility use (9.7%).

4 | DISCUSSION

In our population-based, multi-ethnic study in older Asian adults living in Singapore, we found a significant increase in loneliness during a 2-month COVID-19 lockdown, coupled with a small, but

significant reduction in depressive symptoms. One in three individuals reported a decrease in PA during the lockdown; and over a quarter of our sample experienced a decrease in family income, with one-fifth experiencing financial problems. Various sociodemographic and clinical factors were associated with a clinical worsening of loneliness or depression, including having financial problems, male gender, and reduced PA. Occupation (unemployed, homemakers or retired; and self-employed, cleaners, service and sales workers) was associated with decreased PA and financial problems, respectively. Our results suggest that, although the mental health and PA consequences of the lockdown were substantial, the financial impact was less pronounced. Public health efforts to improve social support and counselling, PA involvement, and financial assistance may be warranted to address the effects of similar lockdowns in the future.

Our finding of a worsening in self-reported loneliness scores during the lockdown compared to pre-lockdown scores corroborates findings from other studies showing an increase in loneliness during

TABLE 3 Factors associated with a decrease in physical activity and facing financial problems in multivariable adjusted models

Characteristic	Decrease in physical activity[a] Adjusted[c] OR [95% CI]	Financial problems[b] Adjusted[d] β [95% CI]
Age	1.00 (0.97–1.03)	0.97 (0.94–1.01)
Gender		
Males	REF	REF
Females	1.31 (0.87–1.97)	1.03 (0.56–1.89)
Occupation		
Unemployed, homemaker or retired	REF	REF
White-collar, administrative, or clerical	1.70 (0.88–3.28)	1.22 (0.53–2.77)
Production, technical or mechanical	0.45 (0.22–0.94)*	1.03 (0.46–2.29)
Self-employed or others	0.59 (0.30–1.15)	3.57 (1.83–6.96)***
Smoking status		
Never	-	REF
Past or current	-	2.00 (1.04–3.81)*
Presence of stressful life event not due to COVID-19 in the past 6 months	-	0.29 (0.07–1.25)

Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019; OR, odds ratio.

[a]Reference class: No change or increased physical activity.

[b]Model included age, gender, and occupation.

[c]Measured using a single item from the Economic Hardship Questionnaire describing participants' household's financial position during the lockdown.

[d]Model included age, gender, occupation, smoking status, and presence of stressful life event not due to COVID-19.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

TABLE 4 Individual item responses from the economic hardship questionnaire

Lifestyle changes	Never	Sometimes	Often	Very often
Cut back on charitable contributions[a]	262 (77.7)	56 (16.6)	6 (1.8)	13 (3.9)
Changed food shopping or eating habits to save money	439 (88.5)	43 (8.7)	8 (1.6)	6 (1.2)
Reduced household utility use	448 (90.3)	29 (5.8)	14 (2.8)	5 (1.0)
Postponed major household purchases	450 (90.7)	34 (6.9)	8 (1.6)	4 (0.8)
Changed transportation patterns to save money	475 (95.8)	18 (3.6)	2 (0.4)	1 (0.2)
Sold some possessions	492 (99.2)	4 (0.8)	0 (0.0)	0 (0.0)
Postponed medical care to save money	492 (99.2)	3 (0.6)	0 (0.0)	1 (0.2)
Took additional employment to help meet expenses	480 (96.8)	7 (1.4)	7 (1.4)	2 (0.4)

[a]Excluded participants who did not give any charitable contributions in the past ($n = 159$).

the COVID-19 lockdown from pre-COVID-19 times, such as among older adults in the Netherlands.[10] This increase in loneliness could be a result of reduced social contact due to bans on household visitation, even amongst family members, coupled with an embargo on all forms of social gathering, closure of community centres and places of worship.[28] Most of the factors independently associated with a clinically important worsening of loneliness identified in our study, including being of Indian ethnicity, living alone, having a higher BMI, greater perceived susceptibility to COVID-19, reduced PA during lockdown, experiencing financial problems, and having a worse

loneliness score pre-lockdown, are congruent with previous non-COVID-19 studies evaluating risk factors for loneliness.[29] However, our finding that male gender was associated with increased odds of loneliness contrasts with a study in the United Kingdom showing that women were more likely to be lonely both before and during the lockdown compared to their male counterparts.[30] This may be due to cultural differences between Singapore and United Kingdom. Nonetheless, future research to examine the relationship of gender with loneliness may be warranted. Given the deleterious impact of loneliness,[9] our findings illustrate a need to provide increased social support, such as improving digital literacy to use video calls for social interactions,[28] to enable older adults, specifically those from vulnerable segments of the population, to keep loneliness at bay.

Contrary to previous studies which found either an increase or no change in depression,[11,12] we found that both the rates of depression and frequency of depressive symptoms were lower in our sample during the lockdown compared to pre-lockdown values.[31] There are several possible explanations. First, our study commenced on 13 May 2020, approximately 1.5 months into the lockdown,[32] potentially allowing our participants time to psychologically adjust to the 'new normal'. Moreover, as 76% of participants were recruited after the end-date of the lockdown was announced (20 May 2020), their mood might have improved as a result of the announcement. Moreover, the effectiveness of the lockdown was evident with a decline in community cases, which may have further lessened any potential distress. Indeed, stratified analyses revealed that participants who completed the study before the announcement of lockdown experienced a worsening in depression scores (adjusted mean change = 0.53, $p = 0.058$) compared to those who completed the study after the announcement (adjusted mean change = −0.59, $p < 0.001$) of lockdown. Secondly, access to mental health services such as the National CARE hotline and other free counselling services in Singapore were readily available during the lockdown.[32] Participants may have learnt about these services through mass media and were encouraged to receive psychological support. Future research evaluating the impact of similar lockdowns on depressive symptoms should incorporate qualitative work to elicit the reasons underlying this seemingly paradoxical improvement. Our finding may suggest early intervention is needed during early stages of a lockdown, especially when the duration of the lockdown is unknown. Our finding that CKD and having financial problems were independently associated with a clinically important worsening of depression is similar to other studies reporting risk factors for depression.[29,33] People with CKD might have experienced challenges and fear going for hospital appointments and dialysis during the lockdown, resulting in increased depressive symptoms.

Consistent with other studies,[13] we found one in three participants had reduced their PA during the lockdown. In particular, individuals who were unemployed, homemakers, or retired were more likely to report a decrease in PA compared to production, technical, or mechanical workers. A possible explanation is that technical and mechanical workers might be more likely to work in essential services such as maintenance and repair services which were exempted

from the lockdown. In contrast, as all senior-centric PA activities and sport and recreation facilities were cancelled or closed during the lockdown,[32] those who usually access these sites were unable to engage in their usual PA.[34] Our findings suggest more public health efforts are needed to encourage unemployed/retired older adults to stay active during future lockdowns, such as broadcasting simple home exercises on media channels frequented by this population.

Lastly, one in five of our participants experienced financial problems during the lockdown, with 28.6% reporting a decrease in household income. Despite government financial subsidies ranging between S$600–S1200 given to all Singaporeans aged 21 and above during the lockdown,[35] this figure was higher than another study which reported that 19.7% of households had a decrease in income during the lockdown among individuals aged 65 and above living in New Zealand.[36] As 92.2% of our participants were part of a larger household compared to only 50% of older adults in New Zealand,[37] it is likely that our sample had more household members who were financially impacted by the lockdown; especially since adults aged 64 and below are more likely experience income loss.[36] We also found that self-employed individuals, cleaners, service and sales workers and smokers were more likely to have financial problems, a result that is supported by previous studies.[36] Our finding could be related to the forced suspension of non-essential services during the lockdown, which are the sole source of income for most self-employed individuals. Additional financial support should therefore be considered for older adults who are self-employed, cleaners, or those working in the service sectors when similar lockdown measures are undertaken in the future.

Strengths of our study include its prospective design to assess psychological outcomes, a study population drawn from the community, and detailed information on a variety of potential confounders. We also utilised Rasch analysis to increase the validity and test-retest reliability of the loneliness scale. Our study limitations include paucity of Malay participants ($n = 48$) in our sample, which may have limited the generalisability of our results since Singapore is a multi-ethnic country comprising of Chinese (75.9%), Malays (15.0%), Indians (7.5%) and other ethnic groups (1.6%).[38] Second, our pre-lockdown data for depressive symptoms and loneliness were collected over 19 months which could have introduced variability in the results; however, sensitivity analyses found no significant differences in these outcomes between participants who completed the baseline PIONEER assessment less than a year from the lockdown assessment versus those who completed the assessment more than a year ago. Third, our study mainly used self-reported questionnaires to measure psychiatric symptoms and did not establish clinical diagnoses, notwithstanding that the gold standard for establishing psychiatric diagnosis involves conducting a structured clinical interview and functional neuroimaging.[39-41] Olszewska-Guizzo and colleagues found decreased brain haemodynamics during the COVID-19 pandemic which is associated with depressive symptoms.[42] As such, future research is required to assess a subset of participants, using functional neuroimaging and clinical diagnosis, for associated lockdown depression, may be

warranted. Lastly, as mentioned previously, our data collection was undertaken towards the tail end of the lockdown. This meant that our findings could not capture the psychological, PA, and financial impact of the initial part of the lockdown. As such, future research should consider examining the change in outcomes across various phases of a lockdown.

In conclusion, in our population of older Asian individuals, we found that a government-mandated lockdown resulted in a significant increase in loneliness and a decrease in PA, although they were less impacted financially, with only one in five reporting some degree of financial difficulty. Our results suggest a need to look beyond the physical health impact of the pandemic itself and address the mental, PA, and financial repercussions of forced lockdown periods through targeted interventions especially for self-employed or retired older males with health problems who are facing financial challenges. During future lockdowns, more public health efforts are needed to enable older adults to stay socially connected and physically active on top of providing financial support.

CONFLICT OF INTEREST
The authors have no conflict of interest declare.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author, Ecosse L. Lamoureux, upon reasonable request.

ORCID
Ester Pei Xuan Lee https://orcid.org/0000-0002-8392-8853
Ryan Eyn Kidd Man https://orcid.org/0000-0001-5028-605X
Eva K. Fenwick https://orcid.org/0000-0003-0417-2048
Amudha Aravindhan https://orcid.org/0000-0002-8859-5592
Kam Chun Ho https://orcid.org/0000-0001-9029-4329
Sharon Cohan Sung https://orcid.org/0000-0003-3293-2112
Tien Yin Wong https://orcid.org/0000-0002-8448-1264
Cyrus Su Hui Ho https://orcid.org/0000-0002-7092-9566
Preeti Gupta https://orcid.org/0000-0002-8285-0783
Ecosse L. Lamoureux https://orcid.org/0000-0001-8674-5705

REFERENCES
1. Safi M, Davidson H, Giuffrida A, et al. One million coronavirus deaths: how did we get here? *The Guardian*. https://www.theguardian.com/world/ng-interactive/2020/sep/29/one-million-coronavirus-deaths-how-did-we-get-here-covid

2. Fung M. Coronavirus: how S'pore's circuit breaker compares with other countries' lockdowns. *The Straits Times*. https://www.straitstimes.com/asia/se-asia/how-spores-circuit-breaker-compares-with-other-countries-lockdowns

3. Baker JA. Singapore's circuit breaker and beyond: Timeline of the COVID-19 reality. *CNA*.

4. O'Connor RC, Wetherall K, Cleare S, et al. Mental health and well-being during the COVID-19 pandemic: longitudinal analyses of adults in the UK COVID-19 Mental Health & Wellbeing study. *Br J Psychiatry*. 2021;218(6):326-333. https://doi.org/10.1192/bjp.2020.212

5. Le HT, Lai AJX, Sun J, et al. Anxiety and depression among people under the nationwide partial lockdown in Vietnam. Original research. *Front Public Health*. 2020;8(656):589359. https://doi.org/10.3389/fpubh.2020.589359

6. Tran BX, Nguyen HT, Le HT, et al. Impact of COVID-19 on economic well-being and quality of life of the Vietnamese during the national social distancing. *Front Psychol*. 2020;11:565153-565153. https://doi.org/10.3389/fpsyg.2020.565153

7. Holmes EA, O'Connor RC, Perry VH, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry*. 2020;7(6):547-560. https://doi.org/10.1016/S2215-0366(20)30168-1

8. Aihara Y, Kiyoshi M. Depressive symptoms in community-dwelling older adults in Japan before and during the COVID-19 pandemic. *Int J Geriatr Psychiatry*. 2021;36(7):1122-1123. https://doi.org/10.1002/gps.5558

9. Holwerda TJ, van Tilburg TG, Deeg DJ, et al. Impact of loneliness and depression on mortality: results from the longitudinal ageing study Amsterdam. *Br J Psychiatry*. 2016;209(2):127-134. https://doi.org/10.1192/bjp.bp.115.168005

10. van Tilburg TG, Steinmetz S, Stolte E, van der Roest H, de Vries DH. Loneliness and mental health during the COVID-19 pandemic: a study among Dutch older adults. *J Gerontol B Psychol Sci Soc Sci*. 2021;76(7):e249–e255. https://doi.org/10.1093/geronb/gbaa111

11. Kusuma D, Pradeepa R, Khawaja KI, et al. Low uptake of COVID-19 prevention behaviours and high socioeconomic impact of lockdown measures in South Asia: evidence from a large-scale multi-country surveillance programme. *SSM – Popul Health*. 2021;13:100751. https://doi.org/10.1016/j.ssmph.2021.100751

12. White RG, Van Der Boor C. Impact of the COVID-19 pandemic and initial period of lockdown on the mental health and well-being of adults in the UK. *BJPsych Open*. 2020;6(5):e90. https://doi.org/10.1192/bjo.2020.79

13. Yamada M, Kimura Y, Ishiyama D, et al. Effect of the COVID-19 epidemic on physical activity in community-dwelling older adults in Japan: a cross-sectional online survey. *J Nutr Health Aging*. 2020:24(9):948-950.

14. Cunningham C, O' Sullivan R, Caserotti P, Tully MA. Consequences of physical inactivity in older adults: a systematic review of reviews and meta-analyses. *Scand J Med Sci Sports*. 2020;30(5):816-827. https://doi.org/10.1111/sms.13616

15. Ong J. The Big Read: with COVID-19 annihilating jobs, many are feeling the pain – and it will get worse. *Channel NewsAsia*. https://www.channelnewsasia.com/news/singapore/covid-19-big-read-jobs-retrenchment-economy-13024666

16. Wang C, Tee M, Roy AE, et al. The impact of COVID-19 pandemic on physical and mental health of Asians: a study of seven middle-income countries in Asia. *Plos One*. 2021;16(2):e0246824. https://doi.org/10.1371/journal.pone.0246824

17. Gupta P, Man REK, Fenwick EK, et al. Rationale and methodology of the PopulatION HEalth and Eye disease PRofile in elderly Singaporeans study (PIONEER). *Aging Dis*. 2020;11(6):1444-1458. https://doi.org/10.14336/ad.2020.0206

18. Upadhyaya AK, Rajagopal M, Gale TM. The six item cognitive impairment test (6-CIT) as a screening test for dementia:

comparison with mini-mental state examination (MMSE). *Curr Aging Sci.* 2010;3(2):138-142. https://doi.org/10.2174/1874609811003020138

19. Hughes ME, Waite LJ, Hawkley LC, Cacioppo JT. A short scale for measuring loneliness in large surveys: results from two population-based studies. *Res Aging.* 2004;26(6):655-672. https://doi.org/10.1177/0164027504268574

20. Lamoureux EL, Pesudovs K. Vision-specific quality of life research: a need to improve the quality. *Am J Ophthalmol.* 2011;151(2):195-197. e2. https://doi.org/10.1016/j.ajo.2010.09.020

21. Chien T. Repeated measure designs and Rasch. *Rasch Meas Trans.* 2008;22(3):1171.

22. Norman GR, Sloan JA, Wyrwich KW. Interpretation of changes in health-related quality of life: the remarkable universality of half a standard deviation. *Med Care.* 2003;41(5):582-592. https://doi.org/10.1097/01.MLR.0000062554.74615.4C

23. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 2001;16(9):606-613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

24. Sung SC, Low CC, Fung DS, Chan YH. Screening for major and minor depression in a multiethnic sample of Asian primary care patients: a comparison of the nine-item Patient Health Questionnaire (PHQ-9) and the 16-item Quick Inventory of Depressive Symptomatology – self-report (QIDS-SR16). *Asia Pac Psychiatry.* 2013;5(4):249-258. https://doi.org/10.1111/appy.12101

25. Lempers JD, Clark-Lempers D, Simons RL. Economic hardship, parenting, and distress in adolescence. *Child Dev.* 1989;60(1):25-39. https://doi.org/10.1111/j.1467-8624.1989.tb02692.x

26. Kidney Disease Improving Global Outcomes. *KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease*; 2012.

27. Smith BW, Dalen J, Wiggins K, Tooley E, Christopher P, Bernard J. The brief resilience scale: assessing the ability to bounce back. *Int J Behav Med.* 2008;15(3):194-200. https://doi.org/10.1080/10705500802222972

28. Armitage R, Nellums LB. COVID-19 and the consequences of isolating the elderly. *Lancet Public Health.* 2020;5(5):e256. https://doi.org/10.1016/S2468-2667(20)30061-X

29. Ohrnberger J, Fichera E, Sutton M. The relationship between physical and mental health: a mediation analysis. *Soc Sci Med.* 2017;195:42-49. https://doi.org/10.1016/j.socscimed.2017.11.008

30. Bu F, Steptoe A, Fancourt D. Who is lonely in lockdown? Cross-cohort analyses of predictors of loneliness before and during the COVID-19 pandemic. *Publ Health.* 2020;186:31-34. https://doi.org/10.1016/j.puhe.2020.06.036

31. Benke C, Autenrieth LK, Asselmann E, Pane-Farre CA. Stay-at-home orders due to the COVID-19 pandemic are associated with elevated depression and anxiety in younger, but not older adults: results from a nationwide community sample of adults from Germany. *Psychol Med.* 2020:1-2. https://doi.org/10.1017/S0033291720003438

32. Yip W, Ge L, Ho AHY, Heng BH, Tan WS. Building community resilience beyond COVID-19: the Singapore way. *Lancet Reg Health West Pac*;7:100091. https://doi.org/10.1016/j.lanwpc.2020.100091

33. Wilson JM, Lee J, Fitzgerald HN, Oosterhoff B, Sevi B, Shook NJ. Job insecurity and financial concern during the COVID-19 pandemic are associated with worse mental health. *J Occup Environ Med.* 2020;62(9):686-691. https://doi.org/10.1097/JOM.0000000000001962

34. Market Insights & Consumer Analytics (Sport Singapore). *Sports Index Participation Trends 2015*; 2015.

35. Government of Singapore. *Solidarity Budget 2020: Additional Cash Payments to Help Families Get Through Circuit Breaker Phase*; 2020. Accessed September 08, 2020. https://www.gov.sg/article/solidarity-budget-2020-additional-cash-payments-to-help-families-get-through-circuit-breaker-phase#:~:text=Every%20adult%20Singaporean%20will%20receive,brought%20forward%20to%20April%202020

36. Fletcher M, Prickett KC, Chapple S. Immediate employment and income impacts of Covid-19 in New Zealand: evidence from a survey conducted during the Alert Level 4 lockdown. *N Z Econ Pap.* 2021:1-8. https://doi.org/10.1080/00779954.2020.1870537

37. Jamieson HA, Gibson HM, Abey-Nesbit R, Ahuriri-Driscoll A, Keeling S, Schluter PJ. Profile of ethnicity, living arrangements and loneliness amongst older adults in Aotearoa New Zealand: a national cross-sectional study. *Australas J Ageing.* 2018;37(1):68-73. https://doi.org/10.1111/ajag.12496

38. Singapore Department of Statistics. M810671 – Singapore citizens by age group, ethnic group and sex, end June, annual. https://www.tablebuilder.singstat.gov.sg/publicfacing/createDataTable.action?refId=15689

39. Ho CSH, Lim LJH, Lim AQ, et al. Diagnostic and predictive applications of functional near-infrared spectroscopy for major depressive disorder: a systematic review. *Front Psychiatry.* 2020;11:378. https://doi.org/10.3389/fpsyt.2020.00378

40. Husain SF, Tang TB, Yu R, et al. Cortical haemodynamic response measured by functional near infrared spectroscopy during a verbal fluency task in patients with major depression and borderline personality disorder. *EBioMedicine.* 2020;51:102586. https://doi.org/10.1016/j.ebiom.2019.11.047

41. Husain SF, Yu R, Tang T-B, et al. Validating a functional near-infrared spectroscopy diagnostic paradigm for major depressive disorder. *Sci Rep.* 2020;10(1):9740. https://doi.org/10.1038/s41598-020-66784-2

42. Olszewska-Guizzo A, Mukoyama A, Naganawa S, et al. Hemodynamic response to three types of urban spaces before and after lockdown during the COVID-19 pandemic. *Int J Environ Res Public Health.* 2021;18(11):6118. https://doi.org/10.3390/ijerph18116118

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.