Are adversities and worries during the COVID-19 pandemic related to sleep quality? Longitudinal analyses of 45,000 UK adults

Liam Wright b, Andrew Steptoe a, and Daisy Fancourt a
a Department of Behavioural Science and Health, University College London
b Department of Epidemiology and Public Health, University College London
*Corresponding author: Dr Daisy Fancourt, 1-19 Torrington Place, London, WC1E 7HB, d.fancourt@ucl.ac.uk

Word Count: 4,028

Abstract

There are concerns that both the experience of adversities during the COVID-19 pandemic and worries about experiencing adversities will have substantial and lasting effects on physical and mental health. One pathway through which both experience of and worries about adversity may impact health is through effects on sleep. Psychosocial stress can reduce sleep length and increase sleep disturbance, which can in turn reduce individuals’ ability to cope and respond to stressors, and worsen health outcomes. Therefore this study explored whether either worries about adversities during the pandemic or the experience of adversities were associated with impaired sleep. We used data from 45,109 adults in the COVID-19 Social Study assessed weekly from 01/04/2020-11/05/2020 in the UK during the pandemic. We studied six categories of adversity including both worries and experiences of: illness with COVID-19, financial difficulty, loss of paid work, difficulties acquiring medication, difficulties accessing food, and threats to personal safety. We used random-effect within-between models that automatically account for all time-invariant confounders. Both the total number of adversity experiences and total number of adversity worries were associated with lower quality sleep. Each additional experience was associated with a 1.17 (95% CI = 1.11, 1.24) times higher odds of poor quality sleep while each additional worry was associated with a 1.20 (95% CI = 1.17, 1.23) times higher odds of poor quality sleep. When considering specific experiences and worries, all worries and experiences were significantly related to poorer quality sleep except experiences relating to employment and finances. Having a larger social network offered some buffering effects on associations but there was limited further evidence of moderation by social or psychiatric factors. Results suggest that poor sleep may be a mechanism by which adversities are affecting mental health and highlight the importance of interventions that seek to reassure individuals and support adaptive coping strategies during the pandemic.

Keywords

Covid-19; sleep; adversities; worries; stress; mental health

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
Introduction

The global pandemic of coronavirus disease 2019 (COVID-19) is leading to increasing experience of adversities. These adversities are both arising from the virus itself (i.e. infection, illness, and possibly death from the disease) and resulting from efforts to contain the disease, such as financial shocks following the loss of employment and income, challenges in accessing food, medication or accommodation, and adverse domestic experiences such as abuse. Similar experiences have been reported in previous epidemics, but the scale of measures implemented and the long time-frames being projected for the COVID-19 pandemic are causing concern that we face manifold public health crises in the years to come.

In particular, there are concerns that adversity experiences will have substantial and lasting effects on physical and mental health. Studies suggest that intimate partner violence and socio-economic adversities such as poverty, job loss, economic recession, and job insecurity, have lasting impacts on mortality and physical and mental health outcomes. Further, it is not just the experience of these stressors, but also worries about the potential experience of these stressors that can affect mental health, increasing levels of stress and affecting depression and wellbeing, as well as affecting physical health such as cardiovascular outcomes.

One pathway through which both experience of and worries about adversity may impact health is through effects on sleep. Studies have related adversity to psychosocial stress, which is known to impair sleep, while worrying has also been associated with shorter sleep length and greater sleep disturbance. Impaired sleep is in turn related to worsened health outcomes, such as cardiovascular disease, weight gain, and mortality. Further, inadequate sleep may reinforce the impact of adversity by reducing individual’s ability to...
respond effectively to stressors, leading to a maladaptive psychophysiological cycle \cite{37-40}. It is therefore essential to understand whether adversities experienced during the COVID-19 are leading to sleep problems.

While adversity may be related to poorer sleep quality on average, there are several factors that could protect against such effects. First, social support may buffer against stress through the provision of informational or tangible assistance or emotional support \cite{41}. A large body of literature shows that social support is associated with better sleep \cite{42} and with improved physical and mental health outcomes, including lower mortality rates \cite{43}. Further, improved sleep has been identified as a pathway through which social support may affect health \cite{44}. However, decreased face-to-face contact and the increasing prevalence of adversity throughout populations may have reduced the availability and quality of social support during the pandemic \cite{7}. Further, the novel nature of several adversities faced may have reduced the efficacy of informational or tangible assistance aspects of social support. Therefore, an unresolved question is whether social support buffers the association between adversity and sleep quality during lockdown.

A second factor that may be important for the link between adversity and sleep is existing mental health. Studies show that individuals with pre-existing mental health issues may be disproportionately affected psychologically by stressful events. For example, anxiety and depression can predispose individuals (especially men) to greater stress reactivity \cite{45}, while anxiety sensitivity can moderate the relationship between exposure to traumatic events and post-traumatic stress \cite{46}. Further, in previous studies of epidemics, there has been some indication that pre-existing psychiatric conditions are a risk factor for poorer psychological outcomes \cite{8}. However, when considering the link between psychological experiences and sleep, it is possible that individuals with existing mental health conditions may already have
poorer sleep, leading to a ceiling effect, such that adversity may not have any further material
detrimental effect on sleep $^{37,47,48}$.

To explore these issues further, the present study used data from a large, longitudinal study of
the experiences of adults during the early weeks of the lockdown due to COVID-19 in the
UK to explore the time-varying longitudinal relationship between (i) worries about adversity,
and (ii) experience of adversity and quality of sleep. Further, it sought to ascertain whether
the relationship between adversity and sleep quality was moderated by social support and
existing mental health diagnoses.

**Materials and Methods**

**Participants**

We use data from the COVID-19 Social Study; a large panel study of the psychological and
social experiences of over 50,000 adults (aged 18+) in the UK during the COVID-19
pandemic. The study commenced on 21 March 2020 and involves online weekly data
collection from participants for the duration of the pandemic in the UK. Recruitment into the
study is ongoing. The study is not random but does contain a well-stratified sample.
Participants were recruited using three primary approaches. First, snowballing was used,
including promoting the study through existing networks and mailing lists (including large
databases of adults who had previously consented to be involved in health research across the
UK), print and digital media coverage, and social media. Second, more targeted recruitment
was undertaken focusing on (i) individuals from a low-income background, (ii) individuals
with no or few educational qualifications, and (iii) individuals who were unemployed. Third,
the study was promoted via partnerships with third sector organisations to vulnerable groups,
including adults with pre-existing mental health conditions, older adults, carers, and people
experiencing domestic violence or abuse. The study was approved by the UCL Research Ethics Committee [12467/005] and all participants gave informed consent.

Our questions asked about experiences of adversity in the last week, so we focused on data from 1st April 2020 (one week after lockdown commenced) to 11th May 2020, limiting our analysis to participants who were interviewed on two or more occasions during this period (n = 47,482, observations = 196,902; 79.4% of individuals interviewed between 1 April – 11 May). We used complete case data, excluding participants with complete data in fewer than two interviews (n = 2,373; 5% of eligible participants). This provided a final analytical sample of 45,109 participants (186,794 observations).

Measures

Adversities

We studied six categories of adversity: illness with COVID-19, financial difficulty, loss of paid work, difficulties acquiring medication, difficulties accessing food, and threats to personal safety.

Adversity experiences were measured weekly as follows. Illness with COVID-19 was measured as suspected or diagnosed illness (including recovery). Personal safety was measured as reporting being physically harmed or psychologically harmed by someone else on at least one day over the past week. Financial problems were measured as experiencing a major cut in household income (in sensitivity analysis, we alternatively operationalised this as inability to pay household bills), while loss of paid employment was measured as reporting having lost a job or having been unable to do paid work. Inability to access sufficient food or required medication were measured using two self-report items. We constructed a weekly total adversity experiences measure by summing the number of adversities present in a given week (range 0-6). For adversities that are likely to be continuing (i.e. once experienced in one
week, their effects would likely last into future weeks), we counted them on subsequent waves after they had first occurred. This applied to experiencing suspected/diagnosed COVID-19, loss of paid work, major cut in household income, and abuse victimisation.

Adversity worries were captured from two questions that asked participants to select which of a list of items had caused them (a) stress (however minor) in the past week, or (b) significant stress in the past week. Participants were prompted that “significant” stress could involve something being constantly on their mind or keeping them awake at night. We used the items "catching COVID-19", "your own safety/security", "finances", "losing your job/unemployment", "getting food", and "getting medication" as analogues to the adversity experiences described above. We constructed a weekly total worries measure by summing the number of items reported as worries in a given week (range 0-6). We considered each to be one-off events and counted them only in the weeks they were reported.

Sleep

Sleep quality was elicited using a single item on sleep over the past week (five categories: very good, good, average, not good, very poor), which we dichotomised into a binary variable for not good or poor vs average or better sleep.

Social Support

We measured social support at first interview using four separate variables for loneliness, perceived social support, social network size, and living alone. Loneliness was measured using the 3-item UCLA-3 loneliness, a short form of the Revised UCLA Loneliness Scale (UCLA-R). Each item is rated with a 3-point rating scale, ranging from “never” to “often”, with higher scores indicating greater loneliness. We used the sum score measure (range 3-9).

Perceived social support was measured using an adapted version of the six-item short form of Perceived Social Support Questionnaire (F-SozU K-6). Each item is rated on a 5-point scale
from “not true at all” to “very true”, with higher scores indicating higher levels of perceived social support. We used the sum score measure (range 6-30). Minor adaptations were made to the language in the scale to make it relevant to experiences during COVID-19 (see Supplementary Table S1 for a comparison of changes). Social network size was measured as number of close friends, with numbers capped at 10+. We included this as a continuous variable.

**Psychiatric Illness**

We defined psychiatric illness as reporting a clinically diagnosed mental health problem (depression, anxiety, or other mental health condition) at first interview.

**Analysis**

We used random-effect within-between (REWB) models 49 (also known as hybrid models 50) to explore the association between within-person change in adversity experiences and adversity worries and the likelihood of poor quality sleep 50. Our basic model can be expressed as follows:

\[
P(\text{Bad Sleep}_{it} = 1) = \text{logit}^{-1}(\beta_0 + \beta_1 \bar{E}_{ikt} + \beta_2 \bar{W}_{ikt} + \beta_4 \bar{W}_{ikt} + \beta_5 \bar{W}_{ikt} + \beta_6 X_i + \alpha_i + \epsilon_{it})
\]

where Bad Sleep\(_i\) is an indicator for whether individual \(i\) reported bad quality sleep at time \(t\). \(\bar{E}_{ikt}\) is the person-specific mean level of adversity experience \(k\) across time periods for individual \(i\), while \(\bar{W}_{ikt}\) is the corresponding figure for adversity worries. \(E_{ikt}\) and \(W_{ikt}\) are the deviations from the person-specific mean values of adversity experiences \(k\) and adversity worries \(k\) for individual \(i\) at time \(t\). \(X_i\) is a vector of control variables defined below. \(\alpha_i\) is the random intercept for individual \(i\), which we model as distributed \(\sim N(0, \sigma_a^2)\). \(\epsilon_{it}\) is the
observation-specific residual error ($\sim N(0, \sigma^2_e)$). Whether terms for adversity experiences and adversity worries were entered simultaneously or separately depends on the model.

Our interest was the sign and size of the coefficients, $\beta_1$ and $\beta_3$, which represent the association between within-person change in adversity experiences and adversity worries and the likelihood of poor sleep. We focused on within-person change rather than cross-sectional variation as cross-sectional associations are likely to be confounded by factors such as socio-economic class or personality, which are related to the prevalence of adversity and to sleep. When looking at within-person changes, these characteristics should be fixed, and so associations should not be biased due the influence of these omitted variables on sleep. In fact, in non-linear models such as the logistic model, the coefficients $\beta_1$ and $\beta_3$ are unbiased by time-invariant heterogeneity if the random intercept, $\alpha_i$, is a linear function of the level-2 predictors. However, simulations have shown that the extent of bias due to violations of this assumption are limited in practice. Nevertheless, results can still be biased if exposure to new adversities or worries is related to other unobserved changes occurring for the individual.

We estimated several models. In Model 1, we regressed sleep quality on the total number of adversity experiences and total number of adversity worries, both (a) separately and (b) jointly, using the fixed effects estimator to account for time-invariant heterogeneity across participants. In Model 2, we regressed sleep quality on adversity experiences and adversity worries separately for each category of adversity in turn (finances, personal safety, etc.). In Model 3, we repeated Model 1a including interactions between adversity measures and each social support variable, for each social support variable in turn. In Model 4, we repeated Model 1a including interactions between adversity measures and baseline mental health. We adjusted for day of week (categorical) and days since lockdown commenced (continuous) in each regression (person-specific means and deviations from these means).
non-random nature of the sample, all data were weighted to the proportions of gender, age, ethnicity, education and country of living obtained from the Office for National Statistics. We carried out several sensitivity analyses to test the robustness of our results. First, we re-estimated Model 3 using inability to pay bills, rather than major cut in household income, as our measure of experienced financial adversity. Second, we repeated each analysis using the sleep item as a continuous variable to test whether results were robust to variable measurement. For these regressions, we used the linear fixed effects estimator which controls for time-invariant confounding by design. Third, we repeated regressions using both the linear probability fixed effect estimator and the fixed effects logit estimators. We did not use the fixed effects logit estimator in the main analysis as the estimator uses information from those whose sleep quality changes only, which may bias results towards those whose sleep is most responsive to adversity. Fourth, we repeated our main REWB model for the subset of individuals whose sleep quality changed and compared results against those from the fixed effect logit estimator to assess the possibility of confounding due to time invariant heterogeneity in our main analysis. Analyses were carried out in Stata version 16.0 (Statacorp, Texas) and R version 3.6.3.

Results

Demographics

Descriptive statistics are shown in Table 1. There was within-variation in each of the measures, suggesting REWB was a valid approach. Table S2 in the supplementary material displays descriptive statistics for baseline social support and mental health diagnosis variables. Individuals with diagnosed mental illness or with lower social support had worse sleep, on average.
| Variable                        | Overall Mean | Overall SD | Between SD | Within SD |
|-------------------------------|--------------|------------|------------|-----------|
| Sleep quality (range 1-5)     | 3.11         | 1.08       | 0.95       | 0.51      |
| Bad Sleep (binary)            | 0.29         | 0.45       | 0.37       | 0.26      |
| Experiences                   |              |            |            |           |
| Total number of adversity     | 0.59         | 0.84       | 0.79       | 0.28      |
| Lost work (binary)            | 0.10         | 0.30       | 0.29       | 0.08      |
| Cut in income (binary)        | 0.19         | 0.39       | 0.37       | 0.12      |
| Unable to access sufficient   | 0.04         | 0.20       | 0.15       | 0.13      |
| food (binary)                 |              |            |            |           |
| Unable to access required     | 0.03         | 0.16       | 0.12       | 0.11      |
| medication (binary)           |              |            |            |           |
| Suspected or diagnosed        | 0.13         | 0.34       | 0.33       | 0.08      |
| COVID-19 (binary)             |              |            |            |           |
| Physically or psychologically | 0.09         | 0.29       | 0.27       | 0.11      |
| harmed (binary)               |              |            |            |           |
| Worries                       |              |            |            |           |
| Total number of adversity     | 1.31         | 1.32       | 1.15       | 0.65      |
| worries (range 0-6)           |              |            |            |           |
| Losing job/unemployment       | 0.13         | 0.33       | 0.28       | 0.18      |
| (binary)                      |              |            |            |           |
| Finances (binary)             | 0.31         | 0.46       | 0.39       | 0.24      |
### Table 1: Descriptive statistics, weighted figures.

| Variable                        | Overall Mean | Overall SD | Between SD | Within SD |
|---------------------------------|--------------|------------|------------|-----------|
| Getting food (binary)           | 0.20         | 0.40       | 0.30       | 0.26      |
| Getting medication (binary)     | 0.12         | 0.32       | 0.25       | 0.20      |
| Catching COVID-19 (binary)      | 0.42         | 0.49       | 0.40       | 0.29      |
| Personal safety (binary)        | 0.13         | 0.34       | 0.26       | 0.22      |

**Associations between adversities and sleep**

Both the total number of adversity experiences and total number of adversity worries were associated with lower quality sleep (Figure 1). The inclusion of experiences and worries in the same model slightly reduced the effect size of experiences and had little effect on the effect size of worries. In models including both experiences and worries, each additional experience was associated with a 1.17 (95% CI = 1.11, 1.24) times higher odds of poor quality sleep while each additional worry was associated with a 1.20 (95% CI = 1.17, 1.23) times higher odds of poor quality sleep.
Figure 1: Associations (with 95% confidence intervals) between (i) change in total number of adversity experiences and (ii) total number of adversity worries and odds of bad quality sleep, derived from REWB models. “Experiences or worries” meant that experiences and worries were entered into separate models. “Experiences and worries” meant that experiences and worries were entered simultaneously into the same model, so were mutually adjusted for one another. Analyses were further adjusted for day of the week and time since lockdown began.

When considering specific experiences and worries, worries were significantly related to poorer quality sleep in every category of adversity (Figure 2). There was some heterogeneity in effect sizes, with the largest effects found for worries about personal safety (OR = 1.44 [1.35, 1.54]), followed by access to medication (OR=1.37 [1.27, 1.47]), employment (OR=1.27 [1.18, 1.38]), access to food (OR=1.24 [1.17, 1.31]), finances (OR=1.22 [1.15, 1.30]), and catching COVID-19 (OR=1.20 [1.13, 1.26]).

For experiences, the largest effects were found for access to medication (OR=1.44 [1.26, 1.64]) and catching COVID-19 (OR=1.39 [1.15, 1.68]) (although the confidence intervals...
were wide indicating heterogeneity in responses. Experiencing adversities relating to personal safety such as abuse were also related to poor quality sleep (OR=1.31 [1.15, 1.50]), as was difficulty in accessing food (OR=1.32 [1.17, 1.48]). There was some evidence of a relationship between losing work and poor sleep (OR= 1.17 [0.97, 1.42]), but no evidence of a relationship with experiencing a cut in income (OR = 0.96 [0.85, 1.10]).

![Figure 2: Associations (with 95% confidence intervals) between (i) change in experience of specific types of adversities or (ii) worries about specific types of adversities and odds of poor sleep, derived from REWB models. Experiences and worries were entered into separate models, for each category of adversity in turn. Analyses were further adjusted for day of the week and time since lockdown began.](image)

**Moderators**

There was little clear evidence that social support moderated the relationship between sleep quality and adversity experiences (Figure 3; see Table S3 in the supplementary information for interaction term coefficients). For adversity worries (Figure 3), there was evidence that the association between poor quality sleep and adversity worries was *weaker* among those
with more close friends (OR = 0.97 [0.948, 0.993]). But for other measures, such as loneliness, associations were more tentative (Table S3).

There was also no evidence of differences in the relationship between worries and sleep quality in people with and without a diagnosed mental illness (Figure 4). There was limited evidence of moderation by mental health for adversity experiences, with larger effects found among those with diagnosed psychiatric conditions (OR = 1.111 [0.991, 1.246]).
Figure 3: Associations (with 95% confidence intervals) between (i) change in total number of adversity experiences and (ii) total number of adversity worries and odds of poor quality sleep according to (a) living arrangement, (b) social network size), (c) loneliness, and (d) perceived social support at baseline interview. Estimates are from REWB models, with experiences and worries entered into separate models. Analyses were further adjusted for day of the week and time since lockdown began.

Figure 4: Associations (with 95% confidence intervals) between (i) change in total number of adversity experiences and (ii) total number of adversity worries and odds of poor quality sleep according to mental health diagnosis at baseline interview. Estimates are from REWB models, with experiences and worries entered into separate models. Analyses were further adjusted for day of the week and time since lockdown began.
Sensitivity Analysis

The results from sensitivity analyses are displayed in the Supplementary Information. Point estimates suggest that inability to pay bills was more highly related to poor sleep quality than reporting a major cut in household income (Figure S1).

Results using the fixed effects linear probability estimator were qualitatively similar to those from REWB models (Figures S2-S5). An increase in adversity experiences or adversity worries was association with a ~2% point increase in the probability of poor sleep (Figure S2). Results using the fixed effects logit estimator, which, as noted above, only uses data from those whose sleep quality changed, were also qualitatively similar to those from REWB models, but produced stronger effect sizes (Figures S6-S9). An increase in adversity experiences or adversity worries was association with a ~4-5% point increase in the probability of poor sleep (Figure S6). Moderation analyses produced similar effect sizes to those from REWB models (Figures S8-S9 and Table S3). When limiting analyses to individuals whose sleep quality changed, similar results were produced by the REWB and fixed effects logit estimators (Figure S10), suggesting our main results are not biased due to time invariant heterogeneity.

When analysing sleep quality as a continuous measure, the main findings were qualitatively also similar, with both experiences and worries related to poorer sleep (Figure S11-14). However, there was no clear evidence of a moderating role of social support in the association between adversities experiences or worries and sleep (Figure S13). There was still a moderating role of mental health in the association between adversity experiences and sleep quality (Figure S14 and Table S3).
Discussion

In this study, we explored the relationship between worries and experience of adversities and quality of sleep during lockdown due to COVID-19. Cumulative number of worries and experience of adversities were both related to lower quality sleep. When considering specific types of adversities, all types of worries explored were associated with poorer sleep quality, while only specific experiences such as abuse, Inabilities to pay bills, access food or medication, and catching COVID-19 were showed clear associations with poorer sleep. Effects sizes were small: additional adversity experience or worries were related to approximately a 2% point higher likelihood of poor quality sleep, on average. Having more close friends helped to moderate the relationship between worries and sleep but there was weaker evidence that other social factors had any clear protective buffering effects.

This study supports findings from emerging research on COVID-19, which has suggested that sleep is being adversely affected amongst people in isolation. The clear relationship between both specific and cumulative worries and poor sleep echoes findings about the adverse effects of stress on sleep from a number of previous studies. However, it is notable that only specific experiences were related to poor sleep. These related specifically to difficulties in accessing food and medication, experience of abuse, and contracting COVID-19. In particular, experience of domestic violence has previously been well-researched in relation to sleep, with studies notably suggesting that fear of future abuse and nightmares can disrupt sleep. There has also been increasing research focus on the neuropsychiatric effects of coronavirus infections, with suggestions that sleep disturbance can follow from infection, which could explain the findings showing a relationship between having COVID-19 and impaired sleep. However, notably we didn’t find a clear relationship between experiencing loss of work or cuts in household income and impaired sleep, although worry about these things was associated with poorer sleep. It is possible that consequences may take time to
arise. For instance, loss of paid work or cuts in income may impact sleep only following repeated rejections during job search or when reduced incomes begin to impact living standards. Financial adversities may also have been anticipated such that effects were felt in anticipation of the financial adversities, and high strain work may itself have adversely impacted sleep. The effect of job loss on stress may also have been counterbalanced by increased leisure time.

Our results also found only limited evidence of buffering of these associations by social factors. Having more close friends appeared to buffer the association between stressors and sleep, which aligns with previous research on social support as a moderator of the relationship between occupational stress and sleep. However, for other social factors there was only limited evidence of any moderating effect. It is possible that decreased social interaction or limited face-to-face contact with social networks may have reduced any protective effects. Further, it is interesting that there was only limited evidence of moderation by mental illness. Anxiety and depression can predispose individuals to greater stress reactivity, and our results suggested there could be slightly larger effects amongst those diagnosed psychiatric conditions. But results were not clear, and both those with and without psychiatric conditions are at risk of poor sleep as a result of adversities. This echoes other research showing how adversities and stresses are affecting not just those at high risk but broad populations.

This study has a number of strengths including its large, well-stratified sample, which was weighted to population proportions for core socio-demographic characteristics. Further, the study collected data covering the entire period from the start of lockdown in the UK on a weekly basis, providing an extremely rich dataset with longitudinal data. This data allowed us to estimate the relationship between adversity and change in sleep within individuals, rather than rely on cross-sectional variation, which would likely be confounded by time-invariant
heterogeneity across individuals. However, the study has several limitations. First, we are unable to confirm causality. Whilst it appears logical that poor sleep itself cannot cause adverse experiences, there is likely a bidirectional relationship between worries and poor sleep, and worries may pre-date experiences. But our analyses suggest that both worries and experiences are independently associated with poor sleep. Additionally, we used a single item five-category self-report measure of sleep quality, which may have lacked sufficient variation and validity to accurately estimate effects. However, single item sleep scales have been shown to possess favourable measurement characteristics to lengthier sleep questionnaires and are widely used in research. It is possible that individuals experiencing worries or adversities may have perceived their sleep to be worse, but without substantial variation in the core qualitative parameters of sleep. Further, our sampling was not random. Although we deliberately sampled from groups such as individuals of low socio-economic position and individuals with existing mental illness, it is possible that more extreme experiences were not adequately captured in the study. It is also possible that individual experiencing particularly extreme situations during the lockdown withdrew from the study. While our statistical method means their data is still included, we would lack longitudinal follow-up on their changing experiences. Social support was measured at first interview, which for many was after lockdown began. Responses to these questions could have been affected by adversities experienced already. We also focused on just six types of adversities, including those relating to health, safety, finances and basic needs. However, many other types of adversity were not included in the study, including those relating to interpersonal relationships, displacement, and bereavement. Finally, our study only followed individuals up over a period of weeks. It remains for future studies to assess how experience of adversities during the COVID-19 pandemic relates to sleep – and to health – long-term.
Conclusion

Results suggest that poor sleep may be a mechanism by which adversities are affecting mental health during the pandemic. Worries about adversities were related to poorer quality sleep over time during lockdown in the UK. Cumulative load of adverse experiences was also associated with poorer quality sleep, but only specific adversities such as those relating to personal safety, catching COVID-19, or challenges in accessing food and medication showed clear associations with poor sleep on their own. These results were relatively consistent amongst those with and without a diagnosed mental illness. Having a larger social network had some protective effects, but other social factors had more limited moderating effects on the relationship. These results suggest the importance of interventions that seek to reassure individuals and support adaptive coping strategies. Given the challenges in providing mental health support to individuals during the lockdown, these findings highlight the importance of developing online and remote interventions that could provide such support, both as COVID-19 continues and in preparation for future pandemics.

Acknowledgements

This work was funded by the Nuffield Foundation [WEL/FR-000022583] but the views expressed are those of the authors and not necessarily the Foundation. The study was also supported by the MARCH Mental Health Network funded by the Cross-Disciplinary Mental Health Network Plus initiative supported by UK Research and Innovation [ES/S002588/1]. DF is supported by the Wellcome Trust [205407/Z/16/Z]. LW is funded by the Economic and Social Research Council through the UCL, Bloomsbury and East London Doctoral Training Partnership (ES/P000592/1). The researchers are grateful for the support of the following organisations with their recruitment efforts: the UKRI Mental Health Networks, the People's
Postcode Lottery, UCL BioResource, HealthWise Wales, NUS, Age UK, SEO Works, the Ramblers, FieldworkHub, Optimal Workshop. All authors declare no conflicts of interest.

References

1. Dorn A van, Cooney RE, Sabin ML. COVID-19 exacerbating inequalities in the US. The Lancet 2020;395(10232):1243–4.

2. Nassif-Pires L, Xavier L de L, Masterson T, Nikiforos M, Rios-Avila F. Pandemic of Inequality [Internet]. Levy Economics Institute; 2020 [cited 2020 Apr 22]. Available from: https://ideas.repec.org/p/lev/levppb/ppb_149.html

3. Chung RY-N, Dong D, Li MM. Socioeconomic gradient in health and the covid-19 outbreak. BMJ [Internet] 2020 [cited 2020 Apr 22];369. Available from: https://www.bmj.com/content/369/bmj.m1329

4. Lancet T. Redefining vulnerability in the era of COVID-19. The Lancet 2020;395(10230):1089.

5. Usher K, Bhullar N, Durkin J, Gyamfi N, Jackson D. Family violence and COVID-19: Increased vulnerability and reduced options for support. International Journal of Mental Health Nursing [Internet] [cited 2020 Apr 29];n/a(n/a). Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/inm.12735

6. COVID-19 and violence against women: What the health sector/system can do [Internet]. World Health Organisation; 2020 [cited 2020 Apr 29]. Available from: http://www.who.int/reproductivehealth/publications/vaw-covid-19/en/
7. Wright L, Steptoe A, Fancourt D. Are we all in this together? Longitudinal assessment of cumulative adversities by socio-economic position in the first 3 weeks of lockdown in the UK. Journal of Epidemiology & Community Health 2020;

8. Jeong H, Yim HW, Song Y-J, et al. Mental health status of people isolated due to Middle East Respiratory Syndrome. Epidemiol Health [Internet] 2016 [cited 2020 Apr 20];38. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5177805/

9. Pellecchia U, Crestani R, Decroo T, Van den Bergh R, Al-Kourdi Y. Social Consequences of Ebola Containment Measures in Liberia. PLoS One [Internet] 2015 [cited 2020 Apr 22];10(12). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4674104/

10. Mihashi M, Otsubo Y, Yinjuan X, Nagatomi K, Hoshiko M, Ishitake T. Predictive factors of psychological disorder development during recovery following SARS outbreak. Health Psychology 2009;28(1):91–100.

11. Taylor MR, Agho KE, Stevens GJ, Raphael B. Factors influencing psychological distress during a disease epidemic: Data from Australia’s first outbreak of equine influenza. BMC Public Health 2008;8(1):347.

12. Desclaux A, Badji D, Ndione AG, Sow K. Accepted monitoring or endured quarantine? Ebola contacts’ perceptions in Senegal. Social Science & Medicine 2017;178:38–45.

13. Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styra R. SARS Control and Psychological Effects of Quarantine, Toronto, Canada. Emerg Infect Dis 2004;10(7):1206–12.
14. Blendon RJ, Benson JM, DesRoches CM, Raleigh E, Taylor-Clark K. The Public’s Response to Severe Acute Respiratory Syndrome in Toronto and the United States. Clin Infect Dis 2004;38(7):925–31.

15. Wilken JA, Pordell P, Goode B, et al. Knowledge, Attitudes, and Practices among Members of Households Actively Monitored or Quarantined to Prevent Transmission of Ebola Virus Disease — Margibi County, Liberia: February-March 2015. Prehospital and Disaster Medicine 2017;32(6):673–8.

16. Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic? The Lancet 2020;395(10228):931–4.

17. McKee M, Stuckler D. If the world fails to protect the economy, COVID-19 will damage health not just now but also in the future. Nat Med 2020;26(5):640–2.

18. 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. The Lancet Psychiatry 2020;S2215036620301681.

19. Ellsberg M, Jansen HA, Heise L, Watts CH, Garcia-Moreno C. Intimate partner violence and women’s physical and mental health in the WHO multi-country study on women’s health and domestic violence: an observational study. The Lancet 2008;371(9619):1165–72.

20. Clark AE, D’Ambrosio C, Ghislandi S. Poverty Profiles and Well-Being: Panel Evidence from Germany [Internet]. In: Garner TI, Short KS, editors. Research on Economic Inequality. Emerald Group Publishing Limited; 2015 [cited 2020 May 11]. p. 1–
21. Sullivan D, Wachter T von. Job Displacement and Mortality: An Analysis Using Administrative Data. Quarterly Journal of Economics 2009;124(3):1265–306.

22. Cutler D, Huang W, Lleras-Muney A. Economic Conditions and Mortality: Evidence from 200 Years of Data [Internet]. Cambridge, MA: National Bureau of Economic Research; 2016 [cited 2020 Apr 7]. Available from: http://www.nber.org/papers/w22690.pdf

23. Cutler DM, Huang W, Lleras-Muney A. When does education matter? The protective effect of education for cohorts graduating in bad times. Social Science and Medicine 2015;127:63–73.

24. Barrech A, Baumert J, Emeny RT, Gündel H, Ladwig K-HH. Mid-life job insecurity associated with subjective well-being in old age: Results from the population-based MONICA/KORA study. Scandinavian Journal of Work, Environment and Health, Supplement 2011;37(2):170–174.

25. Szabó M. The emotional experience associated with worrying: anxiety, depression, or stress? Anxiety, Stress, & Coping 2011;24(1):91–105.

26. Rief W, Glaesmer H, Baehr V, Broadbent E, Brähler E, Petrie KJ. The relationship of modern health worries to depression, symptom reporting and quality of life in a general population survey. Journal of Psychosomatic Research 2012;72(4):318–20.

27. Kubzansky Laura D., Kawachi Ichiro, Spiro Avron, Weiss Scott T., Vokonas Pantel S., Sparrow David. Is Worrying Bad for Your Heart? Circulation 1997;95(4):818–24.
28. Matthews KA, Gallo LC. Psychological Perspectives on Pathways Linking Socioeconomic Status and Physical Health. Annual Review of Psychology 2011;62(1):501–530.

29. Chen E, Miller GE. Socioeconomic Status and Health: Mediating and Moderating Factors. Annual Review of Clinical Psychology 2013;9(1):723–749.

30. El-Sheikh M, Keiley M, Bagley EJ, Chen E. Socioeconomic Adversity and Women’s Sleep: Stress and Chaos as Mediators. Behavioral Sleep Medicine 2015;13(6):506–23.

31. Kim E-J, Dimsdale JE. The Effect of Psychosocial Stress on Sleep: A Review of Polysomnographic Evidence. Behavioral Sleep Medicine 2007;5(4):256–78.

32. De Lange AH, Kompier MAJ, Taris TW, et al. A hard day’s night: a longitudinal study on the relationships among job demands and job control, sleep quality and fatigue. Journal of Sleep Research 2009;18(3):374–83.

33. Kelly WE. Worry and Sleep Length Revisited: Worry, Sleep Length, and Sleep Disturbance Ascribed to Worry. The Journal of Genetic Psychology 2002;163(3):296–304.

34. Talamini LM, Bringmann LF, de Boer M, Hofman WF. Sleeping Worries Away or Worrying Away Sleep? Physiological Evidence on Sleep-Emotion Interactions. PLoS One [Internet] 2013 [cited 2020 May 29];8(5). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3641038/

35. Buysse DJ. Sleep Health: Can We Define It? Does It Matter? Sleep 2014;37(1):9–17.

36. Patel SR, Hu FB. Short Sleep Duration and Weight Gain: A Systematic Review. Obesity 2008;16(3):643–53.
37. Germain A. Sleep Disturbances as the Hallmark of PTSD: Where Are We Now? AJP 2013;170(4):372–82.

38. Yoo S-S, Gujar N, Hu P, Jolesz FA, Walker MP. The human emotional brain without sleep — a prefrontal amygdala disconnect. Current Biology 2007;17(20):R877–8.

39. Prather AA, Bogdan R, Hariri AR. Impact of Sleep Quality on Amygdala Reactivity, Negative Affect, and Perceived Stress: Psychosomatic Medicine 2013;75(4):350–8.

40. Goldstein AN, Walker MP. The Role of Sleep in Emotional Brain Function. Annu Rev Clin Psychol 2014;10(1):679–708.

41. Thoits PA. Mechanisms Linking Social Ties and Support to Physical and Mental Health. J Health Soc Behav 2011;52(2):145–61.

42. Kent de Grey RG, Uchino BN, Trettevik R, Cronan S, Hogan JN. Social support and sleep: A meta-analysis. Health Psychology 2018;37(8):787–98.

43. Uchino BN, Bowen K, Kent de Grey R, Mikel J, Fisher EB. Social Support and Physical Health: Models, Mechanisms, and Opportunities [Internet]. In: Fisher EB, Cameron LD, Christensen AJ, et al., editors. Principles and Concepts of Behavioral Medicine. New York, NY: Springer New York; 2018 [cited 2020 May 11]. p. 341–72. Available from: http://link.springer.com/10.1007/978-0-387-93826-4_12

44. Nordin M, Knutsson A, Sundbom E. Is Disturbed Sleep a Mediator in the Association between Social Support and Myocardial Infarction? J Health Psychol 2008;13(1):55–64.

45. Zorn JV, Schür RR, Boks MP, Kahn RS, Joëls M, Vinkers CH. Cortisol stress reactivity across psychiatric disorders: A systematic review and meta-analysis. Psychoneuroendocrinology 2017;77:25–36.
46. Feldner MT, Lewis SF, Leen-Feldner EW, Schnurr PP, Zvolensky MJ. Anxiety Sensitivity as a Moderator of the Relation Between Trauma Exposure Frequency and Posttraumatic Stress Symptomatology. Journal of Cognitive Psychotherapy 2006;20(2):201–13.

47. Tsuno N, Besset A, Ritchie K. Sleep and Depression. J Clin Psychiatry 2005;66(10):1254–69.

48. Alvaro PK, Roberts RM, Harris JK. A Systematic Review Assessing Bidirectionality between Sleep Disturbances, Anxiety, and Depression. Sleep 2013;36(7):1059–68.

49. Bell A, Fairbrother M, Jones K. Fixed and random effects models: making an informed choice. Qual Quant 2019;53(2):1051–74.

50. Allison P. Fixed Effects Regression Models [Internet]. 2455 Teller Road, Thousand Oaks California 91320 United States of America: SAGE Publications, Inc.; 2009 [cited 2020 May 14]. Available from: http://methods.sagepub.com/book/fixed-effects-regression-models

51. Overview of the UK population: November 2018 [Internet]. Office for National Statistics; 2018 [cited 2020 May 7]. Available from: https://www.ons.gov.uk/releases/overviewoftheukpopulationnovember2018

52. Xue Z, Lin L, Zhang S, Gong J, Liu J, Lu J. Sleep problems and medical isolation during the SARS-CoV-2 outbreak. Sleep Med 2020;70:112–5.

53. Humphreys C, Lowe P, Williams S. Sleep disruption and domestic violence: exploring the interconnections between mothers and children. Child & Family Social Work 2009;14(1):6–14.
54. Rogers JP, Chesney E, Oliver D, et al. Psychiatric and neuropsychiatric presentations associated with severe coronavirus infections: a systematic review and meta-analysis with comparison to the COVID-19 pandemic. The Lancet Psychiatry [Internet] 2020 [cited 2020 May 20];0(0). Available from: https://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(20)30203-0/abstract

55. Wanberg CR, Zhu J, Kanfer R, Zhang Z. After the Pink Slip: Applying Dynamic Motivation Frameworks to the Job Search Experience. AMJ 2012;55(2):261–84.

56. Wanberg C, Basbug G, Van Hooft EAJ, Samtani A. Navigating the Black Hole: Explicating Layers of Job Search Context and Adaptational Responses: PERSONNEL PSYCHOLOGY. Personnel Psychology 2012;65(4):887–926.

57. Aguiar M, Hurst E, Karabarbounis L. Time Use During the Great Recession. American Economic Review 2013;103(5):1664–96.

58. Pow J, King DB, Stephenson E, DeLongis A. Does social support buffer the effects of occupational stress on sleep quality among paramedics? A daily diary study. Journal of occupational health psychology 2017;22(1):71.

59. Snyder E, Cai B, DeMuro C, Morrison MF, Ball W. A New Single-Item Sleep Quality Scale: Results of Psychometric Evaluation in Patients With Chronic Primary Insomnia and Depression. J Clin Sleep Med 2018;14(11):1849–57.