

“Sleepless in Lockdown”: unpacking differences in sleep loss during the coronavirus pandemic in the UK

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## Abstract

**Background:** Covid-19 has a disproportionate impact on the health of individuals from Black, Asian, and Minority Ethnic (BAME) groups and those in certain occupations, whilst the indirect impacts of COVID-19, such as school closures and home working, has disproportionately affected young persons and women. Concern over such direct and indirect effects may also impact upon sleep. We explore the levels and social determinants of self-reported sleep loss among the UK population during the pandemic, focusing on ethnic and gender disparities.

**Methods:** Data from Understanding Society (USoc) COVID-19 Study collected monthly from April to July 2020 were linked to Wave 9 of USoc conducted in 2018/19, providing baseline information about the respondents prior to the pandemic. The analytical sample included 10,918 respondents aged 16 and above who took part in all four waves survey and had available data for sleep loss, providing 43,672 person-month of data. Mixed-effects regression models were fitted to consider within- and between-individual differences.

**Findings:** The cross-sectional prevalence rate of sleep loss in April 2020 amongst all aged 16 and over was 24.3%. Prevalence then declined slightly over the next three consecutive months, with women and BAME individuals reporting higher levels of sleep loss each month. Longitudinally, women were more likely to report sleep loss than men (odds ratio [OR] 2.2 [95% CI 2.0–2.5]) over four months. Being female, having young children, perceived financial difficulties and COVID-19 symptoms were predictive of sleep loss. Once these covariates were controlled for, the bivariate relationship between ethnicity and sleep loss (2.0 [1.6–2.4]) was reversed (0.8 [0.7–1.0]).

Moreover, the strength of the association between gender and ethnicity and the risk of sleep loss varied over time, being weaker among women in May (0.7 [0.6–0.8]), June (0.6 [0.5–0.7]) and July (0.7 [0.6–0.8]) compared with April, but positively stronger among BAME individuals, especially in June (1.4 [1.0–1.9]).

**Interpretation:** The pandemic has widened sleep deprivation disparities, with women with young children, COVID-19 infection and BAME individuals experiencing sleep loss, which may adversely affect their mental and physical health.

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**Keywords:** COVID-19; Pandemic; Sleep Loss; Mental Health; Gender; Ethnicity

### Competing Interest Statement

The authors have declared no competing interest.

### Declaration of ethical approval

This study uses secondary data for the collection of which ethical approval has been obtained by the survey team. All relevant ethical guidelines at the University of Southampton have been followed.

### Authors' contributions

All authors (JF, ME, MQ, AV) contributed equally to the initial discussion of the idea behind the manuscript, to the design of the manuscript, to the analysis plan and to the redrafting and finalisation of the manuscript. MQ conducted the statistical analysis for the paper and drafted sections of the initial draft of the manuscript.

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# “Sleepless in Lockdown”: unpacking differences in sleep loss during the coronavirus pandemic in the UK

## Introduction

The coronavirus disease (COVID-19) is impacting upon physical and mental health globally. Sleep problems associated with increased psychosocial stressors induced by the coronavirus itself, and as a result of the social distancing measures that have been introduced to manage the virus, are emerging as a significant outcome of the COVID-19 crisis. According to a recent report, more than half of the UK population has struggled with sleep during the lockdown<sup>1</sup>. Sleep has long been recognised as an essential determinant of human health and performance. Good sleep restores energy, promotes healing, interacts with the immune system and impacts upon behaviour<sup>2</sup>. Even acute sleep deprivation can impair judgement and cognitive performance, while persistent deviations have been linked to disease development and increased mortality<sup>3,4</sup>. During the pandemic, lack of sleep may itself have had knock-on effects on people's capacity to be resilient. However, to date relatively limited research has been conducted on sleep deprivation during the pandemic.

Sleep is known to be regulated by circadian rhythms, sleep-wake homeostasis and cognitive-behavioural influences<sup>3</sup>. With regards to environmental, behavioural and health determinants, poor sleep has been associated with stress, anxiety, work pressures, financial concerns, mental and physical impairments, and physical activity<sup>5,6,7,8</sup>. Previous studies have found that women were more likely than men to have trouble falling and staying asleep frequently, or to have insufficient sleep<sup>9,10</sup>. The relationship between ethnicity and sleep is complicated due to the broader social and environmental factors determining group differences in sleep behaviours and the structural relationships between these factors and ethnicity<sup>11</sup>. Some studies reported that inadequate sleep duration and poorer sleep were more prevalent among low-income and black and minority ethnic (BAME) communities<sup>12</sup>, whereas others have failed to find this association<sup>13</sup>.

In understanding the relationship between COVID-19 and sleep, it is helpful to conceptually distinguish between those factors linked to being *infected* with COVID-19 and those associated with the policy responses and measures introduced to manage the pandemic that have *affected* everyday life. Although it is still relatively early in our understanding of COVID-19, research by Public Health England 2020 has highlighted that older people, men and individuals from BAME groups are all at increased risk of developing a severe response to the virus and to die from it<sup>14</sup>. The reasons for the heightened risk amongst certain ethnic groups remains unresolved, but potential contributors include the disproportionate representation of BAME individuals in some high risk occupations including front line health care work, as well as wider environmental factors that, interwoven with issues of inequality, deprivation and structural racism, manifest in longstanding ethnic disparities in health<sup>15</sup>. A priori, we might expect those groups facing the greatest health risks from the virus to report increased sleep loss due to worry and thus to observe differences across ethnic groups.

The public health actions taken to control the spread of the virus have, however, impacted all domains of life and thus affected all individuals. On 23rd March 2020, the UK went into lockdown

in an unprecedented attempt to limit the spread of coronavirus, with the Government mandating all those who could to work at home, closing schools, restaurants and all but essential shops, and advising the population to stay at home and limit contact with other individuals outside their household. The resultant move to home working and learning and, for some, the loss of work altogether, along with limited social contact and increased isolation, may all be anticipated to affect mental well-being and the ability to sleep. Preliminary evidence points towards the young and women being disproportionately affected, with women being more likely than men to be working in sectors that were locked down <sup>16</sup> and mothers being more likely to be interrupted whilst working from home than fathers <sup>17</sup>. Lockdown has also resulted in increased instances of domestic violence; the UK domestic abuse organisation, Refuge, reported a 25 per cent increase in calls and online requests since the lockdown began in March 2020 <sup>18</sup>. Given this, we might anticipate a gender differential in increased sleep loss, with women being disproportionately affected by lockdown compared with men.

This study aims to provide novel evidence regarding patterns of self-reported increased sleep loss due to worry during the first four weeks of the COVID-19 related lockdown in the UK. Using recently collected nationally representative survey data, the research provides the first estimates of the prevalence and incidence of increased sleep loss since the coronavirus pandemic. It attempts to unpack the impact of factors associated with being *infected* and being *affected* by COVID-19, with a particular focus on the extent to which the pandemic has exacerbated differentials in sleep loss by ethnicity and gender.

## **Methods**

### **Study design and population**

We used data from the Understanding Society COVID-19 study <sup>19</sup> covering four months right after the first COVID-19 related national lockdown in the UK. Data was collected online monthly. The first wave of the COVID-19 survey was fielded between 24<sup>th</sup>-30<sup>th</sup> April 2020, the second wave between 27<sup>th</sup> May-2<sup>nd</sup> June, the third wave between 25<sup>th</sup> June-1<sup>st</sup> July, and the fourth wave between 24<sup>th</sup> July-31<sup>st</sup> July. The UK Household Longitudinal Study <sup>20</sup> (UKHLS; Understanding Society) is an ongoing panel survey of more than 40,000 households that began in 2009. Between 24-30<sup>th</sup> April 2020, members of households who participated in either of the two most recent UKHLS data collections (Waves 8 or 9), and who were older than 16 years, were invited to complete the first wave of the COVID-19 web survey. The probability sample was drawn from postal addresses. Northern Ireland and areas in England, Scotland, and Wales with proportionately large migrant and ethnic minority populations were oversampled. All household members aged 16 or older in April 2020, were invited to participate, except for those unable to make an informed decision as a result of incapacity, and those with unknown postal addresses or addresses abroad. The response rate (full interview) of four waves of the Understanding Society COVID-19 study was 39%, 35%, 33% and 32% respectively <sup>19</sup>.

The Understanding Society COVID-19 study is funded by the Economic and Social Research Council and the Health Foundation with scientific leadership by the Institute for Social and

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17,452 respondents took part in wave 1 of the COVID-19 study. The inclusion criteria of the analytical sample for this study were all respondents aged 16 and over, who had participated in all four waves survey and had no missing values on the outcome variable, constituting a final sample size of 10,918 individuals and 43,672 person-months. The characteristics of the analytical sample are shown in Table 1. The analytical sample was slightly older and wealthier than the baseline sample (Appendix Table A). Women were more likely to continue to participate in the follow-up studies, but BAME individuals were less likely. Importantly, however, loss to follow-up was not significantly associated with sleep loss at wave 1 of the COVID-19 study (Appendix Table A).

## Procedures

The outcome variables included whether the respondent reported an increase in sleep loss over worry in the last few weeks. The question on sleep loss was identical across both the Understanding Society COVID-19 Study and Wave 9 of Understanding Society. The specific question wording, along with the four response categories, is presented in the text box below.

*The next questions are about how you have been feeling over the last few weeks.*

*Have you recently lost much sleep over worry?*

- 1. Not at all*
- 2. No more than usual*
- 3. Rather more than usual*
- 4. Much more than usual*

Source: University of Essex (2020).

For the purposes of the main analysis we group the first two options as indicating no problem of increased sleep loss due to worry and the latter two options as indicating a problem of sleep loss. A respondent was defined as experiencing sleep loss during the lockdown if he or she reported sleep loss over worry in the last few weeks ‘rather more than usual’ or ‘much more than usual’ in the Understanding Society COVID-19 Study. The outcome variables were binary (1=yes; 0=no).

A range of explanatory variables were included in the analyses, reflecting both known associates of sleep loss<sup>9,21</sup> as well as those that we hypothesise may be associated with heightened anxiety during the pandemic. Demographic and socioeconomic characteristics included age, gender, ethnicity and educational qualification. Gender distinguished between men and women; the survey responses do not differentiate those whose reported sex has changed since birth or those who classify themselves as intersex. Ethnicity was classified into three groups: British/English/Scottish/Welsh/Northern Irish (White), Other White, and Black, Asian, and Minority Ethnic (BAME).

Variables capturing factors associated with COVID-19 itself included whether the respondent reported having experienced symptoms that could be coronavirus and being a key worker<sup>1</sup>. Other

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<sup>1</sup> According to Department of Health and Social Care guidance on testing eligibility (2020)<sup>22</sup>, key workers are people whose jobs are vital to public health and safety during the coronavirus lockdown. The list includes health and social

variables aimed to capture the impacts of the policy response to COVID-19, particularly the effect of lockdown. Increased stress related to childcare and home schooling was proxied by the presence of children in the house (whether at least one child aged 0-4 or school-aged child), and whether the respondent was living with a partner. Exposure to financial stress was proxied by two variables capturing the respondents subjective view of their current and future financial situation. Social isolation was measured by the frequency of having felt lonely in the last 4 weeks. In order to capture regional differences in the intensity of the pandemic <sup>2</sup>, a variable reflecting the respondents' place of residence was included, based on the UK government office region (North East, North West, Yorkshire and The Humber, East Midlands, West Midlands, East of England, London, South East, South West, Wales, Scotland, and Northern Ireland). Finally, in order to capture time effects, we controlled for the survey time point, measured as a dummy variable (April, May, June and July).

Sleep loss and certain covariates such as the frequency of feelings of loneliness in the 4 previous weeks, and the respondents' perceived current and future financial situation, were measured at each wave of COVID-19. For some individuals, their responses to these questions changed over time during the follow-up period; thus, in the statistical models these were all treated as time-varying variables. Other covariates were treated as time-invariant variables.

### **Analytical approach**

We analysed binary outcomes with mixed-effects logistic models in order to assess the existence and strength of associations between sleep loss and COVID-19-related circumstances during the pandemic. Given that the data collected from an individual over four months are not independent of each other, mixed-effects models are the recommended statistical technique to take into consideration between-individuals variance and within-individuals variance <sup>23</sup>. This method has the advantage of including both fixed and random effects. The former are model components used to define systematic relationships such as overall changes of sleep loss over time and/or social determinants induced individual differences, and the latter account for the variability among individuals around the systematic relationships captured by the fixed effects.

For this study, the logistic mixed-effects models included sleep loss as the response variable, and gender, ethnicity group and timepoint as fixed effects. Observations by person-month were attached to each respondent; thus, in order to estimate the random intercepts, we accounted for random variation between individuals and between person-months within the same individual. We modelled an interaction between time and gender, as well as between time and ethnicity, as a fixed effect in order to examine whether the association between gender and ethnicity varied according to time. Other potential confounding variables included the respondents' age, highest qualification, subjective current financial situation, subjective future financial situation, whether they were living with a partner, any children in the house, whether they were a key worker, the frequency of feelings of loneliness in the previous four weeks, any prior problem of sleep, and region. Regression analyses were carried out for the total population and then for men and women separately. Results were

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care, e.g. all NHS staff, frontline health and social care staff such as doctors, nurses, plus support and specialist staff in the health and social care sector; education and childcare, including social workers; food and other necessary goods; key public services; local and national government; utility workers; public safety and national security; and transport.

<sup>2</sup> In the first few weeks of the pandemic in the UK, the rate of infection was much higher in London than elsewhere in the country.

presented as odds ratios of sleep loss by gender and ethnicity, with 95% CIs and associated two-sided p values.

A sensitivity analysis was conducted in order to check the robustness of the results. Here we measured sleep loss as an ordered variable with four categories (not at all, no more than usual, rather more than usual and much more than usual) instead of two. Mixed effects ordered logistic regression was applied. The analyses were carried out in STATA version 15<sup>24</sup>.

## Results

### Descriptive analyses

One in four people in the UK reported increased sleep loss due to worry during the first four weeks of the coronavirus pandemic lockdown in the UK (Table 2). There were clear differences between women and men and across ethnic communities. Strikingly, although men have been found to face a higher risk of experiencing severe symptoms and dying from COVID-19, women were nearly twice as likely as men to report that they had lost sleep ‘much more than usual’ (5.8% v 2.6%) and ‘rather more than usual’ (25.5% v 13.6%), supporting the hypothesis that women have been disproportionately affected by the economic and social consequences of lockdown. In the consecutive months, the proportion reporting increased sleep loss slightly decreased amongst both men and women, but women still showed a much higher proportion of increased sleep loss than men.

The results by ethnicity do, however, support the argument that the risk of infection may play a role; in the first month of lockdown, 6.8% of BAME respondents reported being ‘much more than usual’ to have lost sleep through worry over the last few weeks compared to 4.0% of white respondents. In the following months, this figure slightly dropped among British White respondents, but not among BAME respondents (Table 2).

The prevalence of sleep loss (‘rather more than usual’ and ‘much more than usual’) in April 2020 (24.3%) was higher than that reported prior to the pandemic (15.0%) and the differentials between men and women, and individuals from different ethnic communities have widened during the epidemic (Appendix Table B).

### Multi-variate analysis

Many of the characteristics associated with sleep loss are likely to be interrelated; for example, those with a child aged 0-4 at home are also likely to be aged 25-44; those who are key workers are more likely to have experienced symptoms etc. In order to further unravel the picture, a series of multivariate logistic regression models were run; firstly, for the population as a whole, and then separately for men and women. The first two columns (A1 and A2) for Model A (Table 3) show the unadjusted (bi-variate) odds ratios of experiencing sleep loss by gender and ethnicity (OR=3.4, 95% CI=3.0–3.9; OR=2.0, 95% CI=1.6–2.4), whilst the third column (A3) shows the adjusted odds of the main effect for the full model.

The analysis shows that the differential reporting of sleep loss by gender remains significant even after controlling for all other factors (OR=2.2, 95% CI=2.0–2.5); the differential by ethnicity is however reversed though not statistically significant (OR=0.8, 95% 0.5–1.1) once other factors are



taken into account such as being a key worker, having had symptoms, having children in the household, experiencing financial difficulties and living in London, the initial epicentre of the UK's COVID-19 outbreak in spring 2020. Individuals from BAME communities are disproportionately represented in all of these groups <sup>3</sup> (Appendix Table C). By including interactions between gender and ethnicity with months, Model A4 assessed the effects of gender and ethnicity on shifts over time. The results show that the strength of the association between gender and ethnicity and the risk of sleep loss varied over time. Women presented a lower risk of sleep loss in May, June and July (OR = 0.7, 95 % CI = 0.6 – 0.8; OR=0.6, 95% CI=0.5–0.7; OR=0.7, 95% CI=0.6–0.8). By contrast, the BAME group experienced a higher risk of sleep loss over time, especially in June (OR=1.4, 95% CI=1.0–1.9).

The analysis shows that the coronavirus infection, with school-aged children at home, feeling lonely, perceived financial difficulties and worry, being a woman, and month were all predictive factors of sleep loss (Table 3). The influential factors were slightly different among men (Model B) and women (Model C). Among women, being a key worker was a risk factor and of BAME heritage were protective factors in terms of increased sleep loss whilst both these factors were not associated with sleep loss for men.

In the sensitivity analysis where sleep loss was measured as an ordered variable, the analysis of the data with mixed-effect ordered logistic regression rather than mixed-effect logistic regression did not change the pattern of results (Appendix Table D).

## Discussion and conclusion

This study has revealed several important findings related to sleep health during the COVID-19 pandemic. Firstly it provides robust evidence that sleep loss is affecting more people during the COVID-19 pandemic than previously, reflecting the fact that stress levels have risen due to anxieties about health, financial consequences, changes in social life and the daily routine, all of which may affect sleep homeostasis.

The study also provides evidence that women have been more vulnerable to sleep deprivation during lockdown, which is in line with previous research suggesting that women have more sleep disturbances than men <sup>9,21</sup>, and that women are more prone to stress-related sleep disorders such as post-traumatic stress disorder and anxiety disorders <sup>25</sup>. There is emerging evidence that mental health experiences during the COVID-19 pandemic in the UK differ between men and women, with more women suffering from anxiety in the early stages of lockdown <sup>26</sup>. Women's position in the labour market may increase their exposure to COVID-19, as women represent a significant majority of frontline workers in social care, education and health care <sup>16,27</sup>. Many parents will be affected by school closures, and requirements to balance paid work with increasing childcare and providing support to their children's learning. However, the gendered allocation of childcare means that in many households, it is the mother who continues to provide the majority of primary care for children.

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<sup>3</sup> A range of interaction effects with ethnicity were investigated but none were significant and thus are not included in the final model.

Furthermore, many mid-life women find themselves juggling employment with caring responsibilities for aged parents and grandchildren <sup>28</sup>.

Individuals from BAME communities showed a higher prevalence and incidence rate of sleep loss than British White individuals. This reflects the fact that those of BAME heritage have disproportionately higher rates of coronavirus infection, high anxiety associated with coronavirus-specific circumstances <sup>22</sup>, are more likely to be key workers, to have dependent children, and to feel lonely. All of these factors are likely to increase the risk of sleep loss, with the result that once all these other factors are controlled for, being a member of a BAME community was associated with a *reduced* chance of sleep loss – highlighting the complex relationship between ethnicity and sleep health.

Some limitations should be acknowledged. First, sleep loss was measured by self-reports and is therefore subject to recall bias and participants' perceptions <sup>29</sup>. Secondly, attrition between data collection waves and missing values on the outcome variable meant that follow-up data were not available for more than one-third of participants who were surveyed in Wave 1. The sub-sample lost to follow-up were older and less affluent than those who participated in subsequent waves. This attrition could have confounded the identification of prospective associations between gender, ethnicity and sleep loss, in that more vulnerable people were not retained in the analyses.

In conclusion, the COVID-19 pandemic and the policy responses to it, including home working and schooling, have widened the disparity of sleep deprivation across gender and ethnicity, putting women and ethnic minorities at an even greater disadvantage. Disrupted and poor sleep is associated with wider mental and physical health challenges. Policy makers and health professionals need to take action now to support and promote better sleep health amongst vulnerable groups during the pandemic, averting future secondary complications.

**Table 1. Sample characteristics.**

	%	Number of respondents
Total	100.0	10,918
Age group		
16-24	5.9	571
25-44	24.7	2,454
45-64	40.3	4,648
65-74	19.4	2,340
75+	9.7	905
Gender		
Men	46.3	4,520
Women	53.7	6,398
Ethnicity		
British/English/Scottish/Welsh/Northern Irish (White)	90.4	9,362
Other White	3.3	458
Black, Asian, and Minority Ethnic (BAME)	5.7	871
Unknown	0.6	227
Highest qualification		
No qualification	15.8	1,432
GCSE or lower	26.1	2,208
A level	10.5	994
Degree	36.2	4,369
Unknown	11.4	1,915
Live with a partner		
No	31.9	2,902
Yes	68.1	8,016
Children in the house		
At least one child aged 0-4	7.7	871
At least one school children aged 5-18	20.3	2,288
No school children	72.0	7,759
Key worker		
No	31.5	3,461
Yes	25.9	2,801
Not in paid or self-employed work	42.6	4,656
Has had symptoms that could be coronavirus		
No	89.4	9,681
Yes	10.6	1,237
Feel lonely		
Hardly ever	63.5	7,153
Sometime	28.7	3,054
Often	7.8	711
Subjective current financial situation		
Living comfortably	33.4	4,153
Doing alright	42.8	4,661
Just about getting by	18.0	1,614
Finding it quite difficult/very difficult	5.7	490
Subjective future financial situation		
Better off	6.5	744
Worse off	16.0	1,737
About the same	77.5	8,437
Prior problem of sleep		
No	83.1	8,792
Yes	14.8	1,436
Unknown	2.1	690
Region		
North East	4.3	384
North West	10.4	1,044
Yorkshire and The Humber	8.8	936
East Midlands	7.8	848
West Midlands	9.0	921
East of England	10.5	1,090
London	10.4	958
South East	14.9	1,596
South West	9.6	1,088
Wales	4.4	631
Scotland	7.7	975
Northern Ireland	2.1	447

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

Note: All proportions are weighted using sample weights. Number of respondents are unweighted.

**Table 2. Prevalence of reported sleep loss at each wave of the Understanding Society COVID-19 Study.**

	Not at all	No more than usual	Rather more than usual	Much more than usual
<b>Sleep loss at wave1</b>				
All participants	34.5	41.2	20.0	4.3
By gender	P<.001			
Men	44.0	39.8	13.6	2.6
Women	26.4	42.4	25.5	5.8
By ethnicity	P<.001			
British/English/Scottish/Welsh/Northern Irish (White)	35.0	41.3	19.8	4.0
Other White	33.2	43.4	18.2	5.1
Black, Asian, and Minority Ethnic (BAME)	27.6	40.2	25.4	6.8
<b>Sleep loss at wave2</b>				
All participants	32.5	47.3	16.5	3.7
By gender	P<.001			
Men	41.3	44.2	11.8	2.6
Women	24.8	50.0	20.6	4.6
By ethnicity	P<.001			
British/English/Scottish/Welsh/Northern Irish (White)	33.2	47.3	16.1	3.5
Other White	32.1	43.4	19.7	4.7
Black, Asian, and Minority Ethnic (BAME)	23.1	48.7	21.4	6.8
<b>Sleep loss at wave3</b>				
All participants	29.7	48.7	17.4	4.2
By gender	P<.001			
Men	36.5	45.8	14.1	3.6
Women	24.0	51.2	20.1	4.7
By ethnicity	P<.001			
British/English/Scottish/Welsh/Northern Irish (White)	30.6	48.7	16.8	3.8
Other White	25.2	48.2	19.3	7.3
Black, Asian, and Minority Ethnic (BAME)	20.3	47.3	24.7	7.7
<b>Sleep loss at wave4</b>				
All participants	34.7	48.4	14.0	2.9
By gender	P<.001			
Men	43.0	44.4	10.3	2.2
Women	27.6	51.8	17.1	3.5
By ethnicity	P<.001			
British/English/Scottish/Welsh/Northern Irish (White)	35.4	48.5	13.3	2.8
Other White	31.4	52.2	15.3	1.1
Black, Asian, and Minority Ethnic (BAME)	27.7	43.9	23.5	4.9
<i>N</i>	3,725	4,646	2,135	412

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

Note: All proportions are weighted using sample weights. Number of respondents are unweighted.

**Table 3. Odds ratios and 95% CI of sleep loss during the pandemic**

	Model A All respondents				Model B Men		Model C Women	
	A1	A2	A3	A4	B1	B2	C1	C2
Gender								
Men (ref)								
Women	<b>3.4***</b> (3.0-3.9)		<b>2.2***</b> (2.0-2.5)	<b>3.1***</b> (2.6-3.6)				
Ethnicity								
British/English/Scottish/Welsh/Northern Irish (White) (ref)								
Other White		1.2 (0.9-1.6)	1.0 (0.7-1.3)	0.8 (0.5-1.1)	1.1 (0.6-1.9)	0.7 (0.4-1.1)	1.1 (0.8-1.6)	1.1 (0.8-1.5)
Black, Asian, and Minority Ethnic (BAME)		<b>2.0***</b> (1.6-2.4)	0.8 (0.7-1.0)	<b>0.7*</b> (0.5-0.9)	<b>2.8***</b> (2.0-4.1)	1.0 (0.7-1.4)	<b>1.6***</b> (1.3-2.1)	<b>0.8*</b> (0.6-0.9)
Age group								
16-24 (ref)								
25-44			1.1 (0.9-1.5)	1.1 (0.9-1.5)		1.2 (0.7-2.1)		1.1 (0.8-1.5)
45-64			1.2 (0.9-1.4)	1.2 (0.9-1.6)		1.4 (0.8-2.5)		1.1 (0.8-1.5)
65-74			0.8 (0.6-1.1)	0.8 (0.6-1.1)		1.0 (0.6-1.8)		0.7 (0.5-1.1)
75+			<b>0.6*</b> (0.5-0.9)	0.6 (0.4-0.9)		0.7 (0.4-1.4)		<b>0.6*</b> (0.4-0.9)
Highest qualification								
No qualification (ref)								
GCSE or lower			1.1 (0.9-1.3)	1.1 (0.9-1.3)		1.1 (0.8-1.5)		1.1 (0.9-1.4)
A level			1.1 (0.9-1.4)	1.1 (0.9-1.4)		1.4 (0.9-2.1)		1.0 (0.8-1.4)
Degree			<b>1.3**</b> (1.1-1.5)	<b>1.3**</b> (1.1-1.5)		<b>1.4*</b> (1.0-1.9)		1.2 (0.9-1.5)
Subjective current financial situation								
Living comfortably (ref)								
Doing alright			<b>1.3***</b> (1.1-1.4)	<b>1.3***</b> (1.1-1.4)		<b>1.4**</b> (1.1-1.7)		<b>1.2**</b> (1.1-1.4)
Just about getting by			<b>2.2***</b> (1.9-2.5)	<b>2.2***</b> (1.9-2.5)		<b>2.5***</b> (2.0-3.3)		<b>2.0***</b> (1.7-2.4)
Finding it quite difficult/very difficult			<b>5.0***</b> (4.0-6.2)	<b>5.0***</b> (4.0-6.3)		<b>4.9***</b> (3.4-7.1)		<b>5.0***</b> (3.9-6.6)
Subjective future financial situation								
Better off (ref)								
Worse off			<b>1.7***</b> (1.4-2.0)	<b>1.7***</b> (1.4-2.0)		<b>1.9***</b> (1.4-2.7)		<b>1.6***</b> (1.3-2.0)
About the same			0.9 (0.8-1.1)	0.9 (0.8-1.1)		0.9 (0.7-1.3)		0.9 (0.8-1.1)
Live with a partner								
Yes (ref)								
No			<b>0.8***</b> (0.7-0.9)	<b>0.8***</b> (0.7-0.9)		<b>0.7***</b> (0.5-0.8)		<b>0.8**</b> (0.7-0.9)
Children in the house								
None (ref)								
At least one child aged 0-4			1.2 (0.9-1.5)	1.2 (0.9-1.5)		<b>1.6*</b> (1.1-2.3)		1.1 (0.8-1.4)
At least one school children aged 5-18			<b>1.3**</b> (1.1-1.4)	<b>1.3**</b> (1.1-1.4)		1.2 (0.9-1.5)		<b>1.3**</b> (1.1-1.5)
Key worker								
No (ref)								
Yes			1.1 (0.9-1.3)	1.1 (0.9-1.3)		1.0 (0.8-1.3)		<b>1.2*</b> (1.0-1.4)
Not in paid or self-employed work			0.9 (0.8-1.0)	0.9 (0.8-1.0)		0.8 (0.6-1.0)		0.9 (0.8-1.1)
Has had symptoms that could be coronavirus								
No (ref)								
Yes			<b>1.3***</b> (1.1-1.6)	<b>1.3***</b> (1.1-1.6)		<b>1.7***</b> (1.3-2.2)		1.2 (0.9-1.4)
Feel lonely								
Hardly ever (ref)								
Sometime			<b>4.0***</b> (3.6-4.9)	<b>3.9***</b> (3.6-4.3)		<b>5.1***</b> (4.3-6.1)		<b>3.5***</b> (3.2-4.7)
Often			<b>15.0***</b> (12.7-17.7)	<b>14.9***</b> (12.6-17.7)		<b>22.7***</b> (16.4-31.5)		<b>12.6***</b> (10.4-15.4)
Prior problem of sleep								
No (ref)								
Yes			<b>4.2***</b> (3.7-4.9)	<b>4.2***</b> (3.7-4.9)		<b>5.0***</b> (3.8-6.5)		<b>3.9***</b> (3.3-4.7)
Region								
North East (ref)								
North West			0.9 (0.7-1.3)	0.9 (0.7-1.3)		0.6 (0.3-1.0)		1.2 (0.8-1.8)
Yorkshire and The Humber			1.0 (0.8-1.5)	1.0 (0.8-1.5)		0.6 (0.3-1.0)		1.4 (0.9-2.1)

East Midlands	0.9 (0.6-1.3)	0.9 (0.6-1.3)	0.7 (0.4-1.3)	1.0 (0.7-1.5)
West Midlands	0.9 (0.7-1.3)	0.9 (0.7-1.3)	0.8 (0.5-1.5)	1.0 (0.7-1.5)
East of England	0.9 (0.6-1.2)	0.9 (0.6-1.2)	0.7 (0.4-1.3)	0.9 (0.7-1.5)
London	1.3 (0.9-1.8)	1.3 (0.9-1.8)	0.9 (0.5-1.7)	1.5* (1.0-2.3)
South East	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.9 (0.5-1.5)	1.1 (0.8-1.6)
South West	0.9 (0.6-1.2)	0.9 (0.6-1.2)	0.7 (0.4-1.3)	0.9 (0.7-1.5)
Wales	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.9 (0.5-1.8)	0.9 (0.6-1.5)
Scotland	1.0 (0.7-1.4)	1.0 (0.7-1.4)	0.9 (0.5-1.5)	1.1 (0.7-1.6)
Northern Ireland	1.2 (0.8-1.7)	1.2 (0.8-1.7)	1.0 (0.5-1.9)	1.2 (0.8-2.0)
Month				
April (ref)				
May	<b>0.7***</b> (0.6-0.7)	<b>0.8***</b> (0.7-1.0)	0.9 (0.7-1.0)	<b>0.6***</b> (0.5-0.7)
June	<b>0.7***</b> (0.6-0.8)	<b>1.0</b> (0.8-1.1)	1.0 (0.8-1.2)	<b>0.6***</b> (0.5-0.7)
July	<b>0.4***</b> (0.4-0.5)	<b>0.5***</b> (0.5-0.6)	<b>0.5***</b> (0.5-0.6)	<b>0.4***</b> (0.3-0.4)
Interaction gender#month				
Women#May		<b>0.7***</b> (0.6-0.8)		
Women#June		<b>0.6***</b> (0.5-0.7)		
Women#July		<b>0.7***</b> (0.6-0.8)		
Interaction ethnicity#month				
BAME#May		<b>1.4*</b> (1.0-1.9)		
BAME#June		1.2 (0.9-1.6)		
BAME#July		1.2 (0.8-1.6)		
Other White#May		<b>1.6*</b> (1.0-2.4)		
Other White#June		1.4 (0.9-2.1)		
Other White#July		1.3 (0.8-2.1)		
<i>LR test vs. logistic model (P value)</i>	<i>&lt;0.001</i>	<i>&lt;0.001</i>	<i>&lt;0.001</i>	<i>&lt;0.001</i>
<i>Number of person-month</i>	<i>43,672</i>	<i>43,672</i>	<i>43,672</i>	<i>43,672</i>
			<i>18,080</i>	<i>18,080</i>
			<i>25,592</i>	<i>25,592</i>

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

\*\*\*p<0.001, \*\*p<0.01, \*p<0.05

**Appendix Table A. Characteristics of full wave 1 (baseline) sample and analytical (follow-up) sample**

	Full wave 1 sample	Analytical sample	P*
<b>Age, mean (SD)</b>	50.1 (17,452)	53.3 (10,918)	<.001
<b>Age, % (n)</b>			<.001
16-24	10.2 (1,543)	5.9 (571)	-
25-44	28.6 (4,734)	24.7 (2,454)	-
45-64	36.9 (7,028)	40.3 (4,648)	-
65-74	15.0 (2,925)	19.4 (2,340)	-
75+	9.4 (1,222)	9.7 (905)	-
<b>Gender, % (n)</b>			<.001
<b>Men</b>	48.0 (7,287)	46.3 (4,520)	-
<b>Women</b>	52.0 (10,165)	53.7 (6,398)	-
<b>Ethnicity, % (n)</b>			<.001
British/English/Scottish/Welsh/Northern Irish (White)	86.5 (14,029)	90.4 (9,362)	-
Other White	3.7 (779)	3.3 (458)	-
Black, Asian, and Minority Ethnic (BAME)	8.7 (2,044)	5.7 (871)	-
<b>Subjective current Financial situation, % (n)</b>			<.001
Living comfortably	29.6 (5,815)	33.4 (4,153)	
Doing alright	40.1 (7,045)	42.8 (4,661)	
Just about getting by	17.2 (2,585)	18.0 (1,606)	
Finding it quite difficult/very difficult	6.2 (891)	5.7 (490)	
<b>Sleep loss, % (n)</b>			.079
No	75.2 (12,008)	75.7 (8,371)	-
Yes	24.8 (3,919)	24.3 (2,547)	-

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

\* p-value for comparison between participants in the baseline sample who did and did not respond to follow-up.

Note: All proportions are weighted using sample weights. Number of respondents are unweighted.

**Appendix Table B. Sleep loss comparison before and after the COVID-19 pandemic by sex and ethnicity (N=10,918).**

	Sleep loss before the COVID-19 pandemic (2018/19)	Sleep loss after the COVID-19 pandemic (April 2020)
Total	15.0	24.3
Sex	P<0.001	P<0.001
Men	12.0	16.2
Women	17.5	31.3
Ethnicity	P<0.001	P<0.001
British/English/Scottish/Welsh/Northern Irish (White)	14.8	23.7
Other White	12.8	23.4
Black, Asian, and Minority Ethnic (BAME)	19.5	32.4

Source: authors' analysis, Wave 1 of Understanding Society: COVID-19 Study, 2020; Wave 9 of Understanding Society 2018/19.

Note: All proportions are weighted using sample weights. Number of respondents are unweighted.



**Appendix Table C. Characteristics of participants, by ethnicity (N=10,918).**

	British/English/Scottish/Welsh/Northern Irish (White)	Other White	Black, Asian, and Minority Ethnic (BAME)
<b>Age group % (n)</b>	P<0.001		
16-24	5.4 (337)	2.2 (4)	15.6 (91)
25-44	23.7 (1,971)	28.8 (110)	32.1 (314)
45-64	40.3 (4,020)	47.8 (226)	40.0 (380)
65-74	20.3 (2,182)	16.1 (89)	8.8 (65)
75+	10.3 (852)	5.1 (29)	3.6 (21)
<b>Gender % (n)</b>	P=0.219		
Men	46.4 (3,911)	41.6 (168)	45.6 (356)
Women	53.6 (5,451)	58.4 (290)	54.4 (515)
<b>Subjective current financial situation % (n)</b>	P<0.01		
Living comfortably	34.4 (3,703)	31.8 (161)	18.3 (201)
Doing alright	43.2 (4,004)	44.2 (208)	36.0 (351)
Just about getting by	17.5 (1,302)	18.2 (70)	27.7 (214)
Finding it quite difficult/very difficult	4.9 (353)	5.8 (19)	17.9 (105)
<b>Subjective future financial situation % (n)</b>	P<0.01		
About the same	78.3 (7,314)	68.2 (338)	70.1 (607)
Better off	6.3 (626)	9.9 (36)	5.6 (62)
Worse off	15.3 (1,422)	21.9 (84)	24.4 (202)
<b>Children in the house % (n)</b>	P<0.001		
No school aged child	72.9 (6,884)	65.3 (304)	58.0 (449)
At least one child aged 0-4	7.4 (694)	6.2 (40)	13.9 (116)
At least one school children aged 5-18	19.6 (1,784)	28.5 (114)	28.1 (306)
<b>Key worker % (n)</b>	P<0.05		
No	31.3 (2,931)	38.3 (168)	28.8 (285)
Yes	25.9 (2,379)	27.0 (113)	26.4 (269)
Not in paid or self-employed work	42.8 (4,052)	34.7 (177)	44.8 (317)
<b>Has had symptoms that could be coronavirus % (n)</b>	P<0.01		
No	89.7 (8,332)	90.1 (407)	84.2 (733)
Yes	10.3 (1,030)	9.9 (51)	15.8 (138)
<b>Feel lonely % (n)</b>	P<0.001		
Hardly ever	64.5 (6,275)	63.5 (309)	50.5 (473)
Sometime	27.8 (2,509)	27.4 (122)	41.2 (320)
Often	7.6 (578)	9.1 (27)	8.3 (78)
<b>Prior sleep loss % (n)</b>	P<0.001		
No	84.3 (7,756)	86.4 (376)	73.2 (660)
Yes	14.8 (1,218)	12.8 (67)	19.5 (151)
<b>Region % (n)</b>	P<0.001		
North East (ref)	4.6 (366)	1.1 (4)	0.9 (6)
North West	10.8 (911)	5.8 (25)	7.7 (88)
Yorkshire and The Humber	9.0 (812)	4.7 (23)	8.1 (84)
East Midlands	8.1 (771)	4.7 (18)	4.5 (44)
West Midlands	9.3 (758)	2.9 (26)	9.8 (118)
East of England	10.8 (956)	10.2 (40)	6.6 (68)
London	7.8 (510)	24.0 (97)	43.9 (328)
South East	15.4 (1,436)	12.7 (60)	9.0 (78)
South West	9.9 (1,005)	8.4 (36)	4.9 (29)
Wales	4.6 (587)	5.1 (22)	1.3 (14)
Scotland	8.0 (919)	6.2 (19)	3.4 (12)
Northern Ireland	1.7 (331)	14.2 (88)	0.1 (2)

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

Note: All proportions are weighted using sample weights. The percentages are 100% within each ethnic group. Number of respondents are unweighted.

**Appendix Table D. Sensitivity analyses: odds ratios and 95% CI of mixed-effects ordered logistic regressions.**

	Model A All respondents			
	A1	A2	A3	A4
Gender				
Men (ref)				
Women	<b>3.7***</b> <b>(3.3-4.1)</b>		<b>2.5***</b> <b>(2.3-2.7)</b>	<b>3.4***</b> <b>(3.0-3.9)</b>
Ethnicity				
British/English/Scottish/Welsh/Northern Irish (White) (ref)				
Other White		1.3 (0.9-1.7)	1.0 (0.8-1.3)	0.9 (0.7-1.2)
Black, Asian, and Minority Ethnic (BAME)		<b>2.1***</b> <b>(1.7-2.6)</b>	1.0 (0.9-1.2)	0.9 (0.7-1.1)
Month				
April (ref)				
May			<b>0.7***</b> <b>(0.6-0.7)</b>	<b>0.8*</b> <b>(0.7-0.9)</b>
June			<b>0.7***</b> <b>(0.6-0.8)</b>	1.0 (0.8-1.1)
July			<b>0.4***</b> <b>(0.4-0.5)</b>	<b>0.5***</b> <b>(0.5-0.6)</b>
Interaction gender#month				
Women#May				<b>0.7***</b> <b>(0.6-0.8)</b>
Women#June				<b>0.6***</b> <b>(0.5-0.7)</b>
Women#July				<b>0.7***</b> <b>(0.6-0.8)</b>
Interaction ethnicity#month				
BAME#May				1.2 (0.9-1.5)
BAME#June				1.2 (0.9-1.6)
BAME#July				1.2 (0.8-1.5)
Other White#May				1.2 (0.9-1.6)
Other White#June				1.2 (0.9-1.6)
Other White#July				1.1 (0.8-1.5)
<i>LR test vs. ologit model (P value)</i>	<0.001	<0.001	<0.001	<0.001
<i>Number of person-month</i>	43,672	43,672	43,672	43,672

Source: authors' analysis, Understanding Society: COVID-19 Study, 2020.

\*\*\*p<0.001, \*\*p<0.01, \*p<0.05

Notes: Model A1 and A2 were bivariate models with gender or ethnicity in the model. Model A3 and A4 were multivariate models, controlling for age, highest qualification, subjective current financial situation, subjective future financial situation, live with a partner, children in the house, key worker, felt lonely, prior problem of sleep, region and month.

## References

1. BBC News. Coronavirus: How the UK is sleeping under lockdown. [cited 2020 June 15]. Available: <https://www.bbc.co.uk/news/health-52911395>
2. Schwartz JRL, Roth T. Neurophysiology of sleep and wakefulness: basic science and clinical implications. *Current Neuropharmacology* 2008; **6**: 367–378.
3. Bertisch SM, Pollock BD, Mittleman MA, et al. Insomnia with objective short sleep duration and risk of incident cardiovascular disease and all-cause mortality: Sleep Heart Health Study. *Sleep* 2018; **41**: zsy047.
4. Liu TZ, Xu C, Rota M, et al. Sleep duration and risk of all-cause mortality: a flexible, non-linear, meta-regression of 40 prospective cohort studies. *Sleep Medicine Reviews* 2017; **32**: 28–36.
5. Taheri S. The link between short sleep duration and obesity: we should recommend more sleep to prevent obesity. *Archives of Disease in Childhood* 2006; **91**: 881–884.
6. Kline CE. The bidirectional relationship between exercise and sleep: implications for exercise adherence and sleep improvement. *American Journal of Lifestyle Medicine* 2014; **8**: 375–379.
7. Hafner M, Stepanek M, Taylor J, Troxel WM, van Stolk C. Why sleep matters—the economic costs of insufficient sleep: a cross-country comparative analysis. *Rand Health Quarterly* 2017; **6**: 11.
8. Perez-Pozuelo I, Zhai B, Palotti J, et al. The future of sleep health: a data-driven revolution in sleep science and medicine. *npj Digital Medicine* 2020; **3**: 42.
9. Nugent CN, Black LI. Sleep duration, quality of sleep, and use of sleep medication, by sex and family type, 2013–2014. *NCHS Data Brief* 2016; **230**: 1–8.
10. Vézina-Im L, Moreno JP, Thompson D, Nicklas TA, Baranowski T. Individual, social and environmental determinants of sleep among women: protocol for a systematic review and meta-analysis. *BMJ Open* 2017; **7**: e016592.
11. Grandner MA, Williams NJ, Knutson KL, Roberts D, Jean-Louis G. Sleep disparity, race/ethnicity, and socioeconomic position. *Sleep Medicine* 2016; **18**: 7–18.
12. Jackson CL, Redline S, Emmons KM. Sleep as a potential fundamental contributor to disparities in cardiovascular health. *Annual Review of Public Health* 2015; **36**: 417–40.
13. Hale L, Rivero-Fuentes E. Negative acculturation in sleep duration among Mexican immigrants and Mexican Americans. *Journal of Immigrant Minor Health* 2011; **13**: 402–7.
14. Public Health England. Disparities in the risk and outcomes of COVID-19. PHE publications, gateway number: GW-1311. [cited 2020 June 15]. Available: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/892085/disparities\\_review.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/892085/disparities_review.pdf)
15. Evandrou M, Falkingham J, Feng Z, Vlachantoni A. Ethnic inequalities in limiting health and self-reported health in later life revisited. *Journal of Epidemiology and Community Health* 2016; **70**: 653–662.

16. Joyce R, Xu X. Shutdowns during the coronavirus crisis: which workers are most exposed? IFS Briefing Note BN279. [cited 2020 July 10]. Available: <https://www.ifs.org.uk/uploads/BN278-Sector-Shutdowns.pdf>
17. Andrew A, Cattan S, Dias MC, et al. How are mothers and fathers balancing work and family under lockdown? IFS Briefing Note BN290. [cited 2020 July 10]. Available: <https://www.ifs.org.uk/uploads/BN290-Mothers-and-fathers-balancing-work-and-life-under-lockdown.pdf>
18. BBC News 6<sup>th</sup> April 2020 ‘Coronavirus: Domestic abuse calls up 25% since lockdown, charity says’ [cited 2020 July 10]. Available: <https://www.bbc.co.uk/news/uk-52157620>
19. University of Essex, Institute for Social and Economic Research. Understanding Society: COVID-19 Study, 2020. [data collection]. UK Data Service. 2020; SN: 8644, Available: <http://doi.org/10.5255/UKDA-SN-8644-1>.
20. University of Essex, Institute for Social and Economic Research. Understanding Society: Waves 1-9, 2009-2018 and Harmonised BHPS: Waves 1-18, 1991-2009. [data collection]. 12th Edition. UK Data Service. 2020; SN: 6614, Available: <http://doi.org/10.5255/UKDA-SN-6614-13>
21. Grandner MA, Jackson NJ, Izci-Balserak B, et al. Social and behavioral determinants of perceived insufficient sleep. *Frontiers in Neurology* 2015; **6**: 112.
22. Department of Health and Social Care. Guidance Coronavirus (COVID-19): getting tested. [cited 2020 June 15]. Available: <https://www.gov.uk/guidance/coronavirus-covid-19-getting-tested>.
23. Bell A, Fairbrother M, Jones K. Fixed and random effects models: making an informed choice. *Quality & Quantity* 2018 <https://doi.org/10.1007/s11135-018-0802-x>.
24. StataCorp. Stata Statistical Software: Release 15. 2017. College Station, TX: StataCorp LLC.
25. Li SH, Graham BM. Why are women so vulnerable to anxiety, trauma-related and stress-related disorders? The potential role of sex hormones. *Lancet Psychiatry* 2017; **4**: 73–82.
26. Office for National Statistics (ONS). Coronavirus and anxiety, Great Britain: 3 April 2020 to 10 May 2020. [cited 2020 June 15]. Available: <https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/articles/coronavirusandanxietygreatbritain/3april2020to10may2020>
27. Office for National Statistics (ONS). Coronavirus and key workers in the UK. [cited 2020 June 15]. Available: <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/articles/coronavirusandkeyworkersintheuk/2020-05-15>
28. Gomez-leon M, Evandrou M, Falkingham J, Vlachantoni A. The dynamics of social care and employment in mid-life. *Ageing & Society* 2019; **39**: 381-408.

29.Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ. Sleep duration: how well do self-reports reflect objective measures? The CARDIA Sleep Study. *Epidemiology* 2008; **19**: 838–845. doi: 10.1097/EDE.0b013e318187a7b0