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Original Article

Impact of the novel coronavirus (COVID-19) pandemic on sleep

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Background: The COVID-19 pandemic has led to significant changes in daily routines and lifestyle worldwide and mental health issues have emerged as a consequence. We aimed to assess the presence of sleep disturbances during the lockdown in the general population.

Methods: Cross-sectional, online survey-based study on adults living through the COVID-19 pandemic. The questionnaire included demographics and specific questions assessing the impact of the pandemic/lockdown on sleep, daytime functioning and mental health in the general population. Identification of sleep pattern changes and specific sleep-related symptoms was the primary outcome, and secondary outcomes involved identifying sleep disturbances for predefined cohorts (participants reporting impact on mental health, self-isolation, keyworker status, suspected COVID-19 or ongoing COVID-19 symptoms).

Results: In total, 843 participants were included in the analysis. The majority were female (67.4%), middle aged [52 years (40–63 years)], white (92.2%) and overweight to obese [BMI 29.4 kg/m^2 (24.1–35.5 kg/m^2)]; 69.4% reported a change in their sleep pattern, less than half (44.7%) had refreshing sleep, and 45.6% were sleepier than before the lockdown; 33.9% had to self-isolate, 65.2% reported an impact on their mental health and 25.9% were drinking more alcohol during the lockdown. More frequently reported observations specific to sleep were 'disrupted sleep' (42.3%), 'falling asleep unintentionally' (35.2%), 'difficulties falling'/'staying asleep' (30.9% and 30.8%, respectively) and 'later bedtimes' (30.0%). Respondents with suspected COVID-19 had more nightmares and abnormal sleep rhythms. An impact on mental health was strongly associated with sleep-related alterations.

Conclusions: Sleep disturbances have affected a substantial proportion of the general population during the COVID-19 pandemic lockdown. These are significantly associated with a self-assessed impact on mental health, but may also be related to suspected COVID-19 status, changes in habits and self-isolation.

Keywords: Insomnia; virus; mental health; survey; sleep disruption

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Introduction

In December 2019, an outbreak of the novel strain severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in China, and rapidly spread worldwide. The new condition was named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO) and was declared a pandemic on the 11th of March 2020 (1). Millions of cases were confirmed with hundreds of thousands of deaths. This unprecedented situation and the finding that the virus was highly contagious (person-to-person transmission) (2), required the adoption of non-vaccination public health measures aiming to reduce further spreading of SARS-CoV-2 (2). These measures included track-and-tracing, self-isolation, quarantine, social distancing and community containment, as well as nationwide lockdowns (3). Lockdown measures were implemented in many countries, including the UK, leading to significant social and lifestyle changes. In addition to any direct effects of COVID-19 on people's health the lockdown had an impact on the perception of confinement, caused worries about livelihood, family or friends, and had indirect effects on the health and wellbeing of non-infected people. The psychological consequences of isolation in epidemics or during quarantine have previously been addressed (4,5), however, with scarce focus on their effects on sleep (6).

In the current pandemic, the effects of isolation have been described in cohorts from China and Italy (7,8), with poor quality sleep and comorbid psychological disturbances being identified as significant issues (9-11). We therefore hypothesised that the COVID-19 pandemic and the public lockdown significantly impacted on sleep in the general population. We compared suspected COVID-19 with non-COVID-19, and tested whether there was an association with mental health impact. In order to survey current sleep problems, the British Sleep Society (BSS) initiated the National Early Detection Screening for the COVID-19 pandemic.

We present this article in accordance with the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) reporting checklist (available at http://dx.doi.org/10.21037/jtd-cus-2020-015).

Methods

Study design

The BSS Research and Executive Committee approved this prospective, cross-sectional, survey-based study. The UKRI/MRC and the NHS Health Research Authority (HRA) confirmed that ethical approval was not required owing to the screening survey design (https://cdn.amegroups.cn/static/application/04712039f3b0c07e77f3c779c14d1a17/JTD-CUS-2020-015-1.pdf). The study conformed to the provisions of the Declaration of Helsinki (as revised in 2003). An online survey was available to the general public from May 12th to June 2nd, 2020 (https://cdn.amegroups.cn/static/application/1778ae9dd49ffd9dfb1da63b65421e93/JTD-CUS-2020-015-2.pdf). Eligible participants were adults aged 18 years or older, living through the 2020 COVID-19 pandemic and under national lockdown regulations. Subjects required literacy and access to the Internet. Participants were excluded if they were not living under national lockdown regulations or were underage.

Questionnaire items

Respondents were asked to answer multiple choice questions or provide a free-text response regarding baseline characteristics, and the impact of the pandemic/lockdown including COVID-19 infection history, self-isolation, key-working, mental health, alcohol and sleep medication use, and a sleep profile (current quality/quantity, change in sleep pattern and specific sleep symptoms) (https://cdn.amegroups.cn/static/application/1778ae9dd49ffd9dfb1da63b65421e93/JTD-CUS-2020-015-2.pdf; Supplementary material).

A total of 24 different sleep symptoms were grouped into six sleep symptom categories for analysis (*Table S1*): (I) insomnia/disrupted sleep, (II) daytime symptoms, (III) abnormal behaviours in sleep, (IV) sleep-disordered breathing, (V) restless legs, (VI) sleep phase disturbance.

Primary and secondary outcomes

The primary outcomes were to identify sleep disturbances related to the COVID-19 pandemic lockdown in the general population. Secondary outcomes included subgroup analyses for pre-defined cohorts within the population: reported suspected COVID-19, self-isolation, keyworker and mental health impact.

Statistical analysis

Continuous variables were presented as median [interquartile range, IQR], due to non-normally distributed data. Mann-Whitney U and Chi-squared analyses were

Table 1 Baseline characteristics of total study participants (n=843)

Characteristics	Category	N	% or range
Gender	Female	568	67.4%
	Male	266	31.6%
	Prefer not to say	3	0.4%
	Other	6	0.7%
Age (years)		52	40–63
Age	10–19	5	0.6%
	20–29	40	4.7%
	30–39	154	18.3%
	40–49	190	22.5%
	50–59	189	22.4%
	60–69	182	21.6%
	70–79	81	9.6%
	80–89	2	0.2%
Ethnicity	White	778	92.2%
	Black	11	1.3%
	Asian	32	3.8%
	Other	23	2.7%
Weight (kg)		83.5	69.0–101.6
Height (cm)		167	160–175
BMI (kg/m^2)		29.4	24.1–35.5

Data presented as count (percentage) or median [interquartile range].

performed for comparison of continuous and categorical variables, respectively, in *a priori* subgroup comparison. A main-effects multiple logistic regression was used to identify the strength of association between the six symptom categories or a reported sleep pattern change and factors relating to the pandemic. Further multiple logistic regression modelling was reported as odds ratios where significant associations were found between sleep symptoms and pandemic-related factors (Supplementary material).

'Yes' and 'maybe' responses regarding COVID-19 infection were grouped into 'suspected COVID-19' for analysis due to global limited availability of polymerase chain reaction (PCR) swab testing. "Don't know" answers were not included in the modelling as they were non-binary.

Data were collected on Google Forms (accessed online May 2020, Google Ireland Limited, Dublin, Ireland) and analysed with SPSS version 24 (IBM Corporation, New York, USA) and Prism version 8 (GraphPad Software, San Diego, California, USA). A P value of ≤0.05 was considered statistically significant. Missing data were not imputed.

Results

Demographics and descriptive characteristics

844 participants completed the online survey, one underage participant was excluded, and 843 datasets were included in the final analysis. Respondents were mostly female (67.4%), middle aged [52 years (40–63 years)], predominantly white (92.2%), and overweight to obese [BMI 29.4 kg/m^2 (24.1–35.5 kg/m^2)] (*Table 1*).

A proportion of 21.1% of respondents had suspected COVID-19 and 286 participants (33.9%) had to self-isolate. 550 participants (65.2%) reported an impact of the pandemic on their mental health. 296 participants (35.1%)

were keyworkers; 219 participants (25.9%) reported drinking more alcohol during the pandemic (*Table S2*).

Impact on sleep

Less than half of the participants (47.5%) felt satisfied with their current sleep quantity or felt refreshed from sleep (44.7%), with 27.0% reporting to sleep 6–7 [5; 8] hours; 585 participants (69.4%) noticed a change in their sleep pattern during the pandemic, 45.6% felt sleepier than before the lockdown and 7.4% reported the use of sleep medication during the lockdown compared to 5.2% before the lockdown (*Table S3*); 264 (31.3%) participants reported sleep restriction, with <6 hours of sleep. These were older [55 years (42–64 years) *vs.* 50 (39–62 years), P=0.007), had higher BMI [31.3 (25.7–37.6) *vs.* 28.3 (23.6–34.4) kg/m^2, P<0.001], and were more likely to report shielding due to vulnerability (31.1% *vs.* 22.8%, P=0.038), disability (30.3% *vs.* 20.0%, P=0.001) and an impact on their mental health (71.2% *vs.* 62.5%, P=0.049) (*Table S4*).

The most commonly reported specific sleep symptoms were disrupted sleep (42.3%), falling asleep unintentionally (35.2%), difficulty falling and staying asleep (30.9% and 30.8%, respectively) and going to bed later (30.0%) (*Table 2*). Regarding 'other' symptoms, a small number of respondents stated that their sleep had improved (1.9%) (*Table S5*).

Effect of self-isolation and keyworker status

A positive answer to household self-isolation status question was assumed to report the participants self-isolating themselves. Five cases were excluded from keyworker group comparison due to "don't know" responses.

Participants who self-isolated reported significantly more insomnia/disrupted sleep (60.8% *vs.* 51.7%, P=0.012), daytime symptoms (53.8% *vs.* 46.0%, P=0.030), abnormal behaviours in sleep (27.3% *vs.* 20.1%, P=0.018) and restless legs (23.4% *vs.* 16.2%, P=0.01) (*Table 3*); specifically, these reported more sleep disruption (49.3% *vs.* 38.8%, P=0.003), nightmares (24.1% *vs.* 16.5%, P=0.008), abnormal movements of the limbs/trunk (8% *vs.* 3.1%, P=0.001), restless legs (18.2% *vs.* 11.1%, P=0.005), falling asleep unintentionally (40.6% *vs.* 32.5%, P=0.02) and abnormal sleep rhythm (9.1% *vs.* 4.8%, P=0.016) (*Table S6*). Keyworkers described significantly fewer sleep-related and daytime disturbances than others, namely choking/gasping at night (1.7% *vs.* 5.4%, P=0.010), daytime naps (14.9% *vs.* 23.7%, P=0.003), falls/injuries (0.3% *vs.* 2.2%, P=0.035) and getting up later (17.6% *vs.* 23.8%, P=0.035) (*Table S7*).

Suspected COVID-19 status

The most reported COVID-19 infection symptoms in the total study participants were dry cough and breathlessness (4.5% each), followed by headache (3.7%) and muscle pain (3.6%) (*Table S8*). Participants with suspected COVID-19 had significantly more nightmares (25.8% *vs.* 17.3%, P=0.010) and abnormal sleep rhythm (11.2% *vs.* 5.0%, P=0.002) (*Table S9*). Ongoing COVID-19 symptoms were associated with sleep disruption (OR 2.810, 95% CI, 1.632 to 4.867, P<0.001) (*Figure 1*).

Mental health

Forty "don't know" responses were excluded from mental health impact group comparison. Participants reporting an impact of the pandemic on their mental health also had significantly more sleep symptoms {5 [2–7] *vs.* 0 [0–3], P<0.001} and were more concerned about their sleep {6 [5–8] *vs.* 4 [1–6] out of 10 points, P<0.001} (*Table 3*). A multiple logistic regression analysis demonstrated that reported mental health impact was a predictor of sleep pattern change during the pandemic (β=0.969, 95% CI, 0.663 to 1.281, P<0.001, *Table S10*). In a further regression analysis, an impact on mental health was significantly predicted by the presence of difficulty falling asleep (OR 3.600, 95% CI, 2.317 to 5.752, P<0.001), sleep disruption (OR 2.523, 95% CI, 1.696 to 3.794, P<0.001), excessive sleepiness (OR 3.488, 95% CI, 2.050 to 6.264, P<0.001), falling asleep unintentionally (OR 3.810, 95% CI, 2.588 to 5.726, P<0.001) and nightmares (OR 7.005, 95% CI, 3.951 to 13.600, P<0.001) (*Figure 2*). An impact on mental health was associated with both increased alcohol intake (OR 1.529, 95% CI, 1.074 to 2.203, P=0.02) and sleep medication use (OR 1.634, 95% CI, 1.036 to 2.644, P=0.039).

Predictors of a change in sleep pattern

A multiple logistic regression model including 'change in sleep pattern' as the categorical outcome variable with baseline demographics and pandemic-related factors as predictor variables was performed (*Table S10*). No co-linearity was found between predictor variables. A change in sleep pattern was overall most strongly associated with reported sleep medication use during the pandemic (β=1.276, 95% CI, 0.140 to 2.578, P=0.039), ongoing

Table 2 Reported specific sleep symptoms and within categories by total study participants (n=843)

Variables	N	% or range
Number of sleep symptoms	3	0–6
Insomnia/disrupted sleep	462	54.8%
Disrupted sleep	357	42.3%
Difficulty falling asleep	261	30.9%
Difficulty staying sleep	260	30.8%
Sleep phase disturbance	440	52.3%
Going to bed later	253	30.0%
Getting up later	183	21.7%
Getting up earlier	133	15.8%
Going to bed earlier	104	12.3%
Abnormal sleep rhythm (advanced/delayed)	53	6.3%
Daytime symptoms	410	48.6%
Falling asleep unintentionally	297	35.2%
Daytime naps	173	20.5%
Excessive sleepiness	168	19.9%
Falls/injuries	13	1.5%
Sleep-disordered breathing	223	26.5%
Morning headaches	179	21.2%
Breathlessness during the night	47	5.6%
Choking/gasping at night	34	4.0%
Breath-holding	30	3.6%
Abnormal behaviours in sleep	190	22.5%
Nightmares	161	19.1%
Sleep talking	27	3.2%
Sleep paralysis	22	2.6%
Sleepwalking	6	0.7%
Eating while asleep	6	0.7%
Restless legs	157	18.6%
Restless legs	114	13.5%
Cramps	51	6.0%
Abnormal movements (limbs or trunk)	40	4.7%
How concerned are you about your sleep? (0–10)	6	4–7

Data presented as count (percentage) or median [interquartile range].

Table 3 Sleep symptom categories reported by study participants within subgroups

Groups	Category	No		Yes		χ^2 or MWU	P value
		N	% or range	N	% or range		
Suspected COVID-19	Number of sleep symptoms	3	0–6	4	0–6	56,821	0.406
	Insomnia/disrupted sleep	354	53.2%	108	60.7%	3.139	0.076
	Daytime symptoms	320	48.0%	90	50.6%	0.335	0.563
	Abnormal behaviours in sleep	143	21.5%	47	26.4%	1.932	0.165
	Sleep-disordered breathing	181	27.2%	42	23.6%	0.947	0.330
	Restless legs	125	18.8%	32	18.0%	0.062	0.803
	Sleep phase disturbance	353	53.1%	88	49.4%	0.748	0.387
	How concerned are you about your sleep? (0–10)	6	4–7	6	4–8	21330	0.326
Self-isolation	Number of sleep symptoms	3	0–6	4	1–7	70,651	0.006
	Insomnia/disrupted sleep	288	51.7%	174	60.8%	6.365	0.012
	Daytime symptoms	256	46.0%	154	53.8%	4.704	0.030
	Abnormal behaviours in sleep	112	20.1%	78	27.3%	5.557	0.018
	Sleep-disordered breathing	143	25.7%	80	28.0%	0.513	0.474
	Restless legs	90	16.2%	67	23.4%	6.588	0.010
	Sleep phase disturbance	291	52.2%	150	52.4%	0.003	0.955
	How concerned are you about your sleep? (0–10)	6	4–7	6	4–8	26965	0.115
Keyworkers	Number of sleep symptoms	3	0–6	3	0–6	74,972	0.123
	Insomnia/disrupted sleep	292	54.0%	166	56.1%	0.686	0.558
	Daytime symptoms	273	50.5%	134	45.3%	2.069	0.151
	Abnormal behaviours in sleep	131	24.2%	56	18.9%	5.683	0.079
	Sleep-disordered breathing	157	29.0%	64	21.6%	5.530	0.020
	Restless legs	109	20.1%	48	16.2%	3.334	0.164
	Sleep phase disturbance	291	53.8%	147	49.7%	1.319	0.253
	How concerned are you about your sleep? (0–10)	6	4–7	6	4–7	27,592	0.369
Mental health	Number of sleep symptoms	0	0–3	5	2–7	34,296	<0.001
	Insomnia/disrupted sleep	72	28.3%	377	68.4%	118.238	<0.001
	Daytime symptoms	60	23.6%	338	61.3%	104.778	<0.001
	Abnormal behaviours in sleep	16	6.3%	170	30.9%	63.810	<0.001
	Sleep-disordered breathing	34	13.4%	181	32.8%	34.783	<0.001
	Restless legs	23	9.1%	127	23.0%	22.599	<0.001
	Sleep phase disturbance	89	35.0%	336	61.1%	49.360	<0.001
	How concerned are you about your sleep? (0–10)	4	1–6	6	5–8	11,789	<0.001

Suspected COVID-19: no (n=665), yes (n=178); self-isolation: no (n=557), yes n=286; keyworkers: no (n=541), yes n=296; mental health: no (n=254), yes (n=549). Data presented as count (percentage) and median [interquartile range]. χ^2 = Chi-squared values presented for categorical variables. MWU = Mann-Whitney U values presented for scale variables.

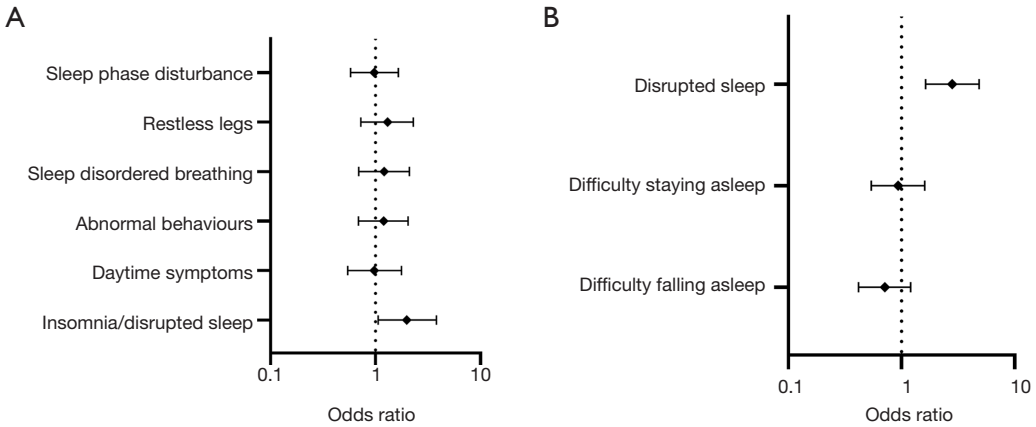

Figure 1 Forest plot displaying associations between ongoing COVID-19 symptoms and reported sleep symptoms (for all sleep symptom categories and specific symptoms within insomnia/disrupted sleep category). (A) Odds ratios for sleep symptom categories. (B) Odds ratios for specific sleep symptoms within insomnia/disrupted sleep category.

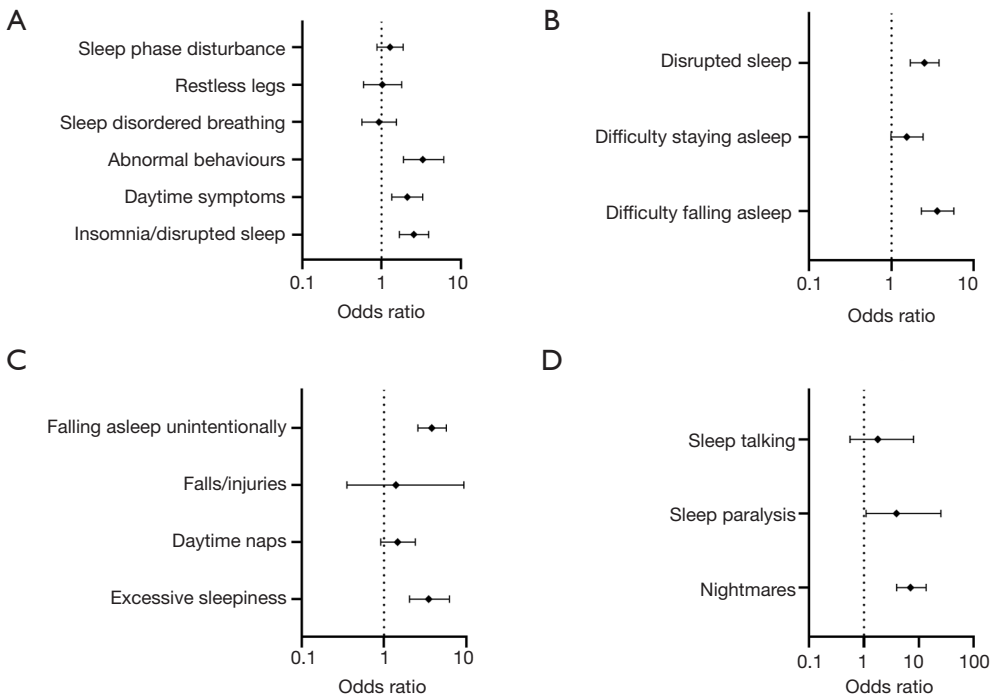

Figure 2 Forest plots displaying significant associations between mental health impact and sleep symptoms (by symptom category, and specific sleep symptoms reported within insomnia/disrupted sleep, daytime symptoms and abnormal behaviours in sleep categories). (A) Odds ratios for the six sleep symptom categories. (B) Odds ratios for insomnia/disrupted sleep. (C) Odds ratios for daytime symptoms. (D) Odds ratios for abnormal behaviours in sleep. Sleepwalking and eating while sleeping excluded due to perfect separation.

COVID-19 symptoms (β=1.124, 95% CI, 0.368 to 1.937, P=0.005) and reported mental health impact (β=0.969, 95% CI, 0.663 to 1.281, P<0.001), displaying a negative association with age (β=–0.026, 95% CI, –0.040 to –0.012, P<0.001), male gender (β=–0.350, 95% CI, –0.658 to –0.040, P=0.026) and general health rating (β=–0.244, 95% CI, –0.343 to –0.149, P<0.001) (Tjur's R^2=0.177, adjusted R^2=0.165).

Association between sleep symptom categories and pandemic factors

Insomnia/disrupted sleep was significantly associated with mental health impact (OR 2.435, 95% CI, 1.821 to 3.281, P<0.001), ongoing COVID-19 symptoms (OR 2.232, 95% CI, 1.159 to 4.385, P=0.018) and sleep medication use during the pandemic (OR 5.933, 95% CI, 2.142 to 20.030, P=0.002). Daytime symptoms were significantly associated with an impact on mental health (OR 2.332, 95% CI, 1.741 to 3.145, P<0.001) and sleep medication use during the pandemic (OR 3.450, 95% CI, 1.425 to 9.285, P=0.009). Abnormal behaviours in sleep were significantly associated with mental health impact (OR 2.198, 95% CI, 1.522 to 3.212, P<0.001) and reported disability (OR 1.504, 95% CI, 1.002 to 2.253, P=0.048). Sleep-disordered breathing was significantly associated with ongoing COVID-19 symptoms (OR 3.405, 95% CI, 1.610 to 7.450, P=0.002) and an impact on mental health (OR 1.725, 95% CI, 1.232 to 2.430, P=0.002). Restless legs symptoms were significantly associated with ongoing COVID-19 symptoms (OR 2.530, 95% CI, 1.143 to 5.388, P=0.024), an impact on mental health (OR 1.933, 95% CI, 1.318 to 2.862, P=0.001) and reported disability (OR 1.566, 95% CI, 1.029 to 2.364, P=0.034). Sleep phase disturbance was significantly associated with an impact on mental health (OR 1.669, 95% CI, 1.254 to 2.212, P<0.001), increased alcohol intake (OR 1.510, 95% CI, 1.080 to 2.121, P=0.017) and sleep medication use during the pandemic (OR 2.553, 95% CI, 1.084 to 6.713, P=0.041) (*Figure 3*).

Discussion

Summary of main findings

The pandemic lockdown had a major impact on the population. The majority of respondents described an altered sleep pattern and almost half of the studied population felt sleepier than prior to the lockdown. Reported problems included dozing off unintentionally in the day, disrupted sleep, difficulties falling/staying asleep and later bedtimes. Over a quarter of all respondents reported an increased alcohol intake during the lockdown. Furthermore, those self-isolating reported more insomnia/disrupted sleep, daytime symptoms, abnormal behaviours in sleep and symptoms of restless legs compared to those not self-isolating. Keyworkers reported fewer sleep alterations than others. In those with suspected COVID-19, nightmares and abnormal sleep rhythm were more common. A reported impact on mental health was most strongly associated with more difficulties falling asleep, sleep disruption, nightmares and daytime sleepiness. A change in sleep pattern was associated with medication use, ongoing COVID-19 symptoms and mental health impact, and it was negatively associated with age, male gender and general health.

Assessing lockdown impact on sleep and clinical significance of findings

Home confinement and isolation procedures have required modifications in lifestyle, leading to the loss of daily routines and habits. Resultant issues such as work, family and financial problems, limited exposure to natural light, and restricted opportunities to exercise may have negative effects on sleep (5). Insufficient sunlight, physical inactivity, dietary changes, weight gain, increased digital screen time, as well as the risk of alcohol use and developing addictions, are associated with prolonged lockdown (12). Additionally, sleep deprivation may lead to immunological alterations and it would therefore seem pertinent to consider the effects of altered sleep on COVID-19 susceptibility (13). Notably, almost a third of participants in our study reported sleeping less than 6 hours, and these were of older age, had higher BMI, reported more vulnerability/disability and mental health impact during the pandemic compared to respondents getting more than 6 hours of sleep.

Reported change in sleep pattern and specific sleep symptoms

Less than half of our study participants were feeling refreshed or felt that they were sleeping enough during the pandemic, and almost half of them felt sleepier than before the lockdown (*Table S3*). The most commonly reported specific sleep symptoms included disrupted sleep, difficulty falling and staying asleep, later bedtimes and falling asleep unintentionally in the day (*Table 2*). A majority

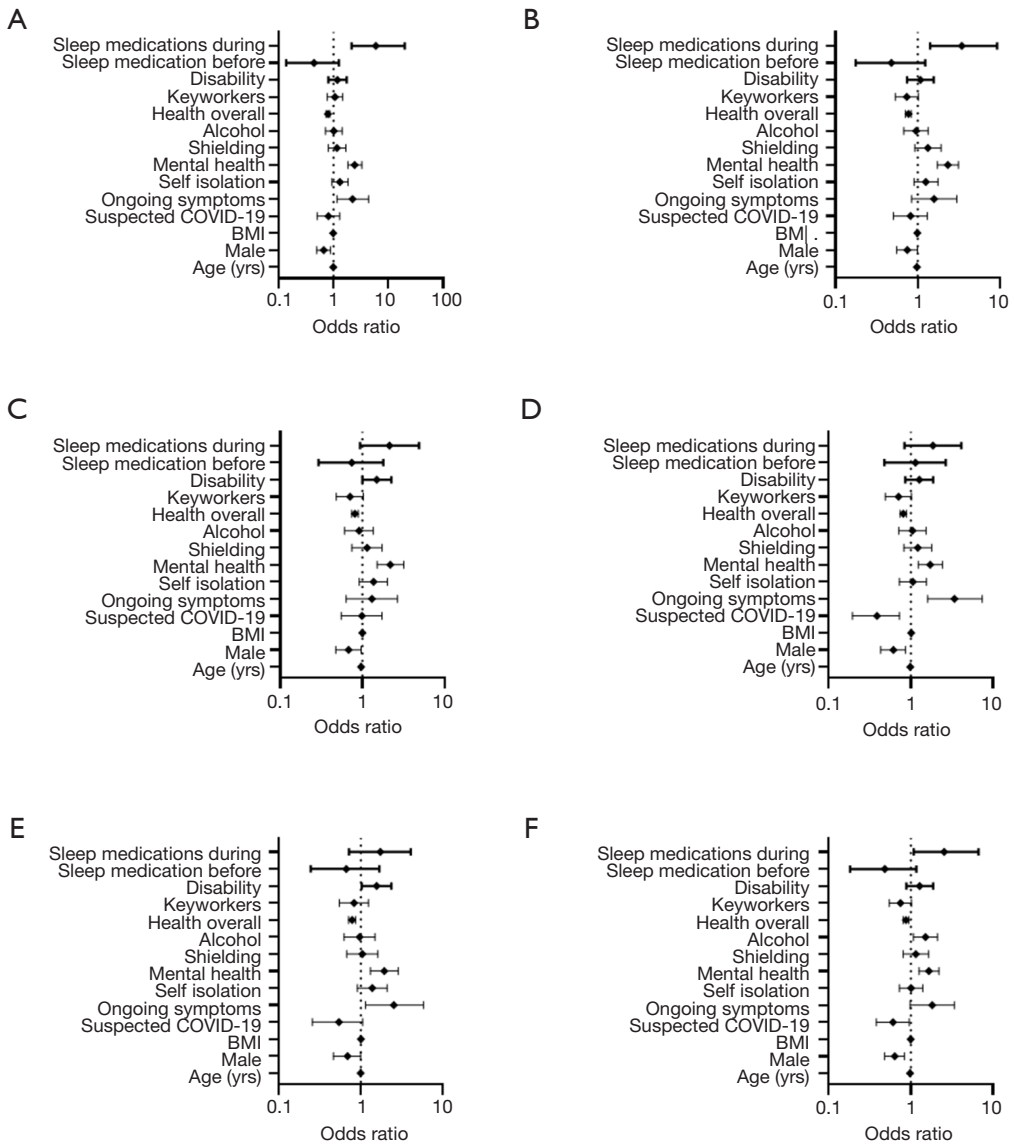

Figure 3 Forest plots displaying association of each sleep symptom category (insomnia/disrupted sleep, daytime sleepiness, abnormal behaviours in sleep, sleep-disordered breathing, restless legs, sleep phase disturbance) with demographics and pandemic-related factors. (A) Odds ratios for insomnia/disrupted sleep. (B) Odds ratios for daytime symptoms. (C) Odds ratios for abnormal behaviours in sleep. (D) Odds ratios for sleep-disordered breathing. (E) Odds ratios for restless legs symptoms. (F) Odds ratios for sleep phase disturbance.

of respondents reported a change in sleep pattern, and this was predicted by the presence of ongoing COVID-19 symptoms, mental health impact, sleep medication use in the pandemic, younger age and worse general health rating (*Table S10*). Similarly, a recent Italian survey including young adults demonstrated a significantly delayed bed and rise times during lockdown, spending overall more time in bed, but reporting a poor sleep quality (8). Also, an increased prevalence of insomnia during the outbreak was found in a Chinese survey-based study (9). Of note, a UK survey showed that half of the respondents experienced more disturbed sleep than usual; 39% of the participants reported sleeping fewer hours than before the lockdown; and 29% reported sleeping longer hours but still felt less rested (14). Consistent with our findings, only a minority of respondents reported improved sleep during the lockdown (14).

Effect of alcohol

Although frequently used by people who suffer from insomnia to try and help sleep (15), alcohol actually disrupts sleep architecture, possibly exacerbates sleep pathologies (such as sleep-disordered breathing and NREM parasomnias), and worsens daytime sleepiness (16). Almost 26% of our study population reported increased alcohol intake during the lockdown (*Table S2*). This is in line with previous evidence showing that, despite the decrease in social gathering, only a third of drinkers have reduced or stopped their alcohol intake, while 21% drink more frequently (17). Stress further contributes to alcohol seeking behaviour (18), and alcohol is also used to alleviate negative emotions (19). In our study, the presence of a sleep phase disturbance was predicted by an increased alcohol intake, reported mental health impact and sleep medication use during the pandemic (*Figure 3*).

Impact on mental health

The potential effect of mood alterations on sleep is relevant in the pandemic. The link between sleep and mood disturbances has previously been demonstrated in circumstances similar to the current lockdown (4,5). Confinement and quarantine have negative psychological consequences (4,5), which can have an impact on sleep. Worsened insomnia symptoms and psychological reactions attributed to the outbreak were demonstrated in the general population using online questionnaires reflecting the situation prior to and following the lockdown (9). Insomnia was associated with being female, mental illness, increased severity of anxiety and depression, COVID-19-related stress and prolonged time in bed (9). In a Chinese study the prevalence of insomnia was at 26%, and over 20% of patients with pre-existing mental health conditions reported a deterioration of these (11). Stronger changes in sleep quality in those with higher scores of depression, anxiety and stress were reported as well. Additionally, a longitudinal study investigating whether sleep quality depends on the social situation found an association between social isolation and poor sleep quality in older adults (20). Of note, over 65% of the population involved in our study reported an impact of the pandemic or lockdown on their mental health (*Table S2*), and this cohort reported more sleep-related symptoms and concerns about their sleep (*Table 3*). Importantly, an impact on mental health was one of the significant predictors for a reported change in sleep pattern (*Table S10*). On regression analysis, reported mental health impact was significantly associated with difficulties falling asleep, disrupted sleep, daytime sleepiness and nightmares (*Figure 2*).

Self-isolation status, keyworkers and sleep

Compared to those who did not self-isolate, self-isolators more frequently reported disrupted sleep, nightmares, abnormal movements, restless legs, falling asleep unintentionally and abnormal sleep rhythm (*Table S6*). Higher rates of difficulties to fall asleep or early awakenings in medically isolated versus self- or non-isolated individuals in the outbreak have been previously demonstrated (7).

A subgroup of the population that deserves special attention in the current circumstances are keyworkers. Healthcare workers account for a proportion of these; they have not only suffered the stress of being directly involved in the care of patients, but also faced the consequences of working long hours during the pandemic. Sleep disruption, poor quality of sleep, insomnia, and mood disturbances have all been reported in healthcare workers under pandemic circumstances (21-23). Although our study did not find an association between sleep disturbances and keyworker status, notably this group also included non-healthcare workers (postal workers, truck driver, police officer and others) (*Table S7*). Possibly keyworkers, considered as a wider group, experienced fewer changes in their routines during the lockdown, as they were allowed to leave the house to continue working.

Suspected COVID-19

There may be additional factors affecting sleep directly when considering individuals who suspect they have had COVID-19. Pre-existing sleep disorders, such as obstructive sleep apnoea, may also be present in COVID-19 patients (24), and might further impact on sleep quality and shortness of breath following the infection. In our study, the presence of symptoms associated with sleep-disordered breathing was significantly associated with ongoing COVID-19 symptoms (*Figure 3*).

Furthermore, potential neuropathogenic mechanisms of SARS-CoV-2 and a range of neurological symptoms have been reported in patients with COVID-19 (25). It could be hypothesised that involvement of structures controlling sleep-wake cycles in the central nervous system play a role in the presence of sleep-related symptoms in COVID-19 patients. We found a significant association between the presence of ongoing COVID-19 symptoms and insomnia/disrupted sleep (*Figure 3*). Moreover, participants with suspected COVID-19 had a higher frequency of nightmares

and abnormal sleep rhythm (*Table S9*). Additionally, our regression analysis showed that restless legs symptoms were significantly associated with ongoing COVID-19 symptoms, mental health impact, and disability (*Figure 3*).

Limitations to the study

A selection bias may be expected in the study, as subjects with affected sleep may have been more interested in completing the survey. Also, as the survey was widely distributed among the population, this could have included subjects living in different countries, with different levels of lockdown measures. Additionally, the self-reported status with regards to having suspected COVID-19 was subjective and affirmatory responses did not require positive formal testing. Moreover, no formal objective assessments of specific sleep disorders were undertaken. Finally, there was limited diversity in the respondents' ethnicity which did not permit assessing the impact of the pandemic on sleep in ethnic minorities.

Despite these limitations, and although it is clear that public health measures are required in such unprecedented circumstances, the potential effects of confinement and isolation on sleep should be screened for, and support needs to be provided for adequate management of sleep disturbances (6). Early identification of sleep disturbances and associated impact on mental health is crucial for timely intervention and support (26,27). Future studies could include formal assessments of subjective and objective measurements of sleep disorders, with more specific focus on subgroups according to infection, keyworker status and ethnicity.

Conclusions

Altered sleep patterns and specific sleep-related symptoms are common in the general population during the pandemic lockdown. These are mainly associated with mental health impact, self-isolation, suspected COVID-19 infection and ongoing symptoms. The potential consequences of the lockdown on sleep should not be overlooked, as they can have an impact on the future wellbeing of society. Sleep issues may be addressed early with appropriate guidance and/or counselling to avoid the longer-term impact of these on a public health scale.

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screening survey design (https://cdn.amegroups.cn/static/application/04712039f3b0c07e77f3c779c14d1a17/JTD-CUS-2020-015-1.pdf). The study conformed to the provisions of the Declaration of Helsinki (as revised in 2003).

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Methods

Study design

Following internal discussions in the research committee, the BSS undertook a prospective, cross-sectional, survey-based study that was conducted from May 12th, 2020 to June 2nd, 2020, available to the general public. The survey was advertised via the BSS webpage, social media, NHS hospital trusts and specialist society and patient charities networks. The survey was submitted to the UKRI/MRC and the NHS Health Research Authority (HRA) 'is it research?' tool, confirming that ethical approval was not required (http://www.hra-decisiontools.org.uk/research/result7.html; outcome of assessment in https://cdn.amegroups.cn/static/application/04712039f3b0c07e77f3c779c14d1a17/JTD-CUS-2020-015-1.pdf; 09/05/2020). It was approved internally by the BSS Research and Executive Committees (11/05/2020; BSS-NEDS-SURVEY_V1-0; Appendix 2) and distributed via Google Forms on an open domain on May 12th, 2020. Data collection stopped on June 2nd, 2020. Eligible participants were adults aged 18 years, or older, living through the 2020 COVID-19 pandemic and under national lockdown regulations. Due to the nature of the survey, subjects required literacy and access to the Internet. Participants were excluded if they were not living under national lockdown regulations or were underage.

Questionnaire items

Participants were asked to read an introduction preceding the questionnaire items outlining the nature and purpose of the survey and the interested bodies (BSS). Following an item reduction phases involving specialists from all participating affiliations, respondents were asked to answer multiple choice questions, including "yes", "no", "don't know" and context- specific answers, or provide a free-text response to "other, please specify".

The following demographics were collected:

- Age (years);
- Gender (male/female/X/prefer not to say/other);
- Ethnicity (White/Black/Asian/other);
- Height (m);
- Weight (kg);
- Body-mass-index (BMI), calculated by weight (kg)/height (m^2);
- Keyworker status (yes/no);
- Disability (yes/no/don't know);
- Need to shield due to vulnerability status (yes/no/don't know).

Specific questions to assess the impact of the pandemic/lockdown related to the following:

- Suspected COVID-19 history [yes/no/maybe (possibly, but they had no test)];
- Ongoing COVID-19 symptoms (tick all that apply: no/dry cough/sore throat/headache/fever/breathlessness/shortness of breath/chest pain/muscle pain/leg pain/loss of smell/skin rash/other);
- Self-isolation history in household (yes/no);
- Impact of the pandemic on mental health (yes/no/don't know);
- Currently feeling refreshed from sleep (yes/no/undecided);
- Current feeling of sleeping enough (yes/no);
- Current sleep quantity (tick all that apply: less than 4 hours/4–5 hours/5–6 hours/6–7 hours/7–8 hours/8–9 hours/9–10 hours/10–11 hours/11–12 hours/more than 12 hours);
- Change in sleep pattern during the pandemic (yes/no);
- Specific sleep symptoms (tick all that apply: difficulties falling asleep/difficulties staying asleep/excessive sleepiness/disrupted sleep/nightmares/sleep paralysis (unable to move when waking)/sleepwalking/talking in your sleep/eating while asleep/abnormal movements (e.g., limbs or trunk)/breathlessness/shortness of breath during the night/breath holding/choking/gasping at night/night sweats/morning headache/restless legs/periodic limb movements/naps required by daytime/falls/injuries/falling asleep unintentionally/cramps/abnormal sleep rhythm (advanced/delayed)/going to bed earlier/going to bed later/getting up earlier/getting up later/other);
- Daytime symptoms of fatigue and/or sleepiness compared to before the lockdown (yes/no/undecided);
- Concern regarding sleep disturbance [rating on a scale from '0' (worst) to '10' (best)];
- Increased alcohol intake (yes/no/prefer not to say);
- Increased sleep medication use before and during the lockdown (yes/no/prefer not to say);
- Current rate of general health [scale from '0' (worst) to '10' (best)].
- Overweight was defined as BMI of 25–29.9 kg/m^2 and obesity was defined as BMI ≥30 kg/m^2.

A total of 24 different sleep symptoms were grouped into six sleep symptom categories for analysis (*Table S1*):

(I) Insomnia/disrupted sleep;
(II) Daytime symptoms;
(III) Abnormal behaviours in sleep;
(IV) Sleep-disordered breathing;
(V) Restless legs;
(VI) Sleep phase disturbance.

Online links were provided for official guidance from the BSS regarding sleep and from the UK government regarding COVID-19. Participants were advised to contact the helplines provided (111/999) if they required urgent or emergent medical care

Primary and secondary outcomes

The primary outcomes were to identify sleep disturbances and specific sleep symptoms related to the COVID-19 pandemic lockdown in the general population. Secondary outcomes included subgroup analyses for pre-defined cohorts within the population: suspected COVID-19, self-isolation, keyworkers and those reporting an impact on mental health.

Statistical analysis

Continuous variables including demographics and scale ratings were presented as median [interquartile range, IQR], due to non-normally distributed data and Mann-Whitney U analysis was performed for comparison. Chi-squared analysis was performed to compare categorical variables. Group comparisons were made based on suspected COVID-19 vs non- infected, self-isolation, keyworker status and impact on mental health due to the COVID-19 pandemic.

A multiple logistic regression model including 'change in sleep pattern' as the categorical outcome variable with 'age', 'male gender', 'BMI', 'suspected COVID-19', 'ongoing COVID-19 symptoms', 'self-isolation', 'impact on mental health', 'shielding due to vulnerability', 'alcohol use', 'global general health rating', 'keyworking', 'disability', 'sleep medication before' and 'sleep medication during', as predictor variables, was performed.

These variables were chosen due to their nature as either baseline demographics or pandemic- related factors.

A main-effects multiple logistic regression model was used to identify the strength of association and odds ratios with 95% CI between the six different symptom categories (insomnia/disrupted sleep, daytime symptoms, abnormal behaviours in sleep, sleep-disordered breathing, restless legs and sleep phase disturbance) and factors relating to the COVID-19 pandemic. Where significant associations were found, further multiple logistic regression modelling was performed and reported as odds ratios between sleep symptoms and factors relating to the COVID-19 pandemic.

'Yes' and 'maybe' responses regarding COVID-19 infection were grouped into 'suspected COVID-19' for analysis due to the limited availability of polymerase chain reaction (PCR) swab testing to the general public and the small sample size of confirmed infected participants. "Don't know" answers were not included in the modelling as they were non- binary.

Data were collected on Google Forms (accessed online May 2020, Google Ireland Limited, Dublin, Ireland) and exported using MS Excel (Microsoft, Version 2004, Seattle, WA, USA). Data were then imported into IBM SPSS version 24 (IBM Corporation, New York, USA) and Prism version 8 (GraphPad Software, San Diego, California, USA) for further analysis. A P value of ≤ 0.05 was considered statistically significant. Missing data were not included in the analysis based on case-by-case decision.

Table S1 Grouping of 24 specific sleep symptoms into six categories

Category	Symptom
Insomnia/disrupted sleep	Difficulty falling asleep
	Difficulty staying asleep
	Disrupted sleep
Daytime symptoms	Falling asleep unintentionally
	Daytime naps
	Excessive daytime sleepiness
	Falls/injuries
Abnormal behaviours in sleep	Nightmares
	Sleepwalking
	Sleep talking
	Eating while asleep
	Sleep paralysis
Sleep-disordered breathing	Morning headaches
	Breathlessness
	Choking/gasping at night
	Breath-holding
Restless legs	Restless legs
	Cramps
	Abnormal movements (trunk or limbs)
Sleep phase disturbance	Abnormal sleep rhythm (advanced or delayed)
	Going to bed earlier
	Going to bed later
	Getting up earlier
	Getting up later

Table S2 Health and social factors during the pandemic on total study participants (n=843)

Factors	Category	N	% or range
Have you been infected with the COVID-19 virus?	Yes	16	1.9%
	Maybe	162	19.2%
Do you have ongoing symptoms?		84	10.0%
Has anyone in your household/family been infected by the COVID-19 virus?	Yes	18	2.1%
	Maybe	164	19.5%
Have you or someone in your household needed to self-isolate?		286	33.9%
Have you needed to shield as a vulnerable person?	Yes	214	25.4%
	Maybe	30	3.6%
Have you felt that the COVID-19 pandemic or the lockdown have had an impact on your mental health?	Yes	550	65.2%
	Maybe	39	4.6%
Do you belong to any key worker group (e.g., NHS, public transport, post office, teacher, truck driver, and others)?		296	35.1%
Do you have any disability?		196	23.3%
Do you drink more alcohol than before the lockdown?		219	25.9%
How would you rate your health currently? (0–10)		7	5–8

Data presented as count (percentage) or median [interquartile range].

Table S3 General sleep-related information of total study participants (n=843)

Variables	Category	N	% or range
Do you currently feel refreshed from sleep?		377	44.7%
Do you currently feel you sleep for long enough?		401	47.5%
How long do you currently sleep? (hours)		6–7	5–8
How long do you currently sleep?	<4 hours	19	2.3%
	4–5 hours	76	9.0%
	5–6 hours	169	20.0%
	6–7 hours	228	27.0%
	7–8 hours	226	26.8%
	8–9 hours	94	11.2%
	9–10 hours	18	2.1%
	10–11 hours	8	0.9%
	11–12 hours	3	0.4%
	>12 hours	2	0.2%
Have you noticed a change in your sleep pattern during the COVID-19 pandemic?		585	69.4%
Do you currently feel sleepier than before the lockdown?	Yes	384	45.6%
	Undecided	142	16.8%
Are you more easily fatigued or worn out when exercising compared to before the lockdown?	Yes	388	46.0%
	Undecided	127	15.1%
Are you concerned about your sleep during the pandemic?		347	41.2%
How concerned are you about your sleep? (0–10)		6	4–7
Are you concerned about the sleep of someone in your family/ household?		244	28.9%
Did you take sleeping pills during the lockdown?		62	7.4%
Did you already take sleeping pills before the lockdown?		44	5.2%
Do you take any other sleep-related medication?		73	8.7%

Data presented as count (percentage) and median [interquartile range].

Table S4 Characteristics of participants with reported sleep restriction (<6 hours of sleep per night)

Characteristics	Sleep restriction (<6 hours of sleep)				χ^2 or MWU	P value
	No (n=619)		Yes (n=224)			
	N	% or range	N	% or range		
Age (years)	50	39–62	55	42–64	67,586	0.007
Gender						
Female	384	66.3%	184	69.7%	2.218	0.528
Male	190	32.8%	76	28.8%		
Prefer not to say	2	0.3%	1	0.4%		
Other	3	0.5%	3	1.1%		
BMI (kg/m^2)	28.3	23.6–34.3	31.3	25.7–37.6	59,954	<0.001
Suspected COVID-19	125	21.6%	53	20.1%	0.249	0.618
Do you have ongoing symptoms?	62	10.7%	22	8.3%	1.140	0.286
Have you or someone in your household needed to self-isolate?	196	33.9%	90	34.1%	0.005	0.946
Have you needed to shield as a vulnerable person?	132	22.8%	82	31.1%	6.552	0.038
Have you felt that the COVID-19 pandemic or the lockdown have had an impact on your mental health?	362	62.5%	188	71.2%	6.041	0.049
Do you belong to any key worker group (e.g., NHS, public transport, post office, teacher, truck driver, and others)?	219	37.8%	77	29.2%	5.967	0.051
Do you have any disability?	116	20.0%	80	30.3%	14.696	0.001
Do you drink more alcohol than before the lockdown?	159	27.5%	60	22.7%	2.114	0.348
Did you take sleeping pills during the lockdown?	35	6.0%	27	10.2%	4.655	0.031
Did you already take sleeping pills before the lockdown?	26	4.5%	18	6.8%	3.313	0.191

Data presented as count (percentage) and median [interquartile range]. χ^2 = Chi-squared values presented for categorical variables. MWU = Mann-Whitney U values presented for scale variables.

Table S5 Other sleep symptoms reported by total study participants (n=843)

Variables	Number
Sleep improvement	16
Vivid dreams	13
Anxiety	7
Anxiety/panic	6
Work related sleep restriction	5
Childcare-related sleep restriction	4
Tachycardia/palpitations	3
Bruxism/tooth-grinding	3
Improved PAP adherence	2
Worsened sleep apnoea symptoms	2
Restless sleep	2
Emotional	2
Snoring	1
Electrified arousal	1
Skipping sleep	1
TV sleep restriction	1
Nocturia	1
Hayfever	1
Lucid dreaming	1
Grief	1
Myalgia	1
Dry mouth	1
Coughing	1
Weight gain	1
Headache	1
Supermarket hours	1
Throat burning	1
Fingers tingling	1

Data presented as counts. PAP, positive airway pressure.

Table S6 Specific sleep symptoms reported by self-isolators versus non self-isolators

Variables	Have you or someone in your household needed to self-isolate?				χ^2	P value
	No (n=557)		Yes (n=286)			
	N	%	N	%		
Difficulty falling asleep	162	29.1%	99	34.6%	2.705	0.100
Difficulty staying sleep	164	29.3%	97	33.9%	1.917	0.166
Excessive sleepiness	111	19.9%	57	19.9%	0.000	0.999
Disrupted sleep	216	38.8%	141	49.3%	8.568	0.003
Nightmares	92	16.5%	69	24.1%	7.081	0.008
Sleep paralysis	13	2.3%	9	3.1%	0.491	0.483
Sleepwalking	5	0.9%	1	0.3%	0.803	0.370
Sleep talking	16	2.9%	11	3.8%	0.578	0.447
Eating while asleep	3	0.5%	3	1.0%	0.696	0.404
Abnormal movements (limbs or trunk)	17	3.1%	23	8.0%	10.410	0.001
Breathlessness during the night	30	5.4%	17	5.9%	1.112	0.738
Breath-holding	18	3.2%	12	4.2%	0.512	0.474
Choking/gasping at night	20	3.6%	14	4.9%	0.831	0.362
Night sweats	72	12.9%	50	17.5%	3.169	0.075
Morning headaches	118	21.1%	61	21.3%	0.002	0.951
Restless legs	62	11.1%	52	18.2%	8.033	0.005
Daytime naps	98	17.6%	75	26.2%	8.628	0.003
Falls/injuries	6	1.1%	7	2.4%	2.337	0.126
Falling asleep unintentionally	181	32.5%	116	40.6%	5.385	0.020
Cramps	31	5.6%	20	7.0%	0.677	0.410
Abnormal sleep rhythm (advanced/ delayed)	27	4.8%	26	9.1%	5.776	0.016
Going to bed earlier	65	11.7%	39	13.6%	0.676	0.411
Going to bed later	173	31.1%	80	28.0%	0.857	0.354
Getting up earlier	81	14.5%	52	18.2%	1.884	0.170
Getting up later	130	23.3%	53	18.5%	2.570	0.109

Data presented as count (percentage). χ^2 = Chi-squared values.

Table S7 Specific sleep symptoms reported by keyworkers versus non-keyworkers

Variables	Do you belong to any keyworker group (e.g., NHS, public transport, post office, teacher, truck driver, and others)?				χ^2	P value
	No (n=541)		Yes (n=296)			
	N	%	N	%		
Difficulty falling asleep	165	30.5%	94	31.8%	0.157	0.707
Difficulty staying sleep	170	31.4%	88	29.7%	0.275	0.612
Excessive sleepiness	117	21.6%	48	16.2%	6.934	0.060
Disrupted sleep	225	41.6%	128	43.2%	1.678	0.643
Nightmares	109	20.1%	49	16.6%	5.334	0.204
Sleep paralysis	15	2.8%	6	2.0%	5.117	0.510
Sleepwalking	4	0.7%	2	0.7%	0.054	0.917
Sleep talking	17	3.1%	9	3.0%	3.540	0.935
Eating while asleep	4	0.7%	2	0.7%	0.054	0.917
Abnormal movements (limbs or trunk)	30	5.5%	10	3.4%	2.289	0.160
Breathlessness during the night	35	6.5%	11	3.7%	4.167	0.095
Breath-holding	21	3.9%	9	3.0%	0.617	0.531
Choking/gasping at night	29	5.4%	5	1.7%	6.916	0.010
Night sweats	80	14.8%	41	13.9%	0.159	0.713
Morning headaches	122	22.6%	55	18.6%	2.332	0.179
Restless legs	80	14.8%	34	11.5%	2.728	0.183
Daytime naps	128	23.7%	44	14.9%	9.129	0.003
Falls/injuries	12	2.2%	1	0.3%	4.550	0.035
Falling asleep unintentionally	192	35.5%	103	34.8%	0.050	0.841
Cramps	36	6.7%	15	5.1%	1.237	0.359
Abnormal sleep rhythm (advanced/ delayed)	32	5.9%	19	6.4%	7.585	0.771
Going to bed earlier	67	12.4%	37	12.5%	0.853	0.961
Going to bed later	172	31.8%	79	26.7%	2.404	0.123
Getting up earlier	85	15.7%	47	15.9%	0.008	0.950
Getting up later	129	23.8%	52	17.6%	4.916	0.035

Data presented as count (percentage). χ^2 = Chi-squared values. “Don’t know” responses excluded from analysis (n=6).

Table S8 Reported symptoms of COVID-19 infection in participants with suspected COVID-19 status (n=178)

Variables	N	%
Dry cough	38	4.5%
Breathlessness	38	4.5%
Headache	31	3.7%
Muscle pain	30	3.6%
Other	23	2.7%
Sore throat	21	2.5%
Leg pain	20	2.4%
Chest pain	18	2.1%
Loss of smell	14	1.7%
Fever	11	1.3%
Skin rash	6	0.7%

Data presented as count (percentage).

Table S9 Specific sleep symptoms reported by suspected COVID-19 versus non-suspected COVID-19

Variables	Suspected COVID-19				χ^2	P value
	No (n=665)		Yes (n=178)			
	N	%	N	%		
Difficulty falling asleep	206	31.0%	55	30.9%	0.000	0.984
Difficulty staying sleep	204	30.7%	56	31.5%	0.040	0.841
Excessive sleepiness	131	19.7%	37	20.8%	0.104	0.747
Disrupted sleep	271	40.8%	86	48.3%	3.289	0.070
Nightmares	115	17.3%	46	25.8%	6.643	0.010
Sleep paralysis	17	2.6%	5	2.8%	0.035	0.851
Sleepwalking	4	0.6%	2	1.1%	0.542	0.462
Sleep talking	21	3.2%	6	3.4%	0.021	0.883
Eating while asleep	3	0.5%	3	1.7%	3.027	0.082
Abnormal movements (limbs or trunk)	28	4.2%	12	6.7%	1.990	0.158
Breathlessness during the night	40	6.0%	7	3.9%	1.157	0.282
Breath-holding	27	4.1%	3	1.7%	2.307	0.129
Choking/gasping at night	28	4.2%	6	3.4%	0.256	0.613
Night sweats	95	14.3%	27	15.2%	0.088	0.766
Morning headaches	146	22.0%	33	18.5%	0.979	0.322
Restless legs	89	13.4%	25	14.0%	0.053	0.819
Daytime naps	133	20.0%	40	22.5%	0.526	0.468
Falls/injuries	8	1.2%	5	2.8%	2.385	0.122
Falling asleep unintentionally	233	35.0%	64	36.0%	0.052	0.820
Cramps	39	5.9%	12	6.7%	0.190	0.663
Abnormal sleep rhythm (advanced/delayed)	33	5.0%	20	11.2%	9.380	0.002
Going to bed earlier	81	12.2%	23	12.9%	0.071	0.789
Going to bed later	201	30.2%	52	29.2%	0.068	0.794
Getting up earlier	101	15.2%	32	18.0%	0.822	0.365
Getting up later	153	23.0%	30	16.9%	3.128	0.738

Data presented as count (percentage). χ^2 = Chi-squared values.

Table S10 Multiple logistic regression to assess association of 'change in sleep pattern' with demographics and pandemic-related factors (Tjur's R^2=0.177, adjusted R^2=0.165)

Variables	β co-efficient	95% confidence intervals	P value
Age (years)	–0.026	–0.040 to –0.012	<0.001
Male	–0.350	–0.658 to –0.040	0.026
BMI	–0.011	–0.030 to 0.007	0.235
Suspected COVID-19	–0.355	–0.851 to 0.145	0.161
Ongoing COVID-19 symptoms	1.124	0.368 to 1.937	0.005
Self-isolation	0.232	–0.141 to 0.609	0.226
Mental health impact	0.969	0.663 to 1.281	<0.001
Shielding	0.0178	–0.387 to 0.428	0.932
Increased alcohol	0.297	–0.090 to 0.694	0.137
General health rating	–0.244	–0.343 to –0.149	<0.001
Keyworkers	–0.153	–0.513 to 0.209	0.405
Disability	0.148	–0.284 to 0.598	0.509
Sleep medication before	–0.626	–1.817 to 0.515	0.287
Sleep medication during	1.276	0.140 to 2.578	0.039