Epidemiology of sleep disorders during COVID-19 pandemic: A systematic scoping review

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Abstract:

Background: A growing burden of mental health problems has become a global concern amid the coronavirus disease (COVID-19) pandemic. Sleep disorders are major mental health problems associated with increased psychosocial stressors; however, no research synthesis is available on the epidemiology of it. In this systematic scoping review, we aimed to assess the current evidence on the epidemiological burden, associated factors, and interventions from the existing literature.

Method: Seven major health databases and additional sources were searched to identify, evaluate, and synthesize empirical studies on the prevalence and correlates of sleep disorders and available interventions. The Joanna Briggs Institute Methodology for Scoping Review were used, and the findings were reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.

Results: A total of 78 articles were retrieved, the prevalence of sleeping disorders ranged from 2.3% to 76.6%. Age, sex, level of education, physical and mental health, COVID-19 related factors, occupation especially being health care workers (HCW) were the main associated factors. Only two intentions were identified to address the issue.

Conclusion: The finding of this review indicated a high burden of sleep disorder with limited interventions that necessitate informing policymakers and practitioners to facilitate future research and implementations.

Keywords: Sleep Disorders; Insomnia; Mental Health; COVID-19; Coronavirus; Systematic Review; Scoping Review

Brief summary:

Current Knowledge/Study Rationale: Despite the paramount importance of sleep for the physical and mental wellbeing of individuals, sleep hygiene is often neglected which resulted in a high prevalence of sleep disorders across the globe. This condition is likely to worsen amid this pandemic. This is the first systematic scoping review of sleep disorders during the COVID-19 pandemic. **Study Impact:** The findings of our study suggest a high prevalence of sleep disorder and highlight a wide range of socio-demographic factors to identify population groups vulnerable to the adverse outcomes of sleep disorder with limited interventions. These pieces of evidence will guide clinicians to make informed choices for better management of patients and aid public health professionals to prevent sleep disorder epidemic concurring with the current pandemic.

1. Introduction:

Novel coronavirus disease or COVID-19, an acute respiratory illness caused by a newly discovered SARS-CoV-2 virus emerged in December 2019 [1,2]. Since then, it has rapidly surged to Europe, especially Italy and Spain, the USA, and progressed to become a global pandemic. In the last couple of months, it's reported to be spreading to the countries in other parts of Asia, Africa, and Latin America. Globally, by September 27th, 2020, a total of 32,730,945 cases of COVID-19 has been reported, including 991,224 deaths [3]. Of note, the World Health Organization declared it a global pandemic on March 11th, and after the declaration, most of the countries worldwide entered nationwide lockdown to prevent the spread of the infection [4]. While the clinical care practitioners and public health experts were focused on containing the spread of the virus, the COVID-19 pandemic and related quarantine measures have taken a heavy toll on people's mental health[4,5]. Historically quarantine has been related to anxiety, depression, panic, irritability, somatic disorder, and insomnia[6–8]. Moreover, a high level of stress and trauma-related disorders are byproducts of being isolated[5,9,10]. Moreover, factors like an extended period of isolation, fear of infection, uncertainty, disappointment, fatigue, stigma, inadequate data and information regarding the disease, insufficient supplies, and economic damage also negatively impact individuals' psychological wellbeing[11]. Psychosocial stressors like anxiety, stress, altered lifestyle with little to no social support, and fear may affect the pattern of sleep among individual often leading to sleep disorders [12,13].

Sleep is an essential physiological activity in keeping up with physical and mental wellbeing and better life quality[14,15]. Breach in the normal sleep cycle can lead to insufficient sleep and prolonged alertness, hence increasing the event of insomnia, nightmares, daytime instability, and fatigue[14]. Recent studies have shown that sleep disorders impact up to 1 in 4 adults[16]. They are also found to be associated with a wide range of adverse health outcomes, for example, increased risk of obesity, diabetes, hypertension, cerebrovascular diseases, malignancy, musculoskeletal diseases, septicemia, and metabolic syndrome[14,15,17]. Further evaluations have found that 50-70 million adults in the United States have at least one sleep disorder[16], while the prevalence of sleep disorders among the Australians and Netherlanders are 20-35% [18]and 27.3% [17]respectively. Potential risk factors of sleep disorders include severe stressful circumstances, depression, anxiety, trauma, low socioeconomic condition, urban living, increased use of technology, and social media[14,16,17].

A substantial amount of evidence suggests a high prevalence of various forms of sleep disorders in the global community. This situation is likely to worsen in the current circumstances with numerous psychological stressors. Many studies have reported a growing burden of a wide range of mental disorders, including sleep disorders[19]. However, to the best of our knowledge, there is a scarcity of concrete evidence on the magnitude of sleep disorders among individuals affected by this pandemic. As there is a growing concern on mental health problems during COVID-19 research synthesis may play a critical role in understanding the burden of those problems addressing the same[6,19]. This scoping review aims to address this knowledge gap through systematically evaluating the current evidence on the epidemiological burden of sleep disorders, associated factors, and interventions addressing the problems. The specific questions for this scoping review are listed below:

- What is the epidemiological burden of sleep disorders among different populations during COVID-19?
- What are the factors associated with sleep disorders during COVID-19?
- What are the available interventions for addressing sleep disorders amid COVID-19?

2. Methods and materials

This scoping review was conducted using the Joanna Briggs Institute (JBI) methodology for scoping reviews[20]. Moreover, the findings of this review are reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[21]. The protocol of this scoping review has been registered with The Open Science Framework[22].

2.1 Search strategy

We searched MEDLINE, Embase, Academic Search Ultimate, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science, and APA PsycInfo databases using the keywords with Boolean operators "AND/OR" as mentioned in Table 1. The search was first conducted on May 13th, 2020 and updated on August 12th, 2020.

Table 1: Search terms for this scoping review

Search terms	Keywords (searched within titles, abstracts, and subject headings fields)
1	"COVID-19" OR "2019-nCoV" OR "2019 coronavirus" OR "Wuhan coronavirus" OR "Wuhan virus" OR "Wuhan pneumonia" OR "2019 novel coronavirus" OR "novel coronavirus" OR "SARS-CoV-2"
2	"sleep" OR "sleep disturbances" OR "sleep disorders" OR "sleep problems" OR "insomnia" OR "circadian rhythm" OR "restless leg syndrome" OR "sleep apnea" OR "narcolepsy" OR "daytime dysfunction" OR "daytime sleepiness"
3	prevalence OR incidence OR epidemiology OR frequency OR case OR rate OR occurrence OR correlates OR determinants OR predictors OR "risk factors" OR "associate factors" OR interventions OR treatment OR therapy OR management
Final search strategy	1 AND 2 AND 3

The keywords were searched within the titles, abstracts, and subject headings fields. Moreover, as COVID-19 literature started to get published since late 2019, we limited our search within 2019 and 2020. Moreover, we searched the reference lists and citing articles in Google Scholar to identify additional articles that could have met our criteria.

2.2 Inclusion criteria

2.2.1 Participants

In this scoping review, we included participants irrespective of their sociodemographic conditions. This makes our review inclusive for all types of participants who fulfill remaining criteria of this review.

2.2.2 Concepts

This review focused on sleep disorders, which can be defined by the International Classification of Diseases or Diagnostic and Statistical Manual of Mental Disorders [23,24]. Moreover, sleep abnormalities expressed as insomnia, excessive sleepiness, poor sleep quality, and abnormal events that occur during sleep will also be considered as sleep disorders in this review [25]. Studies reporting the prevalence, incidence, frequency, score, level or any forms of quantitative assessment of sleep-related conditions were included in this review.

2.2.3 Context

This review especially emphasized on COVID-19 as the context. Therefore, studies conducted among populations affected by COVID-19 (doctors or patients) or population at risk (general population who could have had infected with COVID-19) were be considered in this review. Moreover, studies without mentioning relevance to COVID-19 were excluded from this review.

2.2.3 Types of sources

This review included original studies, cross-sectional or longitudinal in nature, published as peer-reviewed journal articles. Studies published in English language were included in this review. Therefore, unpublished works, non-original articles (for example, letters with no original research reports, editorials, reviews, commentaries etc.), non-peer reviewed articles, and studies in languages other than English were excluded from this review.

2.2.4 Study selection

After searching the databases, all the citations were imported to Rayyan QCRI, a cloud-based software for systematic reviews[26]. Two authors (ST and MR) independently evaluated those citations using the inclusion criteria of this review as stated earlier. At the end of independent screening, potential conflicts were reviewed and resolved based on discussion with a third author (MMH). Finally, the full texts of the included citations were assessed and articles meeting all the criteria were considered for data extraction. A flow chart of the study selection process is depicted in Figure 1.

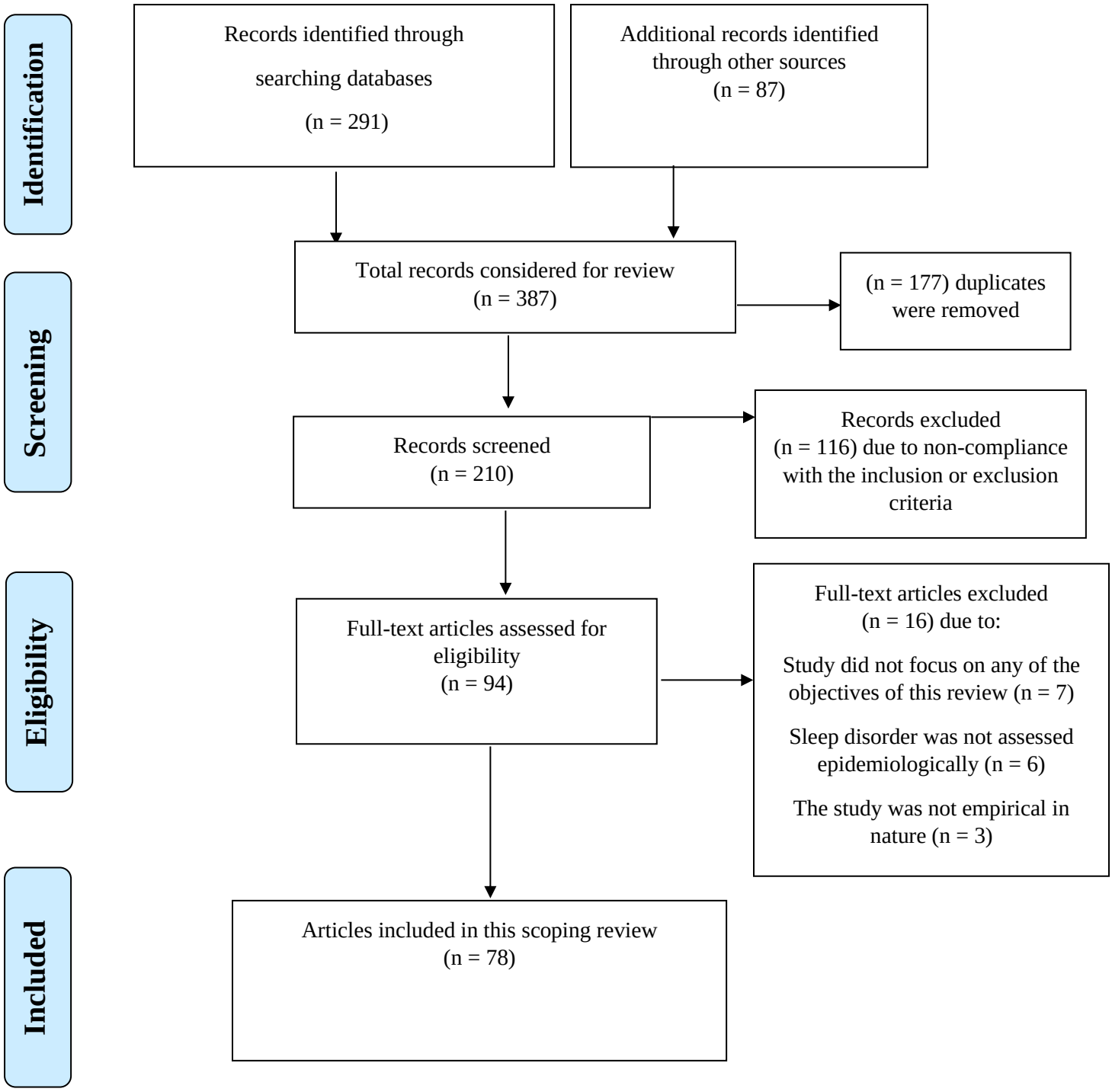

Figure 1: Flow diagram of the systematic scoping review

2.3 Data extraction

A data extraction form was prepared as shown in Table 2. Two authors (ST and MR) independently extracted data using this checklist. At the end of this phase, data for each article were reviewed by a third author to check consistency and potential conflicts were re-assessed by three reviewers and a consensus was made based on discussions. The finalized dataset was reviewed independently by two more co-authors (PP and AS) before final synthesis.

2.4 Data presentation

Data extracted from the included articles were narratively synthesized and presented using tables and a commentary on key findings on the study characteristics, samples, and epidemiological findings as the quantitative burden and associated factors of sleep disorders during COVID-19 and interventions addressing the same. As per the JBI methodology, scoping reviews do not aim to evaluate the quality of the studies. Therefore, no quality evaluation was done in this review.

Table 2: Data extraction instrument

Study information	**Title**
	Author(s)
	Year of publication
	Country of origin
	Type of the study
	Objective of the study
Information on study participants	Sample size
	Sample characteristics
	Recruitment strategy
Epidemiological data	Methodology of the study
	Timeframe of the study (with duration of exposure or intervention, if available)
	Prevalence or quantitative burden of sleep disorders
	Factors (if reported) associated with sleep disorders
	Interventions (if reported) addressing sleep disorders (components and outcomes, if available)
Citation of the article	Full citation of the article including digital object identifier (DOI)
References identified from the cited articles	Articles that were cited in an article or forward citations of that article that may meet the criteria of this review

3. Result:

We found 291 citations from searching the databases and 87 citations from additional sources, totaling 387 citations. After removing 177 duplicates, titles and abstracts of 210 articles were evaluated and 94 articles met the pre-set inclusion criteria. From the remaining articles 16 articles were removed after evaluating the full text. Finally, 78 articles met all criteria and were included in this scoping review.

3.1 Characteristics of the included studies:

3.1.1 Study design:

Most of the studies 82% (n = 64) were of cross-sectional design. For example, Zhang et al., 2020 conducted cross-sectional survey among the hospital workers in China. A few included studies (n = 6) were of cohort studies. For example, the study by Nalleballe et al., 2020[27] reported the findings from their cohort of patients of COVID-19. Remaining were case-control (n = 4) and pre-post study (n = 3) design.

3.1.2 Setting:

Almost half of the studies (n = 36, 46%) were based on community setting. For example, the study by Gao et al.,[28] recruited 699 American adult participants to find out the effects of the pandemic related lockdown on their mental health. However, other half of the studies (n = 37, 47%) recruited participants from hospitals or clinics. The study by Amerio et al.,[29] included general practitioners working in Genoa, Italy evaluate the mental health effects of the Covid-19 pandemic on the healthcare workers.

3.1.3 Geographical scope:

One third of the studies, (n = 25, 32%) were conducted in urban areas. For example, 76.5% of the participants recruited in the study by Voitsidis et al.,[30] were urban citizens. Similarly, the study by Xiao, Zhang, Kong, Li, & Yang et al.,[31] reported 89.4% participants were recruited from urban area. In 13.75% (n = 11) of the studies participants lived equally in urban and rural areas. For example, Renzo et al., [32] reported that the percentage of participants living in rural and urban areas were comparable. However, in a few studies (n = 18, 23%) participants also came from small towns or rural areas.

3.1.4 Country:

47.5% (n = 38) of the studies were conducted in China. The study by Fu et al.,[33] was based on Chinese population where they recruited participants from Wuhan, China. 8.75% (n = 7) of the studies were based on USA. Wright et al.,[34] was an observational study based on the university students of the USA. 8.75% (n = 7) of the studies were based on Italy. For example, the study by Gualano et al.,[35] was based on Italy.

3.1.5 Sample:

A large variation was noted in the sample size of the included studies. The sample size ranged from 26 to 40,469. Studies that provided intervention or conducted in-person assessments had a significantly smaller sample size. For example, Liu et al., [36] conducted a randomized control trial of progressive muscle relaxation for insomnia among the COVID-19 patients in a hospital setting and had a small sample size of 51 participants. Similarly, Korkmaz et al.,[37] conducted face to face evaluation of several mental health conditions of health care workers employed in service for COVID-19 and had a sample size of 140 participant only.

However, studies that utilized the online surveys to collect data had a relatively larger sample size. For example, S. J. Zhou et al.,[38] collected data from 11,835 participants in China via online survey forms.

3.1.6 Sampling technique:

65% of the studies (n = 51) mentioned specific sampling techniques. Among them, 35% of the studies (n = 27) used the convenient sampling technique to recruit the participants. For example, Diomidous,et al.,[39] used convenient sampling technique to include health care providers for their study. Some studies (n = 6) also used the random sampling technique. For example, Liu et al.,[36] randomly selected 51 patients from the list of patients with confirmed COVID-19 admitted to the Hainan General Hospital for participating in their study. A few studies used clustered sampling technique. For example, Abdulah and colleagues' [40] used the clustered sampling technique. They obtained a list of local physicians who work in different medical settings. The participants from one pediatric, one emergency, one special corona, and one maternity and gynecology hospital were invited to participate in their online survey.

3.1.7 Disorders investigated:

All the studies assessed insomnia/sleep disorder or quality of sleep. Most of the studies (n = 38, 49%) also investigated the level of anxiety among participants. For example, Mazza et al.,[41] assessed prevalence of anxiety among the COVID-19 survivors in Italy. Depression/depressive symptoms were assessed by 88 studies. For example, Huang et al.,[42] measured the burden of depression among Chinese public during the outbreak. Loneliness, suicidal ideation, somatic disorders, and Obsessive-Compulsive Disorder (OCD) were among other less frequently assessed disorders.

3.1.8 Mode of data collection:

85% of the studies (n = 66) collected data through online surveys. For example, W.D.S. et al.,[43] collected data using online surveys on different social media platforms. Similarly, J et al.,[44] collected data from the Chinese population using the WeChat (the most widely used mobile app). Only 7% of the studies utilized more than one means of data collection. For example, Renzo et al.,[32] collected data using face to face interview, online survey and from reviewing hospital records of the patients. Remaining studies (n = 6, 7%) collected data solely from face to face interviews. For example, Türkoğlu et al.,[45] collected data from in person evaluation of the children who participated in the study.

3.1.9 Screening instruments and cut off value:

Majority of the studies (n = 50, 64%) employed the PSQI for diagnosing the severity of the insomnia. For example, Huang & Zhao et al.,[42] used the Chinese version of PSQI whereas, the study by Innocenti et al.,[46] used the Italian version of PSQI among their participant. A little over half of the studies (n = 42, 53%) used the ISI scale for diagnosing insomnia. Gualano et al.,[35] used ISI scale to diagnose insomnia among the Italian population. Few studies (n = 15,19%) also utilized the AIS scale for diagnosis. For example, Tselebis et al.,[47] used AIS for diagnosing insomnia among COVID-19 survivors.

Majority of the studies used score of ≤ 7 for PSQI, ≤ 10 for ISI, and ≤ 6 for AIS scale as cut of value for diagnosing the severity of insomnia.

Author, Year	Study design	Setting	Level of education	Country	Population specifics	Mean age (years)	Disorder investigated	Mode of interview	Screening instrument	Cut off value	Sample size	% of males in the sample	Sampling technique	Key findings
Abdullah et al., 2020	Cross-sectional	Hospital/medical setting	Graduate/ Specialized	Iraq	Healthcare providers	35.06 ± 7.61	Insomnia and Anxiety	Online	AIS	6	400	70.10%	Clustered sampling	The mean sleep score of physicians were 8.43/24. More than two-thirds (68.3%) of the physicians were sleepless. Dealing with suspected or confirmed cases of COVID-19, increased stress and increase in number of days dealing with confirmed COVID cases had negative effect on sleep of the physicians.
Anzar et al., 2020	Cross-sectional	Community		Pakistan	General population	25 ± 0.4	Anxiety, Insomnia, Depression	Online	SPSQI	>18 in scale	303	32%	Not specified	Prevalence of sleep disturbance was 6.9%, Quality of sleep was reduced among males and health care workers
Batool-Anwat et., 2020	Retrospective cohort	Hospital/medical setting		USA	Patients of Obstructive sleep apnea	63.5± 13.9	Insomnia, Anxiety	Online and Record review			123	55%	Not specified	After the lockdown, there was an increase in the number of patients with insomnia (41 vs. 48%, p=0.02). Women had higher prevalence of insomnia
Beck et al., 2020	Cross-sectional	Community		France	Mix of COVID positive, suspected and healthy	26% <35	Insomnia	Online	Self-designed		1,005		Random stratified sampling	74% of the participants reported trouble sleeping compared with a prevalence rate of 49% in the last general population survey. Women reported more sleeping problems than men, with greater frequency or severity: 31% vs. 16% (1,005 subjects) reported trouble sleeping compared with a prevalence rate of 49% in the last general population survey. Younger population reported higher sleep disturbance compared to older population (79% vs 72%) and their sleep disturbance started after the lockdown and instate of sleeping pills increased after lockdown (41% vs 16%).
Bhargava et al., 2020	Cross-sectional	Hospital/medical setting	Post graduate	USA	Board-certified dermatologists		Insomnia, Stress, Depression, Mental distress	Online	Self-designed		733		Convenient sampling	30% of the responders reported of insomnia,
Zhang et al., 2020	Cross-sectional	Hospital/medical setting	Graduate	China	Hospital workers	Not reported	Insomnia	Online	ISI	≥8	1563	15%	Random sampling	36.1% reported insomnia. They found education level of high school or below (OR = 2.69), being a doctor (OR = 0.44),currently working in an isolation unit (OR = 1.71),worry about being infected (OR = 2.30,), perceived lack of

														helpfulness in terms of psychological support from news or social media with regard to COVID-19 (OR = 2.10), and having very strong uncertainty regarding effective disease control (OR = 3.30) were associated with insomnia.
Carrigan et al., 2020	Cross-sectional	Community	Graduate	UK	Individuals with dementia or care about the disease	59.2 ± 13.3	Insomnia	Online	PSQI	≥5	3,474	25%	Clustered sampling	44.8% reported of worsened sleep after the lockdown. Low mood, anxiety and suspected, proven or at risk of COVID-19 symptoms were significantly associated with worse sleep . Older people's sleep quality was less affected than younger people by COVID lockdown ($p<0.001$). Better sleep quality was associated with going outside and exercising earlier, rather than later.
Casagrande et al., 2020	Cross-sectional	Community	50% high school	Italy	General population	30.0± 11.5	Insomnia, Anxiety, General wellbeing	Online	PSQI	≥5	2291	25.30%	Convenient sampling	57.1% of participants reported poor sleep quality. Youth and women, those uncertain regarding possible COVID-19 infection, and greater fear of direct contact with those infected by COVID-19 had an increased risk of developing sleep disturbances. Sleep quality was related to GAD, PTSD related to COVID-19 symptom
Dai., 2020	Cross-sectional	Community	Bachelor	Malaysia	General population	30 years	Insomnia, Anxiety, Depression, Distress	Online	AIS	>5	669	48%	Stratified sampling based on location and cluster sampling from ethnic and religious groups	Perceived health conditions, perceived testing availability and age was predictor of insomnia.
Diomidous'2020	Cross-sectional	Hospital/medical setting	Graduate/Specialized	Greece	Healthcare providers	Not reported	Insomnia	Online	Jenkins sleep Scale, the Athens Insomnia Scale and the Sleep_50 Questionnaire.		204	Not reported	Convenient sampling	37.1% reported moderate and 3% reported severe insomnia. Waking up in the middle of the night and inadequate duration of sleeping was common complains. Lack of physical activity was associate with sleep disorders

Fu' et al., 2020	Cross-sectional	Community	Bachelor	Wuhan, China	General population		Anxiety, depression, Insomnia, and passive coping	Online	AIS	>5	1242	30%	Convenient sampling	30.0% had a sleep disorder. Being female (OR=1.62), having a monthly income between 1000 and 5000 CNY (OR= 2.61), not exercising (OR=1.85), having a higher education level (bachelor's degree and above) (OR = 1.40) were the risk factors for sleep disorder.
Gao et al., 2020	longitudinal, cross-sectional, and retrospective recall	Community		USA	General population	38.04 ±11.65	Insomnia	Online	PSQI	≥5	699	55.22%	Convenient sampling	Average sleep quality was unchanged, or even improved, earlier in the pandemic. However, approximately 25% of participants reported that their sleep quality had worsened, which was explained by stress vulnerability, caregiving, adverse life impact, shift work, and presence of COVID-19 symptoms.
Gaur et al., 2020	Cross-sectional	Community	Graduate	India	General population		Insomnia, Anxiety, General wellbeing	Online	ISI	≥10	1015	64%	Snowball sampling	Prevalence of depression was 27%. Living in urban areas, living alone and concern about livelihood were risk factors of insomnia.
Gualano et al., 2020	Cross-sectional	Community	Bachelor	Italy	General population	median age was 42 years (IQR = 23)	Insomnia, depression, anxiety	Online	ISI	≥10	1515	34.4	Convenient sampling	42.2% reported of sleep disturbances and, among them 17.4% were moderate/severe insomnia. . Increasing age, an absence of work-related troubles and being married or being a cohabitant reduced such a probability. Being females, spending an increased time on internet and having chronic conditions were associated with a higher prevalence of sleep disturbances.
Guo et al., 2020	Cross-sectional	Community	Bachelor	China	General population		Depression, PTSD, Insomnia	Online	PSQI	7	2441	41.40%	Quota sampling	Exposure to COVID-19 (OR=1.77), media news exposure and perceived negative income were associated with higher mental health problems
Gupta et al., 2020	Cross-sectional	Community	Graduate	India	General population	37.32 ±13.09	Insomnia	Online	ISI	>14	958	58.80%	Convenient sampling	10% of the group met the criteria for clinically significant insomnia according to ISI, compared to the pre-lockdown period, there was a shift to a later bedtime and waking time, with a reduction in night-time sleep and an increase in day-time napping. These effects mostly affected working individuals except health professionals. Sleep quality deteriorated across all occupational groups. Depressive symptoms were associated with reduction in duration of sleep.

Wang et al., 2020	Cross-sectional	Hospital	Graduate/ specialized	China	Health care workers		Insomnia, depression, anxiety	Online			1045	14.20%	Convenient sampling	The high-risk (o exposure) group had higher levels of clinical insomnia (13.5% v. 8.5%, p = 0.011) and then the low-risk group. Additionally, work experience negatively correlated with insomnia symptoms
Hao et al., 2020	Case-control study	Hospital	Bachelor	China	Psychiatric patients	32.8± 11.8	Depression, Anxiety, Stress and Insomnia	Online	ISI		185		Psychiatric patients from the databases of the First People's Hospital of Chongqing Liang Jiang New Area, China.	ISI scores were higher in psychiatric patients than healthy controls (p < 0.001). More than one-quarter of psychiatric patients suffered from moderately severe to severe insomnia. Respondents who reported no change, poor or worse physical health status and had a psychiatric illness were significantly more likely to have higher mean ISI scores.
Huang et ., 2020	Cross-sectional	Community	Bachelor	China	General population	35.3 ± 5.6	Depression, Anxiety and Insomnia	Online	CPSQI	7	7,236	45.40%	Participants from National Internet Survey on Emotional and Mental Health (NISEMH),	The overall prevalence of sleep quality was 18.2%. Compared with other occupational group, healthcare workers were more likely to have poor sleep quality.
Idrissi et al., 2020	Cross-sectional	Community	Bachelor	Morocco	General population	35.9 ± 12.5	Insomnia, Depression, Anxiety	Online	DBAS-16, AIS, ESS	DBAS ≥4, AIS ≥6, ESS ≥11	827	48.80%	Convenient sampling	56% reported insomnia, 9.9% reported daytime sleepiness. Insomnia score was higher in urban population (OR=2.09), people with chronic disease (OR=2.14)
Innocenti et al., 2020	Cross-sectional	Community	Bachelor	Italy	General population	46.6% in the 30–50 years range	Insomnia	Online	IPSQI	7	1035	17.10%	Convenient sampling	Participants reported of 1–2-hour delay in awakening and sleeping time than before the COVID-19 pandemic and to take longer to fall asleep (those taking > 1 h to fall asleep increased from 2.8 to 16%;). Nighttime awakenings also were reported to be increased (3 out of 4 people woke up early at least once a week vs. 4 out of 10 people before the COVID-19 pandemic) and increase in taking sleeping pills was also noted.

Wang et al., 2020	Cross-sectional	Community	Bachelor	China	General population	31.40 ±13.49	Insomnia	Online	PSQI	7	6437	43.87%	Snowball sampling	Incidence of sleep disturbance among residents was 17.65%. It was associated with older age (OR= 1.42), female gender (OR= 1.35), poor self-reported health status (OR=5.59), who believed COVID-19 was hard to cure (OR=1.73)
Juliana et al., 2020	Pre-post study	Community		Argentina	General population			Online	PSQI	7	1021		Convenient sampling	Sleep onset and offset were delayed during the lockdown, weekday sleep duration was longer. 37.30% of participants did not reach the recommended 7h of sleep on weekdays during the lockdown compared to 60.24% under control conditions.
Kokou-Kpolou et al., 2020	Cross-sectional	Community	Mixed	France	General population	30.06	Insomnia, Loneliness	Online	ISI	>15	556	25%	Purposive and snowball sampling	19.1% met the diagnostic criteria of clinical insomnia (ISI ≥ 15) with the mean total ISI scores of 9.2 (SD = 5.66) with. Individuals with postgraduate levels had reported lower levels of severity of insomnia than those with college (OR = 2.41,) and undergraduate (OR = 2.59) level education. Worries about the COVID-19 (OR = 1.39), fear of being infected by the virus (OR = 0.43), pre-existing mental health illness (OR = 1.22), and loneliness (OR = 0.41) increased the likelihood of being diagnosed with clinical insomnia.
Li et al., 2020	Cross-sectional	Community	Bachelor	Taiwan	General population	37.81 ± 11.00	Insomnia, Suicidal ideation	Online	Self-designed		1970	32.99%	Convenient sampling	55.8% of the participants reported sleep disturbance, Increased worry about COVID-19, more severe impact of COVID-19 on social interaction, lower perceived social support, more severe academic/occupational interference due to COVID-19, lower COVID-19-specified support, and poorer self-reported physical health were significantly associated with sleep disturbance.
Li et al., 2020	Case-control study	Medical staff	Bachelor	China	Medical staff and volunteers	20-40 years	Insomnia	Online	AIS			13.18%	Convenient sampling	The medical staff in Wuhan had higher insomnia than in Ningbo (58.9% vs. 24.97%; p = 0.001). The medical staff in Wuhan, the symptoms of insomnia were related to gender (OR = 1.379), education (OR = 1.54), and general psychological symptoms (OR = 2.124). Among the medical staff in Ningbo, insomnia was not only related to general psychological symptoms (OR = 1.60, P < 0.01, 95%CI = 1.48–1.74) but

														also related to marital status (OR = 0.57)
Li et al., 2020	Cross-sectional	Community		China		34.46 ± 9.62	Insomnia, Anxiety	Online	ISI	>7	3637	43%	Convenient sampling	The prevalence of insomnia increased significantly (ISI > 7, 26.2% vs 33.7%, P < .001); 13.6% developed new-onset insomnia and 12.5% reported worsened insomnia symptoms. Lengths of time in bed (485.5 ± 72.6 vs 531.5 ±94.2 minutes) and total sleep time (432.8 ± 65.6 vs 466.9 ± 95.6 minutes) increased significantly, and SE (88.5% vs 86.8%) decreased significantly. Delayed bedtime (25.6 ± 66.3 minutes) and wakeup time (71.7 ± 89.5 minutes) were also observed
Li et al., 2020	Cross-sectional	Community	Bachelor	China	Worker with income loss	26-40	Depression, anxiety, insomnia, and distress	Online and Face to face	CISI	>7	398	50.50%	Convenient sampling	Prevalence on insomnia 30.9%. Participants working in Hubei province with heavy income losses, especially pregnant women, were found to have a high risk of developing had severe insomnia
Lin et al., 2020	Cross-sectional	Community	Bachelor	China	General population	18-60	Depression, anxiety, insomnia, and stress	Online	ISI	>7	5461	29.90%	Convenient sampling	Threat of COVID-19, age <18, male, and living in Hubei province are significantly correlated with insomnia (p < 0.01) The prevalence of clinical insomnia during the outbreak was 20.05% according to the ISI. 20.01% participants spent more than one hour awake in bed.
Maciaszeck et al., 2020	Cross-sectional	Community	Graduate	Poland	60% health care workers	39.23 ± 12.26	Anxiety, insomnia, somatic symptoms	Online			2039	20%	Convenient sampling	Insomnia are more prevalent among medical staff than workers in other professions.
Marelli et al., 2020	Cross-sectional	Community	Highschool	Italy	university student and staff	22.84 ±2.68	Insomnia, Anxiety, depression	Online	IPSQI	7	400		Convenient sampling	Increase in bedtime hour, sleep latency, and wake-up time between before and during COVID-19 emergency and a worsening of sleep quality and of insomnia symptoms. In particular, during the lockdown, the impact of the delay in bedtime and in wake-up was more common among students. In workers the prevalence if insomnia was 40%, among them 42% reported difficulty in sleep initiation.
Mazza et al., 2020	Cross-sectional	Hospital		Italy	COVID-19 survivor	57.8	Anxiety, insomnia, depression, PTSD	Face to face and online	MOSSS, WHIIRS	>9	402	65%	Convenient sampling	According to self-report 40% was suffering from insomnia. Patients with any psychiatric symptoms had a higher immunological symptom

Pinto et al., 2020	Cross-sectional	Hospital		Portugal	Patients of sleep disordered breathing	63.9	Sleep quality/insomnia	Face to face and online	JSS		365	55.60%	Convenient sampling	69.6% reported at least one sleep difficulty and frequent awakenings was the most prevalent problem. They were associated with home confinement without working, female gender and diagnosed or suspected SDB. Older age was protective factor.
Qi et al., 2020	Cross-sectional	Hospital	Graduate	China	Medical workers	33.1 ± 8.4	Insomnia, Anxiety	Online	PSQI, AIS	6	3061	19.60%	Convenient sampling	Compared to non-Frontline Medical Workers, FMW had significantly higher scores of PSQI (9.3 ± 3.8 vs 7.5 ± 3.7; P < 0.001;), AIS (6.9 ± 4.3 vs 5.3 ± 3.8; P < 0.001;), higher sleep disturbance according to (78.4% vs 61.0%; relative risk [RR] 1⁄4 1.29; P < 0.001) and AIS > 6 points (51.7% vs 35.6%; RR 1⁄4 1.45; P < 0.001).
Que et al., 2020	Cross-sectional	Hospital	Graduate	China	Medical workers	31.06 ±6.99 years	Insomnia, Anxiety, depression	Online	ISI	>15	2285	30.94%	Convenient sampling	Prevalence of insomnia among HCW was 28.75%. Being in the frontline attention to negative or neutral information about the pandemic, receiving negative feedback from families and friends who joined front-line work, and unwillingness to join front-line work if given a free choice were three major factors for these problems.
Romero-Blanco et al., 2020	Longitudinal observational study	Hospital	Bachelor	Spain	Nursing students	20.6± 4.62	Insomnia	Online	PSQI	>7	207	19.4	Convenient sampling	The mean PSQI score worsened by 0.91. Sleep latency, sleep duration and sleep efficiency were most affected by lockdown.
Tan et al., 2020	Cross-sectional	Community	Bachelor	China	Returning workers	30.8 ± 7.4s	Insomnia, Anxiety, PTSD, Depression, Stress	Online	ISI	>7	673	74.40%	Convenient sampling	2.3% respondent reported of insomnia. Factors that were associated with the severity of psychiatric symptoms in the workforce were marital status (being single), presence of physical symptom, poor physical health and viewing return to work as a health hazard (p<0.005). experience of returning to work during the COVID-19 pandemic did not confer an increase in the prevalence of PTSD symptoms, depression, anxiety and stress
Tselebis et al., 2020	Cross-sectional	Hospital	Graduate	Greece	Nursing staff	42.29 ±10.73	Insomnia, Stress	Online	AIS	**6**	150	20%	Random sampling	49.7% patients reported of sleeping difficulties. AIS scores were positively correlated with stress and negatively correlated with family support. Perceived Stress Scale score and years of experience were significant predictors of AIS scores.

Turkoglu et al., 2020	Pre-post study	Hospital	School	Turkey	Children with ASD	7.89 years	Sleep disorder	Face to face	CSHQ	**<23**	46	82.00%	Convenient sampling	Sleep problems increased among children with ASD during home confinement. Severity of the problems were positively correlated with the severity of ASD symptoms.
Amerio et al., 2020	Web based Cross-sectional	Healthcare/Hospital	Graduate and above	Italy	Healthcare Providers	52.31 ± 12.24	Insomnia, generalized anxiety disorder	Online Survey	ISI	>7	131	51.90%	Convenient sampling	Sleep problems were detected in 37.6% of the participants. ISI was higher in female. Urban citizens scorer higher than rural residents. Other risk factors were intolerance to uncertainty, living in the pandemic, unaware of multiple aspects of this novel situation, loneliness, COVID-19 related worry, lack of opportunities of physical activity and exposure to natural environment.
Barghami et al., 2020	Cross-sectional	Hospital (outdoor and indoor)	Not reported	Iran	COVID-19 Patients	40.34 ±14.39 (hospitalized patients) and 43.62 ± 15.81(non-hospitalized patients)	Insomnia, general anxiety disorder, major depressive disorder, adjustment disorder	Mixed (online and phone interview)	Perceived Stress Scale-14 (PSS 14) questionnaires	>5	82	39.03%	Convenient sampling	Prevalence of insomnia 61.6%. The prevalence of sleep disorders was higher among the frontline healthcare workers compared to the non-frontline and non- medical staff. Risk factors were medical occupation, family burden, bereavement, anxiety, and depression
Cai et al., 2020	Case-control	Hospital/ Healthcare	Graduate and above	China	Frontline and non frontline medical workers	30.5 ± 8.7 (non frontline) and 30.6 ± 8.8 (frontline)	Insomnia, anxiety and depressive symptoms	Online Survey	ISI	>9	2346	29.7%	Convenient sampling	Prevalence of insomnia was 38% insomnia. Being an only child, exposure to COVID-19 patients and depression increase the risk of insomnia
Chandra et al., 2020	Cross-sectional	Community	Not reported	Nepal	Quarantined people	29.5± 9.77	Insomnia	Online survey		>7	206	53.40%	Not specified	Prevalence of insomnia 19.7%. Being female, married and current workload and stress was associated with insomnia
Direnzo et al., 2020	web-based	Community	Mixed	Italy	Quarantined people	48.5 years	Insomnia, depressed mood,	Electronic/ Onlin	Self - designed		602	19.90%	Not specified	The prevalence of insomnia disorder in the whole sample was 42.8%. Risk factors of insomnia was female

							hypochondria, anxiety	e Survey						gender, younger age, and higher fatigue and severe anxiety.
Jahrami et al., 2020	Cross sectional	Healthcare	Graduate and above	Bahrain	Healthcare workers	40.2 ± 9.7	Insomnia, stress	Online Survey	PSQI	≥5	257	30%	Purposive sampling	Duration of sleep increased on weekdays (Baseline = 7.9 ± 1.0 h, Stay-at-Home = 8.4 ± 1.1 h, $p < 0.0001$) and weekends (8.4 ± 1.5 h, 8.8 ± 1.2 h, $p < 0.05$) during Stay-at-Home
K Zhuo et al., 2020	Cohort study	Hospital	Graduate and above	China	Medical and nursing staff	41.92	Insomnia	Mixed (online and phone interview)	ISI	>7	26	53.84%	Convenient sampling	Levels of social support for medical staff were significantly associated with sleep quality
Killgore et al., 2020	Cross-sectional	Community	Not reported	United States	Quarantined people	26.5	Insomnia	Online	ISI	>7	1013	44.03%	Not specified	Higher level of social capital was positively associated with increased quality of sleep but anxiety and stress reduced the positive effects of social capital on sleep quality
Korkmaz et al., 2020	Cohort study	Hospital	Graduate and above	Turkey	Healthcare Workers	30.7 ± 6.2 (female), 35.6 ± 8.7 (male)	Insomnia, anxiety and depression symptoms	Face to Face/ Online/ Records data	PSQI	≥ 5	140	56%	Not specified	A total of 76.7% of the medically isolated population reported difficulty falling asleep while the corresponding rates among self-reported isolation (51.0%) and non-reported isolation groups (42.3%) were significantly lower. Risk factors: Fear of infection, isolation
Nallebelle et al., 2020	Cohort study	Individual	Not reported	United States	COVID-19 patients	49	Neuropsychiatric manifestations	N/A	None	N/A	40,469	45%	Not specified	The prevalence of insomnia among participants was 52.8% which was predicted by gender, working experience, chronic diseases, midday nap duration, direct participation in rescue of patients with COVID-19, frequency of night shifts, professional psychological assistance during the pandemic, negative experiences (such as family, friends, or colleagues being seriously ill or dying due to COVID-19), the degree of fear of COVID-19, fatigue, and stress
Patra et al., 2020	Observational, Cross sectional	Individual	Mixed	India	Quarantined people	Group A: 53.44, Group B:52.76	Stress, insomnia	Face to Face/ Online/ Records data	PSQI	>5	100	Group A: 30%, Group B: 50%	Random sampling	Prevalence of poor sleep quality was 14.9%. The average PSQI score was 3.0 ± 2.5 and average duration of sleep was 7.6 ± 1.2 h.. Older than 24 years, higher education level, negative attitude towards COVID-19 control measures, anxiety and depression was related to poor sleep. .

Salehinejad et al., 2020	Cross sectional	individual	Not reported	Iran	Quarantined people	25.79 ± 7.31	Insomnia	online	PSQI	3	160	14.38%		During the period of isolation patients of chronic insomnia, the average score of PSQI was 11.28 which was much higher than the baseline score, indicating worse sleep quality, higher anxiety scores and increased severity of somatic symptoms during the pandemic.
Song et al., 2020	cross-sectional	Community	Mixed	China	General Population	35.35	Insomnia, depression, somatic symptoms	online	ISI	≥8	709	25.80%	Convenient sampling	The prevalence of current insomnia (ISI score of ≥10) was 29.9%.The weighted prevalence of worsened sleep quality, difficulty in sleep initiation, and shortened sleep duration since the outbreak were 38.3%, 29.8%, and 29.1%, respectively. Insufficient stock of masks was significantly associated with worsened sleep quality, impaired sleep initiation, shortened sleep duration, and current insomnia.
Stojanov et al., 2020	Cross-sectional	Clinical center	Mixed	Siberia	Healthcare worker	Group 1- 39.1± 7.3, Group 2- 42.5± 9.7	Insomnia, generalized anxiety disorder, Depression	Online	PSQI	>7	201	not reported	Not specified	Prevalence of sleep disturbance was 55.6%. Compared to the previous sample, the preschoolers during the pandemic reported later bedtime and waking time, longer nocturnal sleep and shorter nap. Proper sleeping arrangement reduced electronic device use, harmonious family environment and increased interaction with parents were associated with less sleep disturbance.
Z Li et al., 2020	Cohort study	Hospital	Not reported	China	COVID-19 patients	50.5	Sleep disorder, respiratory disfunction, anxiety, depression	Face to face	designed questionnaire		280	51.80%	Convenient sampling	Compared with nonmedical health workers, health care workers had a higher prevalence of insomnia (38.4 vs. 30.5%). Among medical health workers, having organic disease was an independent factor for insomnia. Living in rural areas, being female, and being at risk of contact with COVID-19 patients were the most common risk factors for insomnia ($p < 0.01$ or 0.05).
Zhao et al., 2020	Cross-sectional	Healthcare	Not reported	China	Healthcare providers	not reported	Insomnia, anxiety, depression	online	ISI		972	Not reported	Not specified	Around one-third (36.38%) of participants reported of poor sleep during the COVID-19 pandemic. Higher perceived stress was significantly associated with higher anxiety levels, which, in turn, was associated with lower sleep quality. Self-esteem moderated the indirect effect of perceived stress on sleep quality

Zhi-hao Tu et al., 2020	Cross-sectional	Healthcare	Mixed	China	Healthcare providers	34.44	Insomnia, anxiety	Online	PSQI	≥ 7	100		Cluster sampling	Prevalence of insomnia was 23.3% during the COVID-19 pandemic. Female gender, urban dweller and having depression was risk factors of insomnia.
Voitsisis et al., 2020	Cross-sectional	Community	Not reported	Greece	Greek Population	Not reported	Insomnia	Online	AIS.	Not reported	2,427	23.80%	Not specified	Compared to pre-pandemic time, the severity of insomnia was less during the lockdown period (ISI score 6.6 vs 8.1) and significantly less participants reported of insomnia (34.4%) vs 50.3%).
W Wang et al., 2020	cross-sectional	Healthcare	Mixed	China	Healthcare workers (non-medical staff, frontline and non-frontline workers)	41.5	Insomnia, anxiety, depression	Online	PSQI	≥ 5.	2737	35.50%	Convenient sampling	Prevalence of insomnia was significantly higher among PHQ-9 ≥ 10 GPs compared to PHQ-9 <10. Insomnia 11.60 ± 5.53 vs. 4.84 ± 3.81 ; p<.001) Risk Factors: Spending more than 3 hours searching for Covid-19 related information, Inadequate PPEs, Visiting more Covid-19 infected patients. Interventions: providing continuity of care for patients at the community-level, adequate PPE to GPs and a clear guidance from public health institutions.
Wang et al., 2020	Cross-sectional	Children Healthcare Centre	Mixed	China	Healthcare workers (Doctor, Nurse)	33.75 ±8.41	Insomnia, anxiety, depression	Self-reported	PSQI	> 7	123	10%	Convenient sampling	Of the patients, 29.3% reported of insomnia. Hospitalization and being female were associated with higher risk of insomnia.
Wang et al., 2020	Cross-sectional	Healthcare	Mixed	China	Medical Staff	37	Insomnia, anxiety, depression	Online	PSQI.	> 5	274	22.60%	Not specified	Frontline medical workers had higher rates insomnia (47.8% vs. 29.1%) than non-frontline medical workers.
Wang et al., 2020	Cross sectional	Hospital	Mixed	China	COVID-19 inpatients	52.5	Insomnia	Online	CISI	≥ 8	484	49.8	Not specified	The sleep quality among Nepalese residents varied significantly before and after COVID-19 pandemic. Moderate insomnia increased from 2.9% to 16.5%. After the pandemic 11.7% reported of severe difficulty in falling asleep, 5.3% had difficulty in sleep maintenance, 12.6%had severe awakening problem, 16 subjects were dissatisfied with their sleep pattern, 7.8% of subjects had impaired quality of life, 3.9% of subjects were worried about their sleep problem. Female gender and age <45 years was

														associated with higher difficulties in sleeping.
Wright et al., 2020	Observational	University	Not reported	United States	University students	22.2 ± 1.7	Insomnia	Online			139	Not reported	Not specified	Prevalence of insomnia was 52.2%
Xiao et al., 2020	Observational, cross-sectional	Hospital/health care	Mixed	China	Medical Staff (doctor and nurse)	32.31 ±4.88	Insomnia, anxiety	Face to face	PSQI	≥ 20	180	28.30%	Not specified	Prevalence of insomnia 75%. The overall PSQI score was 7.0 ± 3.3. Female sex and medical doctor were risk factor of insomnia.
Xiao et al., 2020	Cross-sectional	Community	Mixed	China	Self-isolated individuals	37.78 ±4.12	Insomnia, anxiety	Online	PSQI	PSQI total scores ≥ 20	170	59.40%	Not specified	Insomnia is related with severe sleep apnea–hypopnea syndrome (SAHS). ISI was positively correlated with total sleep time (TST) and negatively correlated with deep sleep; SRQ-20 (OR= 1.51) and female sex (OR=1.15) were risk factors for insomnia with comorbid SAHS
Xingxing et al., 2020	Cross-sectional	Healthcare	Mixed	China	medical staff personnel	Not reported	Insomnia	Online	AIS	AIS score ≥6, SRQ-20 score ≥7	948 volunteered to Wuhan, 729 stayed at Ningbo)	22.02%	Not specified	56% of participants reported of some degree of insomnia, these levels are notably higher than historically seen in the general population. Greater worries over COVID-19 were significantly correlated with self-reported insomnia. Insomnia severity was also independently associated with elevated suicidal ideation.
Xue et al., 2020	Cohort study	Community	Mixed	China	Quranticned people	Not reported	Insomnia	Online			707	Not reported	Not specified	Prevalence of insomnia 34%
Y Zhan et al., 2020	Cross-sectional, descriptive	Healthcare	Not reported	China	frontline nurses from four tertiary-level general hospitals.	Not reported	Insomnia	Online	AIS	AIS score ≥6	1794	3%	Convenient sampling	Prevalence of sleep disorder was 3.4%
Yang et al., 2020	Cross sectional	Community	Mixed	China	Working individuals	36.3 ± 9.1	Insomnia	Online	CPSQI	>5	2,410	50.80%	Convenient sampling	Group chronic illness scored significantly higher than control, indicating poorer sleep quality among them.
Yang et al., 2020	Cross-sectional	Individual	Mixed	China	Insomnia patients	Not reported	Insomnia, anxiety	Online	PSQI		764	21.50%	Random sampling	Significant delay in bedtime, prolonged average time to fall asleep and longer

														average total duration of sleep during quarantine was reported.
Yu et al., 2020	Cross sectional	Community	Not reported	Hong kong	Chinese population	Not reported	Insomnia	Online	ISI	5-point Likert scale	1138	Not reported	Convenient sampling	Prevalence of insomnia 20.7%. Worrying about unemployment negatively affected, and psychological strengths (i.e., resilience and optimism) positively affected sleep.
Z Liu et al., 2020	Pre-post study						Sleep disorder	Online	CSHQ		1619		Convenient sampling	Generalized anxiety and overall mental health status were predictors of higher score in PSQI indication higher severity of insomnia.
Zhang et al., 2020	Cross-sectional	Healthcare and community	Mixed	China	Medical Health workers and non medical workers	Not reported	Insomnia, anxiety, somatic disorder, obsessive compulsive disorder	Online	ISI	ISI total score >8	2,182	35.80%		Prevalence of sleep disorder 63.6%
Zhao et al., 2020	Cross-sectional	Community	Mixed	China	Chinese population	29.17 ± 10.58	Insomnia, anxiety	Online	PSQI	PSQI score >5	1630		Not specified	39.1% of frontline workers had symptoms of insomnia on the ISI scale
Zhou et al., 2020	Cross-sectional	Community	School and college students	China	Adolescent and young adults	17.41 ±2.70	Insomnia, anxiety	Online	PSQI	PSQI score >5	11835	Not reported	Not specified	60% participants reported of poor sleep quality. Mean sleep duration was 5.71 hours (and mean sleep latency was 33.49minutes (SD=28.87). A total of 76%, 81%, 45%, and 19% reported difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS) or early morning awakening (EMA), nightmares and using hypnotics respectively.
Zhou et al., 2020	Cross-sectional	Community	Not reported	United States	Quarantined young adults	25.5	Insomnia	online	ISI	Total ISI score ≥8	208	36.10%	Exploratory	Intervention: Baduanjin Exercise twice daily under guidance of professionals. Signiant differences found in the Baduanjin group included a 43.9% lower ($p<0.001$) in the GAD-7 score and an approximately 75.9% higher ($p=0.003$) in SMH Sleep Questionnaire score compare with the control group at discharge.
Chen et al., 2020	Case-Control	Hospital	Not reported	China	COVID patients	Case-57.23 ± 14.37, Contr	Insomnia, anxiety	face to face	SMH Sleep Questionnaire		78	43.6%	Not specified	Intervention: Progressive muscle relaxation (PMR) technology for 30 min every day. The average sleep quality score (SRSS) of the two groups before intervention was not statistically

						ol-60.54 ± 16.34								significant (P 1⁄4 0.838), and it was statistically significant after intervention (P < 0.001).
Liu et al., 2020	RCT	Hospital	Not reported	China	COVID patients	50.41 ± 13.04	Insomnia, anxiety	face to face	SRSS		51	56%	Random sampling	The total average PSQI of the experimental group was 16.07±3.761, indicating that the sleep quality was poor. Among them, participants with moderate insomnia reached 61.67%, and participants with severe insomnia reached 26.67%.
Wu et al., 2020	Survey study	Hospital	Mixed	China	Frontline medical workers	Not reported	Somatization, depression, anxiety, insomnia	face to face	PSQI	PSQI score >7	120	26.7%	Convenient sampling	

*AIS= Athens Insomnia Scale, SPSQI= Short, ISI = Insomnia Severity Index, PSQI= Pittsburgh Sleep Quality index, CPSQI= Chinese Pittsburgh Sleep Quality index, DBAS-16= Dysfunctional Beliefs and Attitudes about Sleep, ESS= Epworth Sleepiness Scale, IPSQI= Italian Pittsburgh Sleep Quality index, CISI = Chinese Insomnia Severity Index, MOSSS = Medical Outcomes Study Sleep Scale, WHIIRS = Women's Health Initiative Insomnia Rating Scale, JSS= Jenkins Sleep Scale , CSHQ = Children's Sleep Habits Questionnaire, SRSS= Sleep State Self-Rating Scale (SRSS)

3.2 Characteristics of study population:

3.2.1 Education:

Most studies did not report stratified levels of education among the participants or recruited people with mixed education status. In 16.25% (n = 13) of studies, the participants had at least bachelor's degree. For example, according to Li et al.,[48] 88.37% of the participants had bachelor's degree. Only 20% (n = 16) of the studies included participants with graduate degree or above. According to Bhargava et al.,[49] all the participants included in the study were specialized doctors who had graduate degrees or above. Furthermore, 26.25% (n = 21) studies recruited participants with various level of education. For example, Dai et al.,[50] reported that, 60.69% of the recruited participants had undergraduate degree, 31.99% had graduate degree and 7.32% had high school degree.

3.2.2 Population Specifics:

Nearly one third (n = 22, 27.5%) studies were based on healthcare workers. For example, the study by Korkmaz et al.,[37] was conducted among nurses, physician and other health care staff in the hospital. One fourth of the studies (n = 20) focused on general population. For example, Innocenti et al.,[46] invited general populations of Italy to participate in their study. Alongside, 8.75% (n = 7) of the studies included only COVID-19 patients. Diomidous et al.,[39] included participants (n = 204) from Greece who were confirmed cases of COVID-19. A few studies, (n = 6, 7.5%) included only quarantined people. For example, Salehinejad et al.,[51] included participants who were quarantined at home during COVID-19.

3.2.3 Age:

Mean age ranged from 7.89 years to 63.9 years. Türkoğlu et al.,[45] included 46 children with autism spectrum disorder and the mean age of the participants in this study was 7.89 years. Pinto et al.,[52] a study based on Portugal population, included 365 participants in their study and the mean age of the participants was 63.9 years.

3.2.4 Gender (% of males):

The total percentage of male participants in the study varied widely. It ranged from 3% to 82%, with a median value of 37.5%. Nevertheless, in majority of the studies the percentage of

male participants were between 40%-60%. For example, Gupta et al.,[53] reported of 58% male participants whereas, Li et al.,[54] reported of 43% male participants.

3.3 Prevalence of sleep disorder:

The prevalence of sleep disorders varied across the samples. Ranging from 2.3% to 76.6% For example, Zhang et al.,[55] reported the overall prevalence of insomnia was as high as 76.6% among the medically isolated population. The prevalence rates varied across geographic regions of corresponding primary studies. For example, the prevalence of insomnia in the United States ranged between 20-41%. For example, 30% participants reported of some degree of insomnia in the study by Bhargava et al.,[49] in the USA. Whereas, a significant variation was noted in the prevalence of insomnia in Chinese population. Although only 2.3% of the Chinese workforce reported of insomnia[56], 58% of the frontline medical staff were suffering from insomnia[44]. Such variation was also noted in Italy, where the prevalence of insomnia ranged from 37.6% to 57%. For example, according to Casagrande et al.,[57] 57.1% participants in Italy had insomnia and poor sleep quality.

3.4 Factors associated with sleep disorders during COVID-19:

3.4.1 Sex:

20% of the studies (n =15) reported that females had a higher risk of some degree of insomnia. For example, Batool-Anwar et al.,[58] reported that stratification by gender revealed worsening insomnia only among women. However, two studies also reported that males had higher risk of insomnia. For example, male participants in the study by Anzar et al.,[59] reported higher prevalence of insomnia and poor sleep quality.

3.4.2 Age:

Only 7 studies reported that younger population had worse sleep compared to their older counterpart. For example. Beck et al.,[60] mentioned that, younger population reported higher sleep disturbance compared to older population (79% vs 72%). Nevertheless, 4 studies reported of poor sleep among the older population as well. For example, Wang et al.,[61] reported that older population had 1.42 times higher risk of insomnia.

3.4.3 Education:

Several studies found that level of education was associated with worse sleep. Zhang et al.,[62] reported that education level of high school or below increased the risk of insomnia but [33] reported that participants having higher educational level had worse sleep.

3.4.4 Social support:

Social support was an important factor associated with sleep. Four studies reported that those with lack of social support had higher prevalence of insomnia and poor quality of sleep. For example, Tselebi et al.,[47] reported participants with lack of family support had higher level of insomnia. Individuals in isolation[52], living alone[63] suffering from loneliness[64] or being single [44] also reported of high degree of insomnia. This further emphasizes the impact of social support on sleep.

3.4.5 Physical health:

Individuals with preexisting chronic disease (n = 4) and perceived poor health (n = 5) suffered from higher prevalence of insomnia.

3.4.6 Mental health:

Insomnia worsened among patients with preexisting psychiatric illness (n = 4). Stress (n = 6), anxiety(n = 8), depression (n = 4), fatigue Zhang et al., [62] and low mood Carrigan et al.,[65] was also found to be associated with poor sleep.

3.4.7 Lack of Physical activity:

Three studies reported that reduced opportunities of physical activities were associated with poor sleep among participants.

3.4.8 Being Health Care Worker:

Nearly 13% (n =10) of the studies reported that, health care workers were at risk of some degree of insomnia. For example, Anzar et al.,[59] reported that HCW had not only a higher prevalence of insomnia but also had reduced quality of sleep.

Four studies reported that the health care workers at risk of contracting COVID-19 had poor sleep quality. For example, Carrigan et al.,[65] found that, being at risk of CVID-19 at work lowers the quality of sleep. Zhang et al.,[62]also found that working in the isolation unit impaired

the sleep cycle among HCWs. Frontline medical workers suffered from higher level of insomnia compared to non-frontline workers. For example, Qi et al.,[66] reported that Frontline worker in the Wuhan, China (epicenter of the outbreak in China) scored significantly higher in the PSQI scale compared to non-front liners in Ningbo. Shift work [28], reluctance to join the frontline [67] and higher burden of work [68] also played an important role in sleeping.

3.4.9 Factors Specific to COVID-19:

Two studies reported that patients suffering from COVID-19 reported poor quality of sleep. Fear of COVID-19 (n = 2) and worry about the disease (n = 5) also affected the quality of sleep. Uncertainty due to the pandemic (n = 5), negative attitude toward control measures such as wearing mask [69] and lack of availability of testing [50] were the other factors specific to COVID-19 associated with sleep.

3.4.10 Factors related to work:

Several factors related to employment also impacted sleep significantly. One study found that people with low income had higher risk of sleep disorder compared to their high-income counterparts[33]. Worrying about impact of this pandemic on livelihood, possible negative impact on their income was also associated with sleep disorders[63]. One study mentioned that being at home without any work also impaired regular sleep cycle[52]. On the contrary, stress for returning to work after the lockdown did not impair sleep[56].

3.5 Interventions for sleep disorders:

There were only two interventions for sleep disorders. The study by Chen et al.,[70] was conducted among COVID-2019 patients, where the intervention group performed Baduanjin exercise (traditional Chinese mind-body exercise routine) under professional guidance and the controls received usual care. Their anxiety and insomnia level was measured using GAD-7 and SMH Sleep questionnaire at baseline and discharge. Although there was no significant difference among these groups at baseline, intervention group showed 44% lower score ($P<0.001$) in GAD and 76% lower score ($P=0.003$) in the SMH Sleep questionnaire at discharge which indicated that Baduanjin exercise can be beneficial for improving anxiety and insomnia among COVID-19 patients.

In the randomized controlled clinical trial by Liu et al.,[36] patients with COVID-19 patients who entered the isolation ward were randomly divided into experimental and control groups where the experimental group used progressive muscle relaxation (PMR) technology for 30 min per day for 5 consecutive days and the control group received only routine care and treatment. The Spielberger State-Trait Anxiety Scale (STAI) and Sleep State Self-Rating Scale (SRSS) were used to measure and record patient anxiety and sleep quality pre and post intervention. Both the group had comparable scores before intervention however, STAI and SRSS scores reduces significantly after intervention (P <0.001).

4. Discussion:

4.1 Overview of the synthesized findings

After a thorough review of the available evidence, there were 78 studies that met the pre-set criteria of this scoping review. Most of the studies included were cross-sectional in design, and online questionnaires were the common mode of data collection. Studies were conducted both in the community and hospital settings. Most of the studies on sleep disorders were conducted in China or the USA. Insomnia, anxiety, and depression were commonly assessed disorders, and PSQI, ISIS, and AIS were used to evaluate insomnia and sleep quality. The findings from these existing literatures inform a high burden of sleep disorder during this pandemic. The prevalence of sleep disorder varied widely across the samples and ranged from 2.3% - 76.6%. The majority of the studies reported females had a higher risk of some degree of insomnia. Although older adults generally have a higher rate of insomnia, many studies have reported that younger generations were having difficulties with sleeping during the pandemic. Covariates-adjusted research was limited which could explain how age played a role in sleep patterns among the study samples. Moreover, the education level was also associated with sleep disorders, but there was ambiguity regarding the specific educational status. Both higher education and high school level education were found to impact sleep. This can be attributable to the fact the educated individuals or students may have academic and professional stressors that may have impacted their mental health and sleep conditions[71–73]. Furthermore, social support was found to have a critical role in sleep status and associated disorders. Lack of social support, family support, living alone, and isolation was associated with a higher risk of sleep disorders.

This review also found that comorbid physical and mental illness increased the risks of insomnia. Health care workers, especially those serving the frontline, were at high risk of insomnia during the COVID-19 pandemic. Increased workload, shift work, fear of contracting the virus were the significant risk factors among the HCW. This might have resulted in higher psychosocial stress and burnout, which can be associated with sleep disorders among the frontlines[74]. The fear of contracting the virus, worry about the disease, uncertainty regarding treatment and prevention measures, and negative attitude toward control measures were COVID-19 specific risk factors for sleep disorders. Other related factors were lack of opportunity for physical activity, fear of the negative impact on income, and staying at home without employment. Only two interventions were identified, which focused either on baduanjin exercise (as one of the traditional Chinese mind-body exercise) or progressive muscular reaction. Both reported significant improvement on sleep score after the intervention [75,76]

The findings of this current review are comparable with the previous literature. Our review reports a considerably higher prevalence of both insomnia and insomnia symptoms higher during this pandemic. Several reviews have also reported higher prevalence after stressful events like stroke, chronic injuries[77]. The current review reports that females were at higher risk on insomnia and many studies have found that female are at high risk several mental illnesses such as anxiety and depression[78].

Despite the lack of accurate normative data on evolution of sleep architecture with age, several studies suggest that sleep patterns of the individuals change across the lifespan. In older adults have a significant delay in sleep latency and decrease in total REM sleep[79]. These findings suggest that older adults have more problems with sleep compared to the younger population. However, several studies included in this review reported that younger population had more trouble with sleep. This could be explained by the preexisting and emerging academic and processional uncertainty and the mental stressors amid this pandemic.

Our findings are also in line with evidence suggesting that individuals with insomnia have a higher risk of psychiatric disorders and sleep disturbances may facilitate the onset of several mental health illness. Many studies have reported that there is a bidirectional relationship between anxiety, depression and insomnia[80]. In this circumstance high rate of insomnia among individuals with preexisting psychological was unsurprising.

Our review shed light on the high prevalence of insomnia and sleep disturbances among health care workers especially those in frontline. Studies from previous major outbreaks of SARS, MERS have also reported of elevation of psychological distress among HCW during and after the outbreak which interfered with their social and occupational functioning[81–83]. We need to learn from the history and intervene at the early stage to support these HCWs.

Limitations of the review

This scoping review has several limitations. The foremost limitation of the current literature is that most studies are cross-sectional or longitudinal design, most of which did not collect data before the onset of the pandemic to provide a comparative picture of the situation. The limited number of studies reporting prevalence at multiple time points made it difficult to determine how the insomnia status of individuals changed over time.

To investigate temporality and establish causal relationships, risk factors should be captured before the inception of the disease. Owing to this, causal relationship was not established. Therefore, the conclusion of this scoping review is limited to demonstrating association only.

Additionally, there is a risk of potential selection bias as we did not search all the databases and excluded unpublished studies, reports, and studies in languages other than English. Moreover, there could be a publication bias within the scientific literature as less significant findings are less likely to get published, thus may not contribute to the evidence base. Furthermore, we did not conduct a quantitative evaluation of the patient-level data, which could have eliminated within-study and between-study variations to provide uniform prevalence estimations across samples.

Another notable limitation of this review was limiting the search strategy within bibliometric databases, whereas a major proportion of the literature can be available on preprint servers. As we aimed to synthesize the peer-reviewed empirical research, we did not search the preprint sources that might have had early stage findings rather than peer-reviewed articles. Lastly, as most studies were conducted in China and the USA, our findings' generalizability may be limited because of the wide variation of cultural norms and the healthcare system across the globe. Sleep disorders and co-morbid mental health problems may be highly prevalent in people living in low-income countries that are underrepresented in the existing studies[84,85]. Also, people with preexisting neuropsychiatric conditions or psychosocial vulnerabilities may experience a

disproportionate burden of sleep disorders, that is yet to be examined through empirical research. Our review may not have captured the epidemiology of sleep disorders in those marginalized populations.

4.2 *Implications for future research*

The evidence landscape on COVID-19 and associated mental health problems has been changing rapidly[86,87]. This scoping review examined the epidemiological aspects of sleep disorders. As this review includes literature up to August 12, 2020, the synthesized evidence can be different from those studies published after that date, or those research that are being conducted now. However, as the goal of a scoping review is to chart the initial evidence in a scientific topic, the findings if this review can serve as the basis of future research focusing on specific subtopics of sleep disorders amid this pandemic. Such areas can be examined using specific methods appropriate for respective research objectives.

As most studies in this review were cross-sectional in nature, future studies should adopt longitudinal designs that may explore how the magnitude and correlators of sleep disorders evolve over time. Moreover, it is essential to examine the comorbid physical and mental health problems that are associated with sleep disorders (Hossain et al., 2020). Understanding the syndemic effects of multiple health problems may better inform why the prevalence and risk factors of sleep disorders may vary across samples[88,89]. Furthermore, it is essential to examine the mental health problems associated with sleep disorders in high risk populations such as those with neurodevelopmental disorders or social-economically marginalized populations. Evaluating the Epidemiology of sleep disorders in diverse population groups through cohort studies may provide valuable insights not only during this pandemic but also how different populations may experience unique psychosocial challenges during public health emergencies.

One of the notable findings of this review was the use of multiple scales for assessing sleep disorders as well as associated mental health problems. Many scholars have adopted previous scales, where is several new scales were introduced during this pandemic[90]. It is essential to conduct extensive factor analysis evaluating the appropriateness of multiple skills so that future research can be conducted using standardized scales and measurements. such efforts may provide a more accurate scenario of the epidemiology of sleep disorders.

The emergence of online data collection measures may provide easy access to people who may use those platforms; however, people with digital divide may not participate in such studies[91,92]. it is essential to consider such limitations of the existing research efforts and design inclusive methodology's that may include diverse populations. In future research, measurements on psychosocial health outcomes including sleep disorders can be included in primary care and hospital health records that may offer valuable information on sleep disorders and other mental health problems. Nonetheless, Population based research exploring health and social aspects of COVID-19 may include instruments measuring the impacts of this pandemic on sleep behavior in different populations. Such approaches may improve the research production and the quality of data on Epidemiology of sleep disorders during this pandemic.

4.3 *Implications for mental health policymaking and practice*

This review examined the Epidemiology of sleep disorders, which may provide meaningful insights for mental health policy making and practice. The ongoing interventions and preventive measures adopted in different contexts should revisit the components that may influence sleep outcomes across populations. Institutional and local policies and programs on mental health should not only target mental disorders such as anxiety and depression, but also emphasize on sleep disorders that are highly prevalent in COVID-19 affected populations. Specific provisions should be made to prevent, diagnose, and treat sleep disorders. The emergence of telemedicine and online support systems provide unique opportunities from a public mental health perspective[93]. such services should be developed and implemented considering the burden and risk factors of sleep disorders during this pandemic. psychiatrists and psychologists may access over arcing risk and protective factors of sleep disorders and other mental health problems that can be managed using cost effective and evidence-based approaches. It is necessary to adopt such guidelines and services in psychosocial care policies and programs in different contexts. such measures can be customized using local mental health data considering the available mental health resources in those contexts. Furthermore, pandemic preparedness and mental health action plans should be informed by the epidemiological evidence on sleep disorders that may potentially impact the health and well being of health care providers, hospitalized patients, informal caregivers, and population at risk during COVID-19 pandemic.

Evidence-based pharmacological and psychosocial interventions have paramount importance for addressing sleep disorders. However, despite the elaborate searching through the databases, only two interventions were identified that focused on improving insomnia during the pandemic. Both of these interventions took place inside hospitals among patients admitted with COVID-19. Whereas, our review indicates a high prevalence of insomnia among patients, HCW as well as the general population. This necessitates community-based interventions to improve sleep among the target population. Mental health practitioners may access the relevance and appropriateness of existing interventions that may help during this pandemic. It is essential to conduct implementation research examining the effectiveness and efficiency of available interventions and develop newer interventions that may target specific psychosocial stressors for sleep disorders during this pandemic.

The findings of this review, emphasizes the need for early detection and effective treatment all the symptoms of insomnia, including the mild ones, before they evolve to more complex and evokes enduring psychological responses. Current knowledge of prevalence, type and comorbidities of prevalence, symptom profiles and comorbidities of insomnia should be utilized and tailored interventions targeting the behavioral components should be further developed to address the issue.

It has been evident that there is widespread of insomnia among the general population in this pandemic. All patients coming in contact with health care facilities should be screened, and those diagnosed with any form of insomnia should be referred to appropriate resources. As healthcare workers reported a higher burden of insomnia, specific interventions designed for addressing the problems at health care facilities should be available. The majority of health care workers are overburdened. If their optimal health and wellness are not ensured, their ability to work will be further compromised impose a severe predicament on the current fragile healthcare system.

Cognitive behavioral therapy for insomnia (CBT-I) is the treatment of choice for insomnia. A systematic review and meta-analysis of RCTs reported that, CBI-I is the effective mode of treatment for insomnia capable of producing clinically meaningful effect size with no identifiable adverse effects[94]. Several studies have also shown small to large effects on efficiency and quality and sleep onset latency along with reduction in severity of insomnia, wake after sleep onset and

number of awakenings[95]. Moreover, a full economic evaluation of CBT-I in adult populations revealed CBT-I was cost-effective compared to pharmacotherapy or no treatment. Thus, incorporation of some form of CBT-I in clinical practice will improve the overall sleep status of the population.

If the delivery of in-person CBT-I is not possible due to the social distancing measures for preventing the spread of the virus, similar interventions can be delivered using the virtual platforms. CBT-I delivered though internet or computer was also found to be as effective and a viable alternative in the current context [96–98]. Alongside, other avenues of telepsychiatry such as virtual clinics, remotely delivered psychotherapies, psychoeducation, 24/7 chat lines and digital monitoring should also be explored.

For areas with poor internet connection or individuals who are not accustomed with modern intervention formats, self-help books may be an effective alternative which could possibly reduce ensure standardization of care, quality control and optimal resource utilization[99].

Accumulating evidence show that exercise and dietary interventions are associated with improved quality of sleep. A large RCT conducted in China reported that low fat diet and increased amount of exercise resulted in improved sleep by altering the metabolic pathways. Future intervention research should focus on how lifestyle-based interventions can impact sleep quality and overall mental health in different populations at risk. It is critical to assess the risk and protective factors that can be used to develop mental health promotion programs that potentially prevent sleep disorders among the vulnerable individuals. The scope of digital interventions , peer support groups community-based mental health services, self-management programs, And public mental health resources should be evaluated for promoting mental health and preventing sleep disorders across populations.

5. Conclusions:

Amid this global pandemic burden of mental health issues are becoming a growing concern in addition to infection control. Sleep disorders are significant mental health problems associated with increased psychosocial stressors. Findings from this review suggest a high burden of sleep disorder across different population groups. Female gender, younger population, HCWs, COVID-19 related stressors were the major factors associated with sleep disorder identified in this review.

Despite the high burden, a limited number of interventions were identified to address this problem. Early diagnosis of sleep disorder and adequate treatment is crucial to prevent further worsening of the condition. Evidence-based pharmacological and psychosocial interventions have paramount importance for addressing sleep disorders. Future studies should explore interventions that utilize digital platforms and adopt innovative strategies in order to ensure increased outreach and sustainability.

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