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Review Article

COVID-19 pandemic and mental health consequences: Systematic review of the current evidence

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ABSTRACT

Background: During the COVID-19 pandemic general medical complications have received the most attention, whereas only few studies address the potential direct effect on mental health of SARS-CoV-2 and the neurotropic potential. Furthermore, the indirect effects of the pandemic on general mental health are of increasing concern, particularly since the SARS-CoV-1 epidemic (2002–2003) was associated with psychiatric complications.

Methods: We systematically searched the database Pubmed including studies measuring psychiatric symptoms or morbidities associated with COVID-19 among infected patients and among none infected groups the latter divided in psychiatric patients, health care workers and non-health care workers.

Results: A total of 43 studies were included. Out of these, only two studies evaluated patients with confirmed COVID-19 infection, whereas 41 evaluated the indirect effect of the pandemic (2 on patients with preexisting psychiatric disorders, 20 on medical health care workers, and 19 on the general public). 18 of the studies were case-control studies/compared to norm, while 25 of the studies had no control groups. The two studies investigating COVID-19 patients found a high level of post-traumatic stress symptoms (PTSS) (96.2%) and significantly higher level of depressive symptoms ($p = 0.016$). Patients with preexisting psychiatric disorders reported worsening of psychiatric symptoms. Studies investigating health care workers found increased depression/depressive symptoms, anxiety, psychological distress and poor sleep quality. Studies of the general public revealed lower psychological well-being and higher scores of anxiety and depression compared to before COVID-19, while no difference when comparing these symptoms in the initial phase of the outbreak to four weeks later. A variety of factors were associated with higher risk of psychiatric symptoms and/or low psychological well-being including female gender, poor-self-related health and relatives with COVID-19.

Conclusion: Research evaluating the direct neuropsychiatric consequences and the indirect effects on mental health is highly needed to improve treatment, mental health care planning and for preventive measures during potential subsequent pandemics.

1. Introduction

The world is currently facing the COVID-19 pandemic with a novel corona virus, SARS-CoV-2, initially observed in Wuhan, Hubei, China in the end of 2019 (Huang et al., 2020a). The reported symptoms of COVID-19 are primarily respiratory with acute respiratory distress syndrome ultimately leading to dead in the most severe cases (Fu et al., 2020). However, COVID-19 have also been shown to affect other organs, including the brain, and recently reports on neurological symptoms due to COVID-19 infection are emerging (Haldrup et al., 2020; Stripp and Sondergaard, 2020; Filatov et al., 2020; Asadi-Pooya and Simani, 2020; Nath, 2020). There are indications of neurotropic properties of SARS-CoV-2; however, yet little appears to be known about the exact mechanisms on how it affects brain functioning (Troyer et al., 2020).

COVID-19 is a betacoronavirus (Lu et al., 2020a) and knowledge from other outbreaks with viruses from the corona family, like SARS-CoV-1 (Cui et al., 2019), can now be useful, despite differences between the viruses. Psychiatric symptoms including posttraumatic stress symptoms (PTSS)/posttraumatic stress disorder (PTSD), anxiety and depression among patients with SARS-CoV-1 have been reported during the SARS epidemic (Cheng et al., 2004a; Chua et al., 2004) and after

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1 month (Cheng et al., 2004b; Wu et al., 2005), 1 year (Lee et al., 2007) and 30 months and longer (Mak et al., 2009; Lam et al., 2009). Also psychiatric symptoms of PTSD, depression and anxiety have been described among health care workers during (Lin et al., 2007) and 2 months (Verma et al., 2004); 2 (Lancee et al., 2008) and 3 years (Liu et al., 2012) after the SARS epidemic as well as among the general public during (Hawryluck et al., 2004) and after the epidemic (Ko et al., 2006; Peng et al., 2010).

We aimed to systematically review the literature in order to provide an overview of the psychiatric complications to COVID-19 infection (direct effect) and how COVID-19 are currently affecting mental health among psychiatric patients and general public (indirect effect) alongside with factors altering the risk of psychiatric symptoms in both groups.

2. Material and methods

2.1. Eligibility criteria

The following studies were included:

1. Studies reporting psychiatric symptoms/morbidity of patients with current or prior SARS-CoV-2 infection.
2. Studies reporting psychiatric symptoms/morbidity of psychiatric patients during the COVID-19 pandemic
3. Studies measuring psychiatric symptoms/morbidity/mental health during the COVID-19 in uninfected/not known to be infected participants, divided in health care workers and non-health care workers

Papers with psychiatric symptoms/morbidity in the elderly (including dementia), children/adolescents (including Attention Deficit Hyperactivity Disorder and autism), substance abuse and somatic disease as primary outcome were not included.

2.2. Information sources

Studies were identified by searching the database PubMed. Only papers published in English were included. The publication period was unlimited. The search was performed at the May 10, 2020.

2.3. Search string

(Psychiatry OR “mental health disorders” OR “mental health”) AND (COVID-19 OR SARS-CoV-2)

2.4. Study selection

One investigator (NV) screened titles and abstracts to exclude obviously irrelevant articles and further examined the remaining full text reports to determine compliance with inclusion criteria. One investigator (NV) screened relevant reviews for additional trials and NV examined full text reports of these additional records. The study selection process is illustrated in Supplementary Fig. 1.

2.5. Data collection process

The data extraction was carried out by one investigator (NV) but repeated.

2.6. Data items

We sought for the following information in the full-text records: journal information (authors and year of publication), study design and instruments, number of participants, demographics (sex, age, employment (health-care/non-health care)), psychiatric symptoms/morbidity, risk factors/factors associated with psychiatric symptoms/morbidity and infectious status (currently infected, previously infected, no history of infection).

3. Results

The initial search resulted in 460 hits and additional 4 papers were identified from the references in reviews from the search. Of these 101 were included for full text review leading to inclusion of 43 papers (Tables 1 and 2). Out of these, two papers evaluated patients with confirmed COVID-19 infection, and 41 the indirect effect of the pandemic (2 on patients with preexisting psychiatric disorders, 20 on medical health care workers and 19 on the general public). 18 of the studies were case-control studies or compared to norms, while 25 of the studies had no control groups.

3.1. Patients with COVID-19

Only two papers (Bo et al., 2020; Zhang et al., 2020a) reported on psychiatric symptoms among patients with COVID-19. The first study showed that PTSS were present among 96.2% out of 714 hospitalized but stabile patients. The second study showed that the prevalence of depression (29.2%) was elevated ($p = 0.016$) among 57 patients newly recovered from COVID-19 compared to participants in quarantine (9.8%), while no difference in anxiety level was found ($P = 0.154$).

3.2. Patients with psychiatric disorders prior to and during COVID-19

One study evaluated symptoms of patients with eating disorders during the pandemic and found 37.5% to report worsening in their eating disorder symptomatology and 56.2% to report additional anxiety symptoms (Fernandez-Aranda et al., 2020), while another study reported that 20.9% of patients with preexisting psychiatric disorders reported worsening of their symptoms, but did not report the preexisting diagnoses (Zhou et al., 2020).

3.3. Psychiatric symptoms/psychological distress among health care workers

Among health care workers depression/depressive symptoms (six papers) and anxiety (eight papers) were increased (compared to norms (Chen et al., 2020; Mo et al., 2020), administrative staff (Lu et al., 2020b; Zhang et al., 2020b), when the pandemic was under control (Xu et al., 2020), or to experienced staff (Cai et al., 2020), while two papers found no difference (compared to the general public (Huang and Zhao, 2020) and non-frontline workers (Liang et al., 2020)). Poor sleep quality was found among health care workers compared to norms (Xiao et al., 2020a). No difference in PTSS was observed (Sun et al., 2020), and Vicarious traumatization scale scores were actually less elevated ($P < 0.001$) when comparing to the general public (Li et al., 2020a). Higher levels of obsessive–compulsive disorder symptoms were reported in medical health workers compared to non-medical staff (Zhang et al., 2020b).

3.4. Psychiatric symptoms/psychological distress among the general public

Regarding the general public one paper revealed lower psychological well-being (WHO-5) compared to before COVID-19 (Sonderskov et al., 2020), and one study revealed increased use of words as emotional indicators of anxiety and depression (on Weibo), when compared to prior to the outbreak (Li et al., 2020b). Furthermore a study of parents of children hospitalized during the epidemic period had significant higher scores of anxiety, depression and dream anxiety compared to parents of children hospitalized in the non-epidemic period (all $p < 0.001$) (Yuan et al., 2020). However, a study found no significant difference in anxiety, depression or stress symptoms when comparing

Table 1
Studies of psychiatric symptoms/disorders during the COVID-19 pandemic among patients with COVID-19, psychiatric patients and health-care workers.

Reference	*Design* (study instruments)	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/ morbidity	COVID-19 status	Main findings
A. Patients with COVID-19									
Zhang et al., 2020a	*Case-control* App-based, anonymous questionnaire (GAD-7, GHQ-9)	205	50.9	46.9	China, Guangdong	No	Anxiety, depression	Infected (n = 57) Quarantine (n = 50) Unknown (=98)	Infected: increased prevalence of depression (29.2%) compared to the individuals under quarantine (p = 0.016). No difference compared to the general public. No difference in anxiety between groups (p = 0.154)
Bo et al., 2020	*Cases only* Online survey (PCL-17)	714	49.1	50.2	China, Wuhan	No	PTSS	Infected	PTSS: 96.2%
B. Psychiatric patients without unknown COVID-19 status									
Fernandez-Aranda et al., 2020	*Psychiatric patients only*	32	9.4	29.2	Spain	No	Anxiety, worries, eating disorder symptomatology	Unknown	37.5% reported impairments in their eating disorder symptomatology. 56.2% reported additional anxiety symptoms.
Zhou et al., 2020	*Psychiatric patients only* Self-report questionnaire (GAD-7, PHQ-9, ISI)	2065	n.a.	n.a.	China, Chengdu	No	Anxiety, depression, insomnia	Unknown	20.9% of patients with preexisting psychiatric disorders reported deterioration of their mental health due to the pandemic. Preexisting disorders: depression, bipolar disorders and schizophrenia (no specification of numerical distribution).
C. Health care workers and the COVID-19 pandemic									
Cai et al., 2020	*Case-control* Questionnaire (SCL-90, CD-RISC, SSRS)	1521	24.5	Grouped	China, Jiangsu	Yes	Resilience, support, somatization, OCD, depression, anxiety, hostility, psychoticism	Unknown	Prevalence of psychological abnormality: 14.1%. Phobic anxiety higher among fresh staff compared to experienced staff (P = 0.017).
Huang and Zhao, 2020	*Case-control* Web-based survey (GAD-7, CES-D, PSQI)	7236	45.4	35.3	China, variable regions	Yes	Anxiety, depression, sleep quality	Unknown	General public: Generalized anxiety: 35.1%, depressive symptoms: 20.1% and sleep quality: 18.2% Increased risk of anxiety/depressive symptoms.: Age < 35 (all p < 0-0.001) Increased risk of poor sleep quality: Health care workers (p < 0.001), but no difference in anxiety (p = 0.501) or depression (p = 0.439). No differences according to sex.
Li et al., 2020a	*Case-control* Anonymous questionnaire (VTS)	740	21.9	28.0	China, variable regions	Yes	Vicarious traumatization scores (including scores for physiological and psychological responses)	Unknown	VTS front-line nurses (physiological and psychological responses): significantly lower than of non-front-line nurses (P < 0.001). VTS general public: significantly higher than those of the front-line nurses (P < 0.001)
Li et al., 2020d	*Case-control* (AIS, SRQ-20)	948	23.4	Grouped	China, Wuhan/ Ningbo	Yes	Insomnia	Unknown	Higher degree of insomnia and general psychological symptoms in Wuhan (compared to Ningbo, P = 0.001, P = 0.044). Risk factors of insomnia in Wuhan: females (OR = 1.38, P = 0.042), lower education (OR = 1.54, P = 0.0076) and general psychological symptoms (OR = 2.12, P < 0.01)
Liang et al., 2020	*Case-control* (SDS, SAS)	59	n.a.	Grouped	China	Yes	Depression, anxiety	Unknown	No difference in SDS or SAS among health care workers in COVID-19 department compared to cardiological department and ICU (P = 0.44, P = 0.31). No significant difference between age (over or below 30, P = 0.11, P = 0.76).
Lu et al., 2020b	*Case-control* Online questionnaire (NRS, HAMA, HAMD)	2299	22.1	Grouped	China, Fujian	Yes	Fear, anxiety, depression	Unknown	Significant higher average level of fear (4.89, p < 0.001), anxiety (4.73, p = 0.015) and depression (2.41, p = 0.029) among medical staff compared to administrative staff High-risk contact associated with increased symptoms compared to low-risk contact and non-clinical work (fear: P = 0.027, anxiety: P = 0.003, depression: P = 0.007) and high risk contact had higher ratios of fear (HR = 1.41, P = 0.034), anxiety (HR = 2.06, P = 0.001), depressive symptoms (HR = 2.02, P = 0.0023) compared to non-clinical staff

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Table 1 (*continued*)

Reference	*Design* (study instruments)	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/ morbidity	COVID-19 status	Main findings
Xu et al., 2020	*Case-control* Questionnaire (Anxiety scale, depressionscore, dream anxiety score and SF-36 scale)	120	36.7	36.7	China, Shanghai	Yes	Anxiety, depression, dream anxiety	Unknown	Surgical staff: significant higher degree of anxiety ($p < 0.001$), higher level of dream anxiety ($p < 0.001$), SF-36 ($p < 0.001$), and depression ($p < 0.001$) during compared to surgical staff when the outbreak was under control
Xue et al., 2020	*Case-control* Online questionnaire	14,505 (707)	55.6	Grouped	China	Yes	Difficulty to fall asleep, early wake up	Unknown	Frontline workers (among the medically isolated population) had higher risk of difficulties in falling asleep compared to none-health workers (OR: 1.81, 95%CI: 1.01–3.24) and of waking up early (OR: 3.13, 95%CI: 1.48–6.65) No difference according to age or sex.
Zhang et al., 2020b	*Case-control* Online Survey (ISI, PHQ-4, GAD-2, PHQ-2, SCL-90-R)	2182	35.8	Grouped	China	Yes	Insomnia, anxiety, depression, OCD, phobic anxiety	Unknown	Medical health workers: higher prevalence of insomnia (38.4% vs 30.5% $p < 0.01$), anxiety (13.0% vs 8.5% $p < 0.01$), depression (12.2% vs 9.5% $p < 0.04$), somatization (1.6 vs 0.4%, $p < 0.01$), and OCD symptoms (5.3 vs 2.2%, $p < 0.01$) compared to nonmedical health workers. Significant higher total scores among health care workers of ISI, GAD-2, PHQ-2 and SCL-90-R ($p \leq 0.01$). Increased risk of insomnia medical health workers: living in rural areas (OR: 2.18), risk of contact to COVID-19 patients (OR: 2.53), having organic disease (OR: 3.39) (all $p < 0.001$). Increased risk of anxiety medical health workers: Female (OR: 1.80) and living in rural areas (1.88) (all $p = 0.002$), risk of contact with COVID-19 patient and having organic disease (all $p < 0.001$). Increased risk of depression medical health workers: female (OR: 1.85, $P = 0.02$), having organic disease (OR: 2.51, $P < 0.01$)
Chen et al., 2020	*Comp. to norm* Self-rated questionnaire (SDS, SAS)	105	9.5	32.6	China, Guiyang	Yes	Anxiety, depression	Unknown	Mean SAS and SDS scores were significantly higher than the norms (all $p < 0.001$). Anxiety: Slight: 10.5%, moderate: 5.7%, severe: 1.9%. Depression: slight: 21.0%, moderate: 4.8%, severe: 3.8% No difference in anxiety and depression, but higher rates of depression accompanied by anxiety when exposure experience ($P = 0.042$). Not affected by sex or age.
Mo et al., 2020	*Comp. to norm* Online questionnaire (SOS, SAS)	180	10.0	32.7	China, Guangxi	Yes	Anxiety, stress load	Unknown	SAS scores higher compared to norm ($P < 0.001$). Stress-load correlated positively with anxiety.
Xiao et al., 2020a	*Comp. to norm* Questionnaire (SAS, GSES, SARS, PSQI, SRSS)	180	28.3	32.3	China, variable regions	Yes	Anxiety, stress, self-efficacy, sleep-quality	Unknown	Anxiety, stress, and self-efficacy levels depend on sleep quality and social support Poor sleep quality of health care workers compared to norms
Kang et al., 2020b	*Survey* Questionnaire (PHQ-9, GAD-7, ISI, IES-R)	994	14.5	n.a.	China, Wuhan	Yes	Depression Anxiety Insomnia Distress	1.9% infected	Subthreshold disturbances: 36.9%, mild disturbances: 34.4%, moderate disturbances: 22.4%, severe disturbances: 6.2% Clustered in accordance to psychiatric scores (4 clusters); higher scores associated with infected patients, colleagues, friends, neighbor, co-residents (all $p < 0.001$), own infection ($P = 0.023$) and family infected ($P = 0.005$) and self-perceived health status (<0.001).
Sun et al., 2020	*Survey* Anonymous online survey (PCL-5)	2091	39.2	Grouped	China, Variable regions	Yes	PTSS	2.3% suspected or confirmed	General public PTSS prevalence: 4.6%. High risk public PTSS: 18.4% Health care workers PTSS: 4.4%. Positively associated with higher score (multiple linear regression): female, Hubei province, subjective poor sleep quality (all $p < 0.001$). No difference according to age.

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Table 1 (*continued*)

Reference	*Design* (study instruments)	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/ morbidity	COVID-19 status	Main findings
Chung and Yeung, 2020	*Survey* Online questionnaire (PHQ-9)	69	n.a.	n.a.	Hong Kong	Yes	Depression	Unknown	Mild depression: 34.8% Moderate depression: 14.5%
Du et al., 2020	*Survey* Smart-phone based survey (PSS, BDI, BAI)	134	39.5	36.0	China, Wuhan	Yes	Stress, depression, anxiety	Unknown	Depressive symptoms: 20.1%, anxiety symptoms: 12.7% Health care workers going to Wuhan from other regions in order to help had better sleep quality, lower perceived stress and less depressive symptoms (all Ps < 0.05). Positively associated with depression and anxiety: lack of psychological preparedness, perceived self-efficacy to help the patients, family support; greater perceived stress; or having poor sleep quality. Positively associated with anxiety: Lacking knowledge, higher education attainment, and family/friends infected.
Lai et al., 2020	*Survey* Questionnaire (PHQ-9, GAD-7, ISI, IES-R)	1257	23.3	Grouped	China, variable regions	Yes	Depression, anxiety, insomnia, and distress	Unknown	Depressive symptoms: 50.4%, anxiety symptoms: 44.6%, insomnia: 34.0%, distress: 71.5% Factors associated with significantly higher level of all outcome measures: being nurse (vs. physician, all $p = 0.007$, 0.008, <0.001, 0.009), female (vs male, all $p < 0.001$), frontline (vs. second line, all $p < 0.001$), secondary hospital (vs. tertiary, all $p < 0.001$, 0.005, 0.008, 0.46) an Wuhan (vs. outside Wuhan, all $p < 0.001$) Increased risk of depression symptoms: female (OR = 1.94, $P = 0.003$), secondary hospital (OR = 1.65, $P = 0.004$), title intermediate (OR = 1.77 compared to junior, $P = 0.005$), frontline workers (OR = 1.52, $P = 0.01$). Increased risk of anxiety symptoms: female (OR = 1.69, P 0.001), secondary hospital (OR = 1.43, $P = 0.01$), title intermediate (OR = 1.82, $P < 0.001$), frontline (OR = 1.57, $P < 0.001$). Insomnia: frontline (OR = 2.97, $P < 0.001$). Distress: female (OR = 1.45, $P < 0.01$), intermediate (OR = 1.94, $P < 0.001$), frontline (OR = 1.60, $P < 0.001$). Decreased risk of distress: outside Hubei (OR = 0.62, $P = 0.008$)
Li et al., 2020c	*Survey* Questionnaire (PHQ-9, GAD-7, IES-R)	4369	0	Grouped	China, Wuhan	Yes	Stress, depression, anxiety	Unknown	Depression: 14.2%, anxiety: 25.2%, stress: 31.6%. Positively associated factors: >10 years of working, with medical history (including psychiatric history and ≥ 2 children. Negatively associated: exercise habit. Increased risk of anxiety and depression with drinking history (OR: 1.95, $P < 0.001$ and OR: 1.71, $P = 0.004$), depression with relatives suspected confirmed COVID-19 (OR: 1.31, $P = 0.018$), self being suspected/confirmed (OR: 1.93, $P = 0.001$). Increased risk of stress among nurses compared to medical technician (OR: 1.41, P 0.007) and family member suspected/confirmed infected (OR: 1.39, $P < 0.001$)
Wang et al., 2020c	*Survey* Self-report questionnaire (PSQI, SAS, SDS)	123	10	33.8	China, Wuhan	Yes	Sleep disturbances, depression, anxiety	Unknown	Factors positively associated with poor sleep: job title (doctor, $P < 0.05$), frontline worker ($P < 0.001$), being only child ($P < 0.01$). Poor sleep quality was associated with higher anxiety and depression score ($P < 0.01$, $P < 0.001$). Not related to sex or age. Risk factors of sleep disturbance: being only child (vs not OR: 3.40), frontline worker (vs not OR: 2.97), depressive symptoms (vs. not OR: 2.83) (all Ps < 0.05).

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Table 1 (*continued*)

Reference	*Design* (study instruments)	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/ morbidity	COVID-19 status	Main findings
Zhang et al., 2020d	*Survey* Questionnaire (ISI, PHQ-9, GAD-7, IES-R)	1563	17.3	n.a.	China	Yes	Insomnia, depression, anxiety, stress	Unknown	Overall prevalence: Insomnia symptoms: 36.1%, depressive symptoms: 50.7% (PHQ-9 ≥ 5), anxiety symptoms: 44.7% (GAD-7 ≥ 5), stress symptoms: 73.4% (IES-R ≥ 9). Increased risk: lower educational level (OR: 2.69, P = 0.042), working in isolation unit (OR: 1.71, P = 0.038), worry about being infected (OR: 2.30, P > 0.001), less perceived social support (OR: 2.10, P = 0.001, uncertainty of disease control (OR: 3.30, P = 0.013). Higher proportions of females (P = 0.003 in the insomnia group.

Abbreviations: PCL-C: self-reported PTSD Checklist (5 or 17 items), GHQ-9/12: 9/12-item General Health Questionnaire, GAD-7: 7-item Generalized Anxiety Disorder, SDS: Self-rating Depression Scale, SAS: Self-rating Anxiety Scale, CES-D: Center for Epidemiology Scale for Depression, PSQI: Pittsburgh Sleep Quality Index, ISI: Insomnia Severity Index, IES-R: 22-item Impact of Event Scale-Revised, VTS: Vicarious Traumatization Scale, NRS: numeric rating scale on fear, HAMA: Hamilton Anxiety Scale, HAMD: Hamilton Depression Scale, GSES: General Self-Efficacy Scale, SARS: Stanford Acute Stress Reaction, SSRS: Social Support Rate Scale, SF-36: 36-Item Short Form Survey, SCL-90-R: Symptom Check List-revised, PHQ-2/4/9: Patient Health Questionnaire-2/4/9 items.

scores measured in a period with increase in number of confirmed cases to a period with increase in number of recovered cases (P > 0.05); however, only 333 of the 1210 cases were followed up (Wang et al., 2020a). One study found no significant difference in any items between workers/technical staff (n = 551) and management/executive staff (n = 122) (all P > 0.05) (Tan et al., 2020), and one study found no difference between being in quarantine (n = 1443) or not (n = 836) (Zhu et al., 2020).

3.5. Risk factors of anxiety and depression

The following factors were reported to be associated with risk of psychiatric symptoms among health care workers and the general public:

3.5.1. Sociodemographic factors

The following sociodemographic factors were associated with depression and/or anxiety: living alone (Cao et al., 2020), lower educational level (Gao et al., 2020; Mazza et al., 2020), but also higher (Du et al., 2020), student status (Wang et al., 2020b), not having a child (Mazza et al., 2020), or having ≥ 2 children (Li et al., 2020c), living in urban areas (Gao et al., 2020; Ozdin and Bayrak Ozdin, 2020), but also in rural areas (Zhang et al., 2020b; Cao et al., 2020), female gender (Zhang et al., 2020b; Lai et al., 2020; Mazza et al., 2020; Wang et al., 2020b; Ozdin and Bayrak Ozdin, 2020) was reported frequently, but was not consistent (Chen et al., 2020; Gao et al., 2020), while reports on age as a risk factor were inconsistent (Gao et al., 2020; Mazza et al., 2020; Huang et al., 2020b).

3.5.2. Current or past medical history

Current medical disease (including psychiatric disorders and substance abuse) (Zhang et al., 2020b; Wang et al., 2020a; Ozdin and Bayrak Ozdin, 2020), and a past medical history (including psychiatric history and substance abuse) (Wang et al., 2020a; Mazza et al., 2020; Li et al., 2020c; Ozdin and Bayrak Ozdin, 2020) were associated with/increased the risk of depression and/or anxiety.

3.5.3. Psychological and social factors

Poor-self rated health (Wang et al., 2020a; Gao et al., 2020; Wang et al., 2020b), poor sleep quality (Du et al., 2020), higher perceived stress load (Mo et al., 2020; Du et al., 2020), previous distressful lifeevents (Mazza et al., 2020), lack of psychological preparedness (Du et al., 2020), perceived self-efficacy to help the patients (Du et al., 2020), lacking knowledge of the pandemic (Du et al., 2020; Wang et al., 2020b), not taking precautionary measures (Wang et al., 2020b), and impacts on daily life (Zhu et al., 2020). Furthermore relatives/friends/acquaintance suspected of/acquired COVID-19 (Cao et al., 2020; Mazza et al., 2020; Du et al., 2020; Li et al., 2020c; Ozdin and Bayrak Ozdin, 2020; Kang et al., 2020a), less family support (Du et al., 2020), low social capital (during isolation) (Xiao et al., 2020b), unsteady family income (Cao et al., 2020), and higher social media exposure (Gao et al., 2020) were associated with/increased the risk of depression and/or anxiety.

3.5.4. Job related factors

Working in frontline compared to second line (Lu et al., 2020b; Lai et al., 2020), secondary hospital compared to tertiary (Lai et al., 2020), title intermediate compared to junior (Lai et al., 2020), and >10 years of working (Lai et al., 2020) were associated with/increased the risk of depression and/or anxiety.

3.6. Risk factors of PTSS, psychological distress and affected general mental health

The risk of PTSS were positively associated with female gender (Sun et al., 2020; Liu et al., 2020), living in Hubei province (Sun et al., 2020;

Table 2
Studies of psychiatric symptoms/disorders during the COVID-19 pandemic among the general public.

Reference	*Design* study instruments	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/morbidity	COVID-19 status	Main findings
Li et al., 2020b	*Case-control* Weibo posts	17,865	25.2	33	China, variable regions	No	Words of emotions Words of concerns	Unknown	Significant differences of emotional indicators prior to and after COVID-19 with increased anxiety, depression and indignation (all P < 0.001).
Sonderskov et al., 2020	*Case-control* Online survey (WHO-5)	2458	49	49.1	Denmark	No	Psychological well-being	Unknown	WHO-5 mean score significantly lower than in 2016 (62.0 vs 64.3 (p < 0.001)). Significantly higher proportion of female respondents with WHO-5 scores < 50 compared to 2016 (28.8% vs. 24.6%, P = 0.005), but not among males (21.8% vs. 20.0%, P = 0.110)
Tan et al., 2020	*Case-control* Online questionnaire (DASS-21, ISI, IES-R)	673	74.4	30.8	China, Chongquing	No	PTSD, anxiety, depression, stress	Unknown	Prevalence: PTSD: 10.8%, anxiety: 6.0%, depression: 5.9%, stress: 3.3%, insomnia: 2.3%, hallucinations: 3.1%, paranoid ideations: 2.2%, suicidal ideations: 1.6%. No significant difference in any items between workers/ technical staff (n = 551) and management/executive staff (n = 122) (all P > 0.05)
Yuan et al., 2020	*Case-control* Questionnaire (HADS, VDAS, SF-36)	100	43.0	37.0	China,	No	Depressive, anxiety, dream anxiety	Unknown	Parents of children hospitalized during the epidemic period had significant higher scores of anxiety, depression and dream anxiety compared to parents of children hospitalized in the non-epidemic period (all p < 0.001)
Zhu et al., 2020	*Case-control* App-based questionnaire (SRQ-20, GAD-7, PHQ-9)	2279	40.5	Grouped	n.a.	No (yes 37.6%)	Anxiety, depression,	Unknown	Increased risk of psychological (OR: 3.593), anxiety (OR: 4.686) and depression symptoms (OR: 4.313) with impacts on daily life (all p < 0.001), but not with quarantine status between quarantine (n = 1443) and non-quarantine (n = 836) group (all p ≥ 0.303).
Wang et al., 2020a	*Survey (Longitudinal)* National University of Singapore COVID-19 questionnaire (IES-R, DASS-21)	1738 (333)	32.7	Grouped	China, variable regions	No	Anxiety, depression, stress	Unknown	No significant difference in anxiety, depression and stress symptoms in a with increasing number of confirmed cases compared to a period with increasing number of recovered cases (all P > 0.05) Overall mean score for both measuring points > 24 indicating presence of PTSD symptoms. Positively associated with stress, anxiety or depression: physical symptoms, very poor self-rating of health, and history of chronic illness (both measuring points).
Li et al., 2020e	*Survey* Online survey (GHQ-12, perceived severity, BSCS)	4607	27.5	23.7	China, variable regions	No	Mental health problems	2.3% infected	Participants with low self-control and/or higher perceived severity of COVID-19 reported more mental health problems (p < 0.001)
Xiao et al., 2020b	*Survey* Questionnaire (PSCI-16, SAS, SASR, PSQI)	170	59.4	37.8	China, variable regions	No	Anxiety, sleep quality, distress, social capital	10.6% infected	Low social capital was positively correlated with anxiety, stress and sleep quality (All p < 0.01)
Cao et al., 2020	*Survey* Questionnaire (GAD-7)	7143	30.4	n.a.	China, variable regions	No	Anxiety	Unknown	Severe anxiety: 0.9%, moderate anxiety: 2.7% mild anxiety: 21.3% Increased risk: relative/acquaintance infected with COVID-19 (OR = 3.007, P < 0.001) Decreased risk: living in urban areas (OR = 0.810, P = 0.002), steady family income (OR = 0.726, P < 0.001), living with parents (OR = 0.752, P = 0.017) Negatively correlated: economic worry, academic delay worry, influence on daily life (All p < 0.001). Positively correlated: social support (P < 0.001).

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Table 2 (*continued*)

Reference	*Design* study instruments	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/morbidity	COVID-19 status	Main findings
Gao et al., 2020	*Survey* Online survey (WHO-5, GAD-7)	4827	32.3	32.3	China, variable regions	No (yes 5.2%)	Depression, anxiety	Unknown	Depression prevalence: 48.3%, anxiety: 22.6% Increased risk of anxiety/depression: age 31–40 compared to < 20 (OR: 1.69 95%CI: 1.07–2.68). lower educational level, lower self-rated health (OR: 1.77 95%CI: 1.41–2.21) and higher social media exposure (OR: 1.91, 95%CI: 1.52–2.41). Increased risk of depression: age 21–30 (OR: 1.49) compared to < 20 and living in urban areas. Increased risk of anxiety: living in Hubei. No difference in sex in anxiety/depression (OR: 0.90 (95%CI: 0.77–1.05) and age (OR: 1.51, 95%CI: 1.00–2.30).
Moccia et al., 2020	*Survey* Anonymous online questionnaire (*K*10, TEMPS-A, ASQ)	500	40.4	Grouped	Italy	No	Psychological distress	Unknown	62%: No likelihood of psychological distress 19.4%: mild likelihood of psychological distress 18.6%: moderate-severe likelihood of psychological distress Moderate-severe compared to no distress: Increased risk: cyclothymic (OR = 1.24, P < 0.001), depressive (OR: 1.52; p < 0.001) and anxious (OR: 1.58; p = 0.002) temperaments, need for approval (Or = 1.08, P = 0.01). Decreased risk: confidence (OR = 0.89, P = 0.002), discomfort with closeness (OR = 0.92, P = 0.001) No difference in age (OR = 1, P = 0.97) and sex (OR = 0.58, P = 0.08).
Liu et al., 2020	*Survey* Questionnaire (PCL-5, PSQI)	285	45.6	Grouped	China, Hubei	No (yes: 4.2%)	PTSS	Unknown	PTSS: 7% Positively associated factors: female, high risk public, lower education, poor sleep quality (all p < 0.001).
Mazza et al., 2020	*Survey* Online survey (DASS-21, PID-5-BF)	2766	28.3	32.9	Italy	No	Depression, anxiety, stress	Unknown	Factors associated with depressive and anxiety symptoms: female (all Ps < 0.001), history of stress (P = 0.001, P = 0.003) and history of medical problems (all Ps < 0.001). Factors associated with depressive symptoms: lower education (P < 0.001), not having a child (P = 0.033), relative infected (0.006), Factors associated with anxiety symptoms: young age (P = 0.001),), infected family (P = 0.013). Factors associated with stress: young age, female (all P < 0.001), going to work (P = 0.006), acquaintance infected (P = 0.018), history of stress (P = 0.035) and medical problems (P = 0.003).
Ozdin and Bayrak Ozdin, 2020	*Survey* Online survey (HADS, HAI)	343	50.7	37.2	Turkey	No	Depression, anxiety	Unknown	Factors associated with depression and anxiety (P = 0.047, P < 0.001), infected friends/relatives (P = 0.001, P = 0.014), current psychiatric illness (P = 0.020, P < 0.001), previous psychiatric illness (P = 0.036, P = 0.011). Factors associated with depression: living in urban areas (compared to rural, P = 0.029) and anxiety: chronic disease (P = 0.001). Increased risk of depression and anxiety: female (OR: 2.48, P = 0.001), previous psychiatric history (OR = 0.363, P = 0.001), Decreased risk of depression and anxiety: urban residence (vs rural, OR = 0.36, P = 0.015, OR = 0.53, P = 0.36).

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Table 2 (*continued*)

Reference	*Design* study instruments	Partici-pants	Males (%)	Mean age	Country	Health care workers	Psychiatric symptom/morbidity	COVID-19 status	Main findings
Qiu et al., 2020	*Survey* Online questionnaire (CPDI)	52,730	35.3	n.a.	China, Hong Kong, Taiwan, Macau	No	Anxiety, depression, specific phobias, cognitive change, avoidance and compulsive behavior, physical symptoms and loss of social functioning	Unknown	Psychological distress: 34.4% Factors associated with higher psychological distress: female (24.87 vs. 21.41, P < 0.001), age 18–30 or > 60, migrant workers, middle region of China (all p < 0.001)
Roy et al., 2020	*Survey* Online questionnaire (Likert scale)	662	48.6	29.1	India	No	Anxiety	Unknown	72% was worried for them self/relatives. 12% had sleep difficulties.
Tian et al., 2020	*Survey* Online questionnaire (SCL-90)	1060	51.8	35.0	China, variable regions	No (yes)	Somatization, OCD, IS, depression, anxiety, hostility, phobica, anxiety, paranoid ideation and psychoticism.	Unknown	Psychological symptoms (moderate or more): 70% (OC, IS, PHOB, and PSY 4 dimensions) Factors associated with more symptoms: higher ages, undergraduate education and below, divorced or widowed, and agricultural workers (all p < 0.001), No significant difference according to sex (P = 0.72)
Wang et al., 2020a	*Survey* Online Survey (IES-R, DASS-21)	1210	32.7	Grouped	China, variable regions	No	Depression, anxiety, distress	Unknown	Experienced psychological impact moderate-severe: 53.8% Moderate-severe depressive symptoms: 16.5% Moderate-severe anxiety symptoms: 28.8% Moderate-severe stress levels: 8.1% Factors positively associated with stress, anxiety and depression symptoms: Female gender, student status, specific physical symptoms (e.g., myalgia, dizziness, coryza),and poor self-rated health (all p < 0.05) Factors negatively associated: health information, precautionary measures (all p < 0.05).
Zhang et al., 2020c	*Survey* Survey (SF12, K6)	369	55.0	36.6	China, variable regions	No	Mental health, distress	Uninfected	People working at office (P = 0.01) and people working from home (P = 0.03) had better mental health compared to people who stopped working.

Abbreviations: PCL-C: self-reported PTSD Checklist (5 or 17 items), GHQ-9/12: 9/12-item General Health Questionnaire, GAD-7: 7-item Generalized Anxiety Disorder, SAS: Self-rating Anxiety Scale, PSQI: Pittsburgh Sleep Quality Index, ISI: Insomnia Severity Index, IES-R: 22-item Impact of Event Scale-Revised, SF-36: 36-Item Short Form Survey, SCL-90-R: Symptom Check List-revised, PHQ-2/4/9: Patient Health Questionnaire-2/4/9 items, BSCS: Brief Self-Control Scale, CPDI: COVID-19 Peritraumatic Distress Index, *K*10: Kessler 10 Psychological Distress Scale, TEMPS-A: Italian Temperament Evaluation of Memphis, Pisa, Paris and San Diego-Autoquestionnaire, ASQ: Attachment Style Questionnaire, PSCI-16: Personal Social Capital
Scale 16, DASS-21: Depression, Anxiety and Stress Scale, SF12: Short Form 12, K6: six-item Kessler psychological distress scale, VDAS: Van Dream Anxiety Scale, SRQ-20: Self-Report Questionnaire (20-items), CD-RISC: Connor-Davidson resilience scale, SOS: Stress overload Scale, PSS: Perceived Stress Scale. BDI-II: Beck Depression Inventory-II, BAI: Beck anxiety inventory, AIS: Athen Insomina, Scale, PID-5-BF: Personality Inventory DSM-5-Brief-Form-Adult, HAI: Health Anxiety Inventory.

Liu et al., 2020), lower education (Liu et al., 2020) and subjective sleep quality (Sun et al., 2020; Liu et al., 2020), but not with age (Sun et al., 2020). A variety of factors was associated with higher psychological distress/affected general mental health (Lai et al., 2020; Mazza et al., 2020; Wang et al., 2020b; Li et al., 2020c; Kang et al., 2020a; Xiao et al., 2020b; Tian et al., 2020; Zhang et al., 2020c,d; Li et al., 2020d; Qiu et al., 2020; Li et al., 2020e) and/or insomnia/poor sleep quality (Zhang et al., 2020b; Lai et al., 2020; Du et al., 2020; Xiao et al., 2020b; Li et al., 2020d; Wang et al., 2020c; Xue et al., 2020).

4. Discussion

A total of 43 studies were included. Only two studies investigated mental health issues in COVID-19 patients finding a high level of PTSS (96.2%) and significantly higher level of depressive symptoms (29.2%). Two studies reported symptoms on psychiatric patients, which appeared to have worsening in psychiatric symptomatology. Among health care workers depression/depressive symptoms, anxiety, psychological distress and poor sleep quality were increased. Regarding the general public one paper revealed lower psychological well-being (WHO-5) compared to before COVID-19, while a longitudinal study found no difference in anxiety, depression or stress symptoms early in the pandemic compared to after four weeks. A variety of factors were associated with higher risk of psychiatric symptoms and/or low psychological well-being of the general public including female gender, front-line health care workers, and poor self-rated health.

4.1. Psychiatric symptoms among COVID-19 patients

It is well known that surviving critical illness can induce PTSS (Sparks, 2018) and in line with this, levels of PTSS were found to be very high (96.2%) among patients during hospital admission with COVID-19 infection (Bo et al., 2020), which is far higher than found in the general public (7%) (Liu et al., 2020). The risk of depression was also found to be higher among patients with COVID-19 (Zhang et al., 2020a). It is generally established that infections are associated with a higher risk of mood disorders (Benros et al., 2013), and there seems to be a higher risk after severe infections (Kohler et al., 2017a). This is in line with the findings from the SARS-CoV-1 epidemic revealing depressive symptoms among patients during the infection (Cheng et al., 2004a; Chua et al., 2004). This higher risk could be due to the coronavirus affecting the brain directly or indirectly by inducing a massive cytokine response affecting the brain (Troyer et al., 2020).

Of notice is that among patients with prior SARS-CoV-1 infection a higher rate of depression/depressive symptoms was observed after 1 month (Cheng et al., 2004b; Wu et al., 2005) and 1 year (Lee et al., 2007). The SARS-CoV-1 spread to more than 26 countries affecting more than 8000 people (WHO, 2020) and 774 died from the infection (Mak et al., 2009), while COVID-19 has already spread to 185 countries affecting more than 4.238.703 people (COVID-19, 2020) and we must expect a huge after-wave of patients surviving COVID-19 suffering from depression.

Regarding anxiety the evidence is still scarce, and this should be investigated further since anxiety symptoms were reported during (Cheng et al., 2004a) and following (Cheng et al., 2004b; Wu et al., 2005) SARS-CoV-1. Furthermore SARS-CoV-1 has been shown to induce affective psychosis at least during the acute phase of the illness (Lee et al., 2004), but we found no papers addressing this matter yet for SARS-CoV-2. Severe infections and inflammatory processes can cause delirium with a broad variety of psychiatric symptoms and encephalopathy, which has been reported among SARS-CoV-2 positive patients, but the evidence is still scarce and the neurotropic potential of SARS-CoV-2 needs to be elucidated (Kotfis et al., 2020).

4.2. COVID-19 pandemic and impact on psychiatric symptoms among psychiatric patients

Worsening of the psychiatric symptoms among some patients with pre-existing psychiatric disorders, was reported (Fernandez-Aranda et al., 2020; Zhou et al., 2020), and two case studies report on the COVID-19 pandemic being a part of the psychotic content of two non-infected patients admitted to the psychiatric word (Fischer et al., 2020; Sahoo et al., 2020). However, our systematic review reveals that knowledge on the COVID-19 impact on patients with preexisting psychiatric disorders is very scarce, and the knowledge of impact from earlier pandemics/epidemics on this group is also very limited.

4.3. COVID-19 pandemic and impact on psychiatric symptoms among health care workers

From previous studies of the SARS CoV-1 epidemic it is known that health care workers are at risk of anxiety and depressive symptoms, which the current studies indicate also is the case of COVID-19. Health care workers should be regarded as a highly exposed group with a higher risk of psychiatric symptoms during the COVID-19 pandemic, and risk factors are female gender and frontline workers among others.

4.4. COVID-19 pandemic and impact on mental health in the general public

Currently data is scarce, but indicates that mental health is affected in the general public, when compared to before the outbreak (Sonderskov et al., 2020); however, the only longitudinal study (following 333 participants up) found no difference in depression, anxiety and stress in the period with many new cases compared to the period with many recovering (Wang et al., 2020a). This is interesting, since it is known from the prior SARS-CoV-1 epidemic that those in the general public, who were impacted of the epidemic (e.g. by quarantine) had psychiatric symptoms months after control of the epidemic (Peng et al., 2010), and this could indicate that long lasting symptoms after SARS-CoV-2 also must be expected.

4.5. Risk factors of psychiatric symptoms in relation to the COVID-19 pandemic

Many risk factors (especially of depressive and anxiety symptoms) has been reported, but most of them are already well-known risk factors for mental health conditions (e.g. female gender (Malhi and Mann, 2018), current or past medical history (Kohler et al., 2018), and poor-self-related health (Molarius and Janson, 2002). However the pandemic is adding an aspect of quarantine and isolation that is also an established risk factor with psychological impact (Brooks et al., 2020), like worrying about family, friends and acquaintances being infected is also a newly added dimension. Due to the altered living conditions many of the identified risk factors will increase most likely leading to an increase in patients.

4.6. Potential biological mechanisms of SARS-CoV-2 and the effect on psychiatric symptoms

There are indications in the literature of a neurotropic effect of SARS-CoV-2. Evidence of a variety of neurological symptoms among patients suffering from COVID-19 is evolving (Mao et al., 2020), and delirium is a frequently reported symptom of SARS-CoV-2 and could be caused by a direct CNS invasion (Kotfis et al., 2020). Interestingly two case studies reports SARS-CoV-2 meningitis/encephalitis (Moriguchi et al., 2020; Ye et al., 2020); however, only one of them had a confirmed positive SARS-CoV-2 RT-PCR test on CSF (Moriguchi et al., 2020). ACE2 is a functional receptor for SARS-CoV-2 (Li et al., 2005)

and it is known that ACE2 is expressed in neurons (Troyer et al., 2020), which is interesting in the light of the many reports of anosmia as an early symptom of COVID-19 (Lechner et al., 2020), since SARS-CoV-1 has been suggested to enter the brain trough the olfactory bulb (Netland et al., 2008). Taken together this indicates that SARS-CoV-2 could be neurotrophic entering the brain through the olfactory bulb, leading to an increase in neuropsychiatric symptoms among the patients surviving COVID-19.

When discussing the potential effects of SARS-CoV-2 on the brain it is worth noting the reports on altered peripheral immunological alterations among COVID-19 patients (Troyer et al., 2020). Significantly higher levels of neutrophils, but significantly lower levels of lymphocytes have been reported among severe cases compared to nonsevere (Mao et al., 2020), and patients with SARS-CoV-2 have been reported to have high amounts of the pro-inflammatory cytokines (IL-1beta, IFN-gamma, IP10 and MCP-1) suggesting a Th1 response (Huang, 2020). A pro-inflammatory response has been reported among patients with MDD in both plasma (Kohler et al., 2017b) and CSF (Enache et al., 2019), and the associations between neuropsychiatric symptoms and proinflammatory response needs to be elucidated further.

4.7. Strengths and limitations

The strength of this review is that it was systematically conducted. The study is limited by several factors. Firstly, the majority of the studies were conducted in Asia (only four studies from Europe and none from other continents), limiting the current generalization of the results. Secondly, most of the studies were not case-control studies no (35/43) and with a variety of reported outcomes, measuring of outcomes and statistical analysis was revealed. Thirdly, the literature on psychiatric symptoms among patients with SARS-CoV-2 infection and among psychiatric patients were very limited.

5. Conclusion and perspectives

Although the current evidence is scarce concerning direct effects of COVID-19 on mental health, there are indications of increased levels of PTSS and depression following the COVID-19 infection. Regarding the indirect effects of COVID-19 on general mental health there seems to be evidence of an increase in depressive and anxiety symptoms along with negative impact on general mental health, particularly among health care workers. Research evaluating the direct neuropsychiatric consequences and the indirect effects on mental health is highly needed to improve treatment, mental health care planning and for preventive measures during potential subsequent pandemics.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bbi.2020.05.048.

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