



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

## Journal of Psychiatric Research

journal homepage: [www.elsevier.com/locate/jpsychires](http://www.elsevier.com/locate/jpsychires)

Review article

## Mental health outcomes of coronavirus infection survivors: A rapid meta-analysis

Dong Liu<sup>a</sup>, Roy F. Baumeister<sup>b,c,1</sup>, Yong Zhou<sup>a,\*</sup><sup>a</sup> School of Journalism, Renmin University of China, China<sup>b</sup> Department of Psychology, Florida State University, FL, USA<sup>c</sup> School of Psychology, University of Queensland, Brisbane, Australia

## ARTICLE INFO

## Keywords:

Coronavirus

SARS

Mental health

Meta-analysis

## ABSTRACT

**Background:** The current COVID pandemic is happening while the long-term effects of coronavirus infection remain poorly understood. The present article meta-analyzed mental health outcomes (anxiety, depression, etc.) from a previous coronavirus outbreak in China (2002).

**Method:** CNKI, Wanfang, PubMed/Medline, Scopus, Web of Science, Baidu Scholar, and Google Scholar were searched up to early June 2020 for articles in English or Chinese reporting mental illness symptoms of SARS patients. Main outcome measures include SCL-90, SAS, SDS, and IES-R scales. 29 papers met the inclusion criteria. The longest follow-up time included in the analysis was 46 months.

**Findings:** The systematic meta-analysis indicated that mental health problems were most serious before or at hospital discharge and declined significantly during the first 12 months after hospital discharge. Nevertheless, average symptom levels remained above healthy norms even at 12 months and continued to improve, albeit slowly, thereafter.

**Interpretation:** The adverse mental health impact of being hospitalized with coronavirus infection long outlasts the physical illness. Mental health issues were the most serious for coronavirus infected patients before (including) hospital discharge and improved continuously during the first 12 months after hospital discharge. If COVID-19 infected patients follow a similar course of mental health development, most patients should recover to normal after 12 months of hospital discharge.

## 1. Introduction

Coronavirus infection may have an adverse impact on patients' mental health. Coronavirus may infect the central nervous system (CNS), thereby affecting the brain, and it may cause a series of neuropsychiatric symptoms such as headache and dizziness (Liu et al., 2020a, b; Mao et al., 2020). Moreover, infected patients may experience a variety of stressors and traumatic events, such as difficulty gaining admission to hospital wards, social and physical isolation, and deaths of other patients and/or family members. Previous data on severe acute respiratory syndrome (SARS) infection showed that coronavirus can cause sustained mental disorder with long-lasting neuropsychiatric consequences (Lam et al., 2009; Hong et al., 2020a,b). Post-traumatic stress disorder (PTSD), depression, anxiety, fatigue, and insomnia may

be common among coronavirus patients, continuing after the virus infection passes. Previous studies following severe acute respiratory syndrome (SARS) infected patients in 2003 found that the prevalence of PTSD in SARS survivors was respectively 46.2% and 38.8% at 3 months and 12 months after discharge (Guo et al., 2020).

Data reporting the mental health consequences, especially long-term, of coronavirus infection are needed to improve treatment, mental health care planning, and preventive measures during the current COVID-19 pandemic. Many patients worldwide are suffering the mental and physical effects of COVID-19, and interventions cannot wait for several years until solid data are available. To address this problem, we compiled data from a previous coronavirus outbreak in China, specifically the Severe Acute Respiratory Syndrome (SARS) during 2002. The long-term mental health effects of SARS infection may provide the

**Abbreviations:** COVID-19, 2019 novel coronavirus; SARS, Severe acute respiratory syndrome; PTSD, post-traumatic stress disorder.

\* Corresponding author. Department of Journalism, Renmin University of China, No 59 Zhongguancun Street, Beijing, 100872, China.

E-mail address: [zhouyong@ruc.edu.cn](mailto:zhouyong@ruc.edu.cn) (Y. Zhou).

<sup>1</sup> Authors contributed equally to this paper.

<https://doi.org/10.1016/j.jpsychires.2020.10.015>

Received 11 August 2020; Received in revised form 5 October 2020; Accepted 12 October 2020

Available online 21 October 2020

0022-3956/© 2020 Elsevier Ltd. All rights reserved.

**Table 1**  
Studies included in the meta-analysis of SCL-90 anxiety subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.47	0.51	Anxiety	NA	59.22%
Wang et al. (2003b)	-2	669	3.16	0.93	Anxiety	35	44.26%
Wang et al. (2003b)	0	177	1.97	0.82	Anxiety	NA	NA
Sun et al. (2003)	-1	35	1.72	0.23	Anxiety	30.24	88.57%
Xu et al. (2003)	-1	40	2.13	0.84	anxiety	NA	NA
Liu et al. (2007)	0	48	2.07	0.88	anxiety	NA	70.80%
Liu et al. (2007)	6	48	1.63	0.69	anxiety	NA	70.80%
Liu et al. (2007)	12	48	1.50	0.72	anxiety	NA	70.80%
Gao et al. (2005)	0	45	1.86	0.43	anxiety	NA	73.30%
Gao et al. (2005)	6	45	1.76	0.69	anxiety	NA	73.30%
Gao et al. (2005)	12	45	1.46	0.72	anxiety	NA	73.30%
Lin et al. (2004)	4.5	45	1.69	0.95	anxiety	32	48.89%
Xu et al. (2006)	-2	114	1.79	0.78	anxiety	36.9	54.39%
Xu et al. (2006)	0	114	1.76	0.84	anxiety	36.9	54.39%
Xu et al. (2006)	3	114	1.50	0.66	anxiety	36.9	54.39%
Xue et al. (2005)	-2	116	1.79	0.78	anxiety	36	55.17%
Xue et al. (2005)	0	116	1.76	0.84	anxiety	36	55.17%
Xue et al. (2005)	12	116	1.50	0.66	anxiety	36	55.17%
Gao et al. (2006a,b)	6	67	1.76	0.69	anxiety	NA	NA
Liu et al. (2007)	0	48	2.07	0.88	anxiety	NA	70.80%
Liu et al. (2007)	6	48	1.63	0.69	anxiety	NA	70.80%
Liu et al. (2007)	12	48	1.50	0.72	anxiety	NA	70.80%
Wang et al. (2003c)	-1	40	2.13	0.84	anxiety	NA	NA
Peng et al. (2005)	-1	102	2.36	0.55	anxiety	31.70	52.94%
Yang (2004)	-2	43	1.72	0.68	anxiety	34.5	41.86%
Yang (2004)	0	43	1.67	0.81	anxiety	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

best currently available evidence to guide how to deal with COVID-19 sufferers.

We searched the published Chinese and English literature examining SARS to identify the long-term psychiatric status for the SARS survivors. We meta-analyzed the sustained psychiatric symptoms at different follow-up time points to examine how the mental status of SARS survivors changed after infection and after hospital release. We recognize one previous meta-analysis for SARS and MERS survivors, but it included only 7 studies, and in particular the long-term mental health outcomes of SARS patients remained unclear (Rogers et al., 2020). The present meta-analysis included four times as many studies, some of which followed up almost four years after hospital discharge, enabling a much better picture of the long-term impact.

**Table 2**  
Studies included in the meta-analysis of SCL-90 depression subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.43	0.47	depression	NA	59.22%
Wang et al. (2003b)	-2	669	2.47	0.89	depression	35	44.26%
Wang et al. (2003b)	0	177	2.31	0.86	depression	NA	NA
Sun et al. (2003)	-1	35	1.81	0.18	depression	30.24	88.57%
Xu et al. (2003)	-1	40	2.63	0.38	depression	NA	NA
Liu et al. (2007)	0	48	1.99	0.83	depression	NA	70.80%
Liu et al. (2007)	6	48	1.84	0.85	depression	NA	70.80%
Liu et al. (2007)	12	48	1.55	0.75	depression	NA	70.80%
Gao et al. (2005)	0	45	2.34	0.78	depression	NA	73.30%
Gao et al. (2005)	6	45	1.90	0.78	depression	NA	73.30%
Gao et al. (2005)	12	45	1.58	0.85	depression	NA	73.30%
Lin et al. (2004)	4.5	45	1.64	0.65	depression	32	48.89%
Xu et al. (2006)	-2	114	1.81	0.87	depression	36.9	54.39%
Xu et al. (2006)	0	114	1.78	0.85	depression	36.9	54.39%
Xu et al. (2006)	3	114	1.59	0.75	depression	36.9	54.39%
Xue et al. (2005)	-2	116	1.81	0.87	depression	36	55.17%
Xue et al. (2005)	0	116	1.78	0.85	depression	36	55.17%
Xue et al. (2005)	12	116	1.59	0.75	depression	36	55.17%
Gao et al. (2006a,b)	6	67	1.90	0.78	depression	NA	NA
Liu et al. (2007)	0	48	1.99	0.83	depression	NA	70.80%
Liu et al. (2007)	6	48	1.84	0.85	depression	NA	70.80%
Liu et al. (2007)	12	48	1.55	0.75	depression	NA	70.80%
Wang et al. (2003c)	-1	40	2.63	0.38	depression	NA	NA
Peng et al. (2005)	-1	102	2.78	0.56	depression	31.70	52.94%
Yang (2004)	-2	43	1.80	0.73	depression	34.5	41.86%
Yang (2004)	0	43	1.77	0.81	depression	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

## 2. Method

### 2.1. Literature search and inclusion criteria

We searched CNKI, WANFANG, Baidu Scholar, Google Scholar, PsycINFO, and Medline databases for studies or abstracts published until June 10, 2020. We used a combined set of keywords to identify SARS related studies. The search terms combination was: (SARS OR severe acute respiratory syndrome OR coronavirus) AND (mental health OR anxiety OR depression OR SCL-90 OR SAS OR SDS OR Post traumatic stress disorder OR PTSD OR Impact of Event Scale - Revised OR IES-R OR life quality). Inclusion criteria were original articles in English or Chinese that reported statistics of SCL-90, SAS or SDS scores of SARS patients.

Articles were excluded for the following reasons: lack of original data (reanalyses of previously analyzed datasets); failing to report essential

**Table 3**  
Studies included in the meta-analysis of SCL-90 somatization subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.54	0.59	somatization	NA	59.22%
Wang et al. (2003b)	-2	669	2.48	0.86	somatization	35	44.26%
Wang et al. (2003b)	0	177	1.84	0.73	somatization	NA	NA
Sun et al. (2003)	-1	35	2.11	0.33	somatization	30	88.57%
Xu et al. (2003)	-1	40	1.75	0.64	somatization	NA	NA
Liu et al. (2007)	0	48	2.31	0.96	somatization	NA	70.80%
Liu et al. (2007)	6	48	1.75	0.91	somatization	NA	70.80%
Liu et al. (2007)	12	48	1.65	0.98	somatization	NA	70.80%
Gao et al. (2005)	0	45	2.21	0.95	somatization	NA	73.30%
Gao et al. (2005)	6	45	1.64	0.75	somatization	NA	73.30%
Gao et al. (2005)	12	45	1.43	0.64	somatization	NA	73.30%
Lin et al. (2004)	4.5	45	1.75	0.88	somatization	32	48.89%
Xu et al. (2006)	-2	114	1.85	0.90	somatization	36.9	54.39%
Xu et al. (2006)	0	114	1.77	0.84	somatization	36.9	54.39%
Xu et al. (2006)	3	114	1.60	0.75	somatization	36.9	54.39%
Xue et al. (2005)	-2	116	1.85	0.90	somatization	36	55.17%
Xue et al. (2005)	0	116	1.77	0.84	somatization	36	55.17%
Xue et al. (2005)	12	116	1.60	0.75	somatization	36	55.17%
Duan et al. (2005)	-2	92	1.89	0.94	somatization	37	57.61%
Duan et al. (2005)	0	92	1.81	0.88	somatization	37	57.61%
Duan et al. (2005)	2	92	1.63	0.79	somatization	37	57.61%
Gao et al. (2006a, b)	6	67	1.64	0.75	somatization	NA	NA
Liu et al. (2007)	0	48	2.31	0.96	somatization	NA	70.80%
Liu et al. (2007)	6	48	1.75	0.91	somatization	NA	70.80%
Liu et al. (2007)	12	48	1.65	0.98	somatization	NA	70.80%
Wang et al. (2003c)	-1	40	1.75	0.64	somatization	NA	NA
Peng et al. (2005)	-1	102	1.87	0.37	somatization	31.70	52.94%
Yang (2004)	-2	43	1.72	0.87	somatization	34.5	41.86%
Yang (2004)	0	43	1.68	0.78	somatization	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

mental health scores; use of nonstandard mental health measures (indeed we relied only on studies using SCL-90, SAS, SDS, or IES-R); reporting only SCL-90 total scores (i.e., failing to provide subscale data); reporting only percentages of positive cases; focusing on other infectious diseases such as MERS; and failing to report data by specific follow-up times.

**Table 4**  
Studies included in the meta-analysis of SCL-90 hostility subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.31	0.50	hostility	NA	59.22%
Wang et al. (2003b)	-2	669	2.18	1.02	hostility	35	44.26%
Wang et al. (2003b)	0	177	2.16	0.97	hostility	NA	NA
Sun et al. (2003)	-1	35	1.49	0.12	hostility	30	88.57%
Xu et al. (2003)	-1	40	1.88	0.36	hostility	NA	NA
Liu et al. (2007)	0	48	2.01	0.86	hostility	NA	70.80%
Liu et al. (2007)	6	48	1.60	0.85	hostility	NA	70.80%
Liu et al. (2007)	12	48	1.46	0.98	hostility	NA	70.80%
Gao et al. (2005)	0	45	1.78	0.71	hostility	NA	73.30%
Gao et al. (2005)	6	45	1.68	0.85	hostility	NA	73.30%
Gao et al. (2005)	12	45	1.60	0.98	hostility	NA	73.30%
Lin et al. (2004)	4.5	45	1.37	0.33	hostility	32	48.89%
Xu et al. (2006)	-2	114	1.59	0.75	hostility	36.9	54.39%
Xu et al. (2006)	0	114	1.53	0.65	hostility	36.9	54.39%
Xu et al. (2006)	3	114	1.44	0.55	hostility	36.9	54.39%
Xue et al. (2005)	-2	116	1.59	0.75	hostility	36	55.17%
Xue et al. (2005)	0	116	1.53	0.65	hostility	36	55.17%
Xue et al. (2005)	12	116	1.44	0.55	hostility	36	55.17%
Gao et al. (2006a,b)	6	67	1.68	0.85	hostility	NA	NA
Liu et al. (2007)	0	48	2.01	0.86	hostility	NA	70.80%
Liu et al. (2007)	6	48	1.60	0.85	hostility	NA	70.80%
Liu et al. (2007)	12	48	1.64	0.98	hostility	NA	70.80%
Wang et al. (2003c)	-1	40	1.88	0.36	hostility	NA	NA
Peng et al. (2005)	-1	102	1.96	0.35	hostility	31.70	52.94%
Yang (2004)	-2	43	1.43	0.67	hostility	34.5	41.86%
Yang (2004)	0	43	1.47	0.66	hostility	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

### 2.2. Data coding

Data were extracted by the first author and one graduate student. Descriptive variables extracted were average score and standard deviation of SCL-90, SAS or SDS scores, percentage of positive symptoms, number of cases, age, female proportion, and follow-up time. All nine scores of SCL-90 symptom dimensions were coded separately. The 3 subscale scores of IES-R (intrusion, avoidance, and hyperarousal) were coded separately. If a study simultaneously reported the score at several follow-up time points, all effects were coded. (see Tables 1–12).

### 2.3. Statistical analysis

Most studies did not include control groups, which made it impossible to compare across different scales even when they measured the

**Table 5**  
Studies included in the meta-analysis of SCL-90 interpersonal sensitivity subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.31	0.46	interpersonal sensitivity	NA	59.22%
Wang et al. (2003b)	-2	669	2.32	0.78	interpersonal sensitivity	35	44.26%
Wang et al. (2003b)	0	177	2.04	0.91	interpersonal sensitivity	NA	NA
Sun et al. (2003)	-1	35	1.43	0.10	interpersonal sensitivity	30 .24	88.57%
Xu et al. (2003)	-1	40	2.00	0.57	interpersonal sensitivity	NA	NA
Liu et al. (2007)	0	48	2.02	0.82	interpersonal sensitivity	NA	70.80%
Liu et al. (2007)	6	48	1.68	0.90	interpersonal sensitivity	NA	70.80%
Liu et al. (2007)	12	48	1.64	0.76	interpersonal sensitivity	NA	70.80%
Gao et al. (2005)	0	45	1.75	0.69	interpersonal sensitivity	NA	73.30%
Gao et al. (2005)	6	45	1.68	0.90	interpersonal sensitivity	NA	73.30%
Gao et al. (2005)	12	45	1.64	0.82	interpersonal sensitivity	NA	73.30%
Lin et al. (2004)	4.5	45	1.52	0.49	interpersonal sensitivity	32	48.89%
Xu et al. (2006)	-2	114	1.62	0.68	interpersonal sensitivity	36.9	54.39%
Xu et al. (2006)	0	114	1.73	0.80	interpersonal sensitivity	36.9	54.39%
Xu et al. (2006)	3	114	1.63	0.70	interpersonal sensitivity	36.9	54.39%
Xue et al. (2005)	-2	116	1.62	0.68	interpersonal sensitivity	36	55.17%
Xue et al. (2005)	0	116	1.73	0.80	interpersonal sensitivity	36	55.17%
Xue et al. (2005)	12	116	1.63	0.70	interpersonal sensitivity	36	55.17%
Gao et al. (2006a,b)	6	67	1.68	0.90	interpersonal sensitivity	NA	NA
Liu et al. (2007)	0	48	2.02	0.82	interpersonal sensitivity	NA	70.80%
Liu et al. (2007)	6	48	1.68	0.90	interpersonal sensitivity	NA	70.80%
Liu et al. (2007)	12	48	1.64	0.76	interpersonal sensitivity	NA	70.80%
Wang et al. (2003c)	-1	40	2.00	0.57	interpersonal sensitivity	NA	NA
Peng et al. (2005)	-1	102	1.94	0.33	interpersonal sensitivity	31.70	52.94%
Yang (2004)	-2	43	1.60	0.63	interpersonal sensitivity	34.5	41.86%
Yang (2004)	0	43	1.78	0.83	interpersonal sensitivity	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 6**  
Studies included in the meta-analysis of SCL-90 obsessive-compulsive disorder subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.50	0.56	obsessive-compulsive disorder	NA	59.22%
Wang et al. (2003b)	-2	669	2.62	0.96	obsessive-compulsive disorder	35	44.26%
Wang et al. (2003b)	0	177	2.16	0.87	obsessive-compulsive disorder	NA	NA
Sun et al. (2003)	-1	35	1.77	0.32	obsessive-compulsive disorder	30 .24	88.57%
Xu et al. (2003)	-1	40	1.50	0.68	obsessive-compulsive disorder	NA	NA
Liu et al. (2007)	0	48	2.30	0.88	obsessive-compulsive disorder	NA	70.80%
Liu et al. (2007)	6	48	1.91	0.86	obsessive-compulsive disorder	NA	70.80%
Liu et al. (2007)	12	48	1.59	0.71	obsessive-compulsive disorder	NA	70.80%
Gao et al. (2005)	0	45	2.12	0.90	obsessive-compulsive disorder	NA	73.30%
Gao et al. (2005)	6	45	1.82	0.68	obsessive-compulsive disorder	NA	73.30%
Gao et al. (2005)	12	45	1.72	0.82	obsessive-compulsive disorder	NA	73.30%
Lu et al. (2006)	-2	116	NA	NA	obsessive-compulsive disorder	36	55.17%
Lu et al. (2006)	0	116	NA	NA	obsessive-compulsive disorder	36	55.17%
Lu et al. (2006)	24	116	NA	NA	obsessive-compulsive disorder	36	55.17%
Lin et al. (2004)	4.5	45	1.90	0.66	obsessive-compulsive disorder	32	48.89%
Xu et al. (2006)	-2	114	1.71	0.71	obsessive-compulsive disorder	36.9	54.39%
Xu et al. (2006)	0	114	1.80	0.80	obsessive-compulsive disorder	36.9	54.39%
Xu et al. (2006)	3	114	1.76	0.78	obsessive-compulsive disorder	36.9	54.39%
Xue et al. (2005)	-2	116	1.71	0.71	obsessive-compulsive disorder	36	55.17%
Xue et al. (2005)	0	116	1.80	0.80	obsessive-compulsive disorder	36	55.17%
Xue et al. (2005)	12	116	1.76	0.78	obsessive-compulsive disorder	36	55.17%
Gao et al. (2006a,b)	6	67	1.82	0.68	obsessive-compulsive disorder	NA	NA
Liu et al. (2007)	0	48	2.30	0.88	obsessive-compulsive disorder	NA	70.80%
Liu et al. (2007)	6	48	1.91	0.86	obsessive-compulsive disorder	NA	70.80%
Liu et al. (2007)	12	48	1.59	0.71	obsessive-compulsive disorder	NA	70.80%
Wang et al. (2003c)	-1	40	1.50	0.68	obsessive-compulsive disorder	NA	NA
Peng et al. (2005)	-1	102	1.91	0.38	obsessive-compulsive disorder	31.70	52.94%
Yang (2004)	-2	43	1.60	0.59	obsessive-compulsive disorder	34.5	41.86%
Yang (2004)	0	43	1.70	0.65	obsessive-compulsive disorder	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

same symptoms. To deal with that, we limited our review to studies that used the most frequently reported scales, for which published norms are available. We calculated all analyses using the Comprehensive Meta-Analysis (CMA 3.0). We used  $I^2$  and  $\tau$  to estimate heterogeneity variance. Values of  $I^2$  greater than 35% were deemed indicative of study heterogeneity. We used random-effects models for the analysis because

of the high heterogeneity. Because of the paucity of studies reporting percentage of positive mental health symptoms, we only meta-analyzed the score of mental illness scales.

Results of meta-analyses were grouped by follow-up time (admission, in hospital, hospital discharge, 1 month after discharge etc.). Furthermore, we performed a subgroup analyses to compare the effects

**Table 7**  
Studies included in the meta-analysis of SCL-90 paranoid ideation subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.26	0.43	paranoid ideation	NA	59.22%
Wang et al. (2003b)	-2	669	1.93	0.73	paranoid ideation	35	44.26%
Wang et al. (2003a,b,c)	0	177	1.78	0.81	paranoid ideation	NA	NA
Sun et al. (2003)	-1	35	1.32	0.06	paranoid ideation	30.24	88.57%
Xu et al. (2003)	-1	40	1.38	0.35	paranoid ideation	NA	NA
Liu et al. (2007)	0	48	1.72	0.74	paranoid ideation	NA	70.80%
Liu et al. (2007)	6	48	1.50	0.94	paranoid ideation	NA	70.80%
Liu et al. (2007)	12	48	1.45	0.84	paranoid ideation	NA	70.80%
Gao et al. (2005)	0	45	1.50	0.55	paranoid ideation	NA	73.30%
Gao et al. (2005)	6	45	1.48	0.94	paranoid ideation	NA	73.30%
Gao et al. (2005)	12	45	1.43	0.84	paranoid ideation	NA	73.30%
Lin et al. (2004)	4.5	45	1.46	0.61	paranoid ideation	32	48.89%
Xu et al. (2006)	-2	114	1.41	0.57	paranoid ideation	36.9	54.39%
Xu et al. (2006)	0	114	1.43	0.56	paranoid ideation	36.9	54.39%
Xu et al. (2006)	3	114	1.36	0.51	paranoid ideation	36.9	54.39%
Xue et al. (2005)	-2	116	1.41	0.57	paranoid ideation	36	55.17%
Xue et al. (2005)	0	116	1.43	0.56	paranoid ideation	36	55.17%
Xue et al. (2005)	12	116	1.36	0.51	paranoid ideation	36	55.17%
Gao et al. (2006a,b)	6	67	1.48	0.96	paranoid ideation	NA	NA
Liu et al. (2007)	0	48	1.62	0.74	paranoid ideation	NA	70.80%
Liu et al. (2007)	6	48	1.50	0.94	paranoid ideation	NA	70.80%
Liu et al. (2007)	12	48	1.45	0.84	paranoid ideation	NA	70.80%
Wang et al. (2003a,b,c)	-1	40	1.38	0.35	paranoid ideation	NA	NA
Peng et al. (2005)	-1	102	2.40	0.53	paranoid ideation	31.70	52.94%
Yang (2004)	-2	43	1.31	0.34	paranoid ideation	34.5	41.86%
Yang (2004)	0	43	1.37	0.40	paranoid ideation	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

at different follow-up time points. Funnel plots, Begg and Egger tests were conducted to check for the publication bias.

### 3. Results

#### 3.1. Sample characteristics

The initial search yielded 1124 results. Initially screening of abstracts left 50 articles. We further excluded 14 studies based upon our exclusion criteria. For the remaining 36 studies, 16 studies used the SCL-90, 13 studies used the SAS, 14 studies used the SDS, and 5 studies used the IES-R. Ultimately, 29 studies and 385 effects were included in our

**Table 8**  
Studies included in the meta-analysis of SCL-90 phobic anxiety subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.20	0.35	phobic anxiety	NA	59.22%
Wang et al. (2003b)	-2	669	3.42	1.13	phobic anxiety	35	44.26%
Wang et al. (2003b)	0	177	1.79	0.93	phobic anxiety	NA	NA
Sun et al. (2003)	-1	35	1.29	0.10	phobic anxiety	30.24	88.57%
Xu et al. (2003)	-1	40	1.62	0.28	phobic anxiety	NA	NA
Liu et al. (2007)	0	48	1.66	0.69	phobic anxiety	NA	70.80%
Liu et al. (2007)	6	48	1.50	0.85	phobic anxiety	NA	70.80%
Liu et al. (2007)	12	48	1.36	0.89	phobic anxiety	NA	70.80%
Gao et al. (2005)	0	45	1.60	0.68	phobic anxiety	NA	73.30%
Gao et al. (2005)	6	45	1.44	0.99	phobic anxiety	NA	73.30%
Gao et al. (2005)	12	45	1.33	0.89	phobic anxiety	NA	73.30%
Lin et al. (2004)	4.5	45	1.63	0.89	phobic anxiety	32	48.89%
Xu et al. (2006)	-2	114	1.38	0.63	phobic anxiety	36.9	54.39%
Xu et al. (2006)	0	114	1.48	0.74	phobic anxiety	36.9	54.39%
Xu et al. (2006)	3	114	1.36	0.61	phobic anxiety	36.9	54.39%
Xue et al. (2005)	-2	116	1.38	0.63	phobic anxiety	36	55.17%
Xue et al. (2005)	0	116	1.48	0.74	phobic anxiety	36	55.17%
Xue et al. (2005)	12	116	1.36	0.61	phobic anxiety	36	55.17%
Gao et al. (2006a,b)	6	67	1.44	0.99	phobic anxiety	NA	NA
Liu et al. (2007)	0	48	1.66	0.69	phobic anxiety	NA	70.80%
Liu et al. (2007)	6	48	1.50	0.85	phobic anxiety	NA	70.80%
Liu et al. (2007)	12	48	1.36	0.89	phobic anxiety	NA	70.80%
Wang et al. (2003c)	-1	40	1.62	0.28	phobic anxiety	NA	NA
Peng et al. (2005)	-1	102	3.29	0.49	phobic anxiety	31.70	52.94%
Yang (2004)	-2	43	1.34	0.45	phobic anxiety	34.5	41.86%
Yang (2004)	0	43	1.51	0.64	phobic anxiety	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

meta-analyses. This rapid meta-analysis followed PRISMA guidelines. Details of the selection of studies can be found Fig. 1.

#### 3.2. Quality assessment

We used the criteria established by Rogers et al. (2020), which was adapted from the Newcastle Ottawa Scale, to assess the quality of the study, see appendix. The coders rated the quality of the included studies. 21 of the 29 studies were rated poor or medium quality and only 8 were of high quality.

#### 3.3. Meta-analysis of SARS effect

For symptom severity scores, the weighted mean symptom score for



**Table 9**  
Studies included in the meta-analysis of SCL-90 psychoticism subscale score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Wang et al. (2003a)	-1	103	1.26	0.36	psychoticism	NA	59.22%
Wang et al. (2003b)	-2	669	2.14	0.76	psychoticism	35	44.26%
Wang et al. (2003b)	0	177	1.93	0.91	psychoticism	NA	NA
Sun et al. (2003)	-1	35	1.30	0.14	psychoticism	30	88.57%
Xu et al. (2003)	-1	40	1.25	0.37	psychoticism	NA	NA
Liu et al. (2007)	0	48	1.79	1.48	psychoticism	NA	70.80%
Liu et al. (2007)	6	48	1.48	0.84	psychoticism	NA	70.80%
Liu et al. (2007)	12	48	1.41	0.95	psychoticism	NA	70.80%
Gao et al. (2005)	0	45	1.62	0.60	psychoticism	NA	73.30%
Gao et al. (2005)	6	45	1.48	0.84	psychoticism	NA	73.30%
Gao et al. (2005)	12	45	1.38	0.95	psychoticism	NA	73.30%
Lu et al. (2006)	-2	116	NA	NA	psychoticism	36	55.17%
Lu et al. (2006)	0	116	NA	NA	psychoticism	36	55.17%
Lu et al. (2006)	24	116	NA	NA	psychoticism	36	55.17%
Lin et al. (2004)	4.5	45	1.18	0.38	psychoticism	32	48.89%
Xu et al. (2006)	-2	114	1.45	0.52	psychoticism	36.9	54.39%
Xu et al. (2006)	0	114	1.47	0.53	psychoticism	36.9	54.39%
Xu et al. (2006)	3	114	1.40	0.46	psychoticism	36.9	54.39%
Xue et al. (2005)	-2	116	1.45	0.52	psychoticism	36	55.17%
Xue et al. (2005)	0	116	1.47	0.53	psychoticism	36	55.17%
Xue et al. (2005)	12	116	1.40	0.46	psychoticism	36	55.17%
Gao et al. (2006a, b)	6	67	1.48	0.84	psychoticism	NA	NA
Liu et al. (2007)	0	48	1.79	0.70	psychoticism	NA	70.80%
Liu et al. (2007)	6	48	1.48	0.84	psychoticism	NA	70.80%
Liu et al. (2007)	12	48	1.41	0.95	psychoticism	NA	70.80%
Wang et al. (2003c)	-1	40	1.25	0.37	psychoticism	NA	NA
Peng et al. (2005)	-1	102	1.98	0.52	psychoticism	31.70	52.94%
Yang (2004)	-2	43	1.41	0.43	psychoticism	34.5	41.86%
Yang (2004)	0	43	1.37	0.40	psychoticism	34.5	41.86%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

the SCL-90 anxiety subscale at 12 months after hospital discharge, was 1.49 on a scale from 0 to 4, with higher scores meaning more symptoms (95% CI 1.41–1.58, N = 257). The anxiety subscale score was the highest at hospital admission (M = 2.12; 95% CI 1.24–3, N = 942) (see Table 13). The weighted mean symptom score for the SCL-90 depression subscale at 12 months after hospital discharge, was 1.57 (95% CI 1.48–1.67, N = 257). The depression subscale score was the highest in hospital 2.26 (95% CI 1.74–2.77, N = 320) (see Table 14).

**Table 10**  
Studies included in the meta-analysis of SAS score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Li et al. (2014)	-1	24	43	3.60	SAS	NA	29.17%
Xu et al. (2003)	-1	40	57.71	10.19	SAS	NA	NA
Yang et al. (2003)	-1	78	56.42	11.01	SAS	38.2	56.41%
Zhang et al. (2004)	-1	89	39.54	9.58	SAS	NA	50.60%
Wu (2003)	-1	14	48.08	6.55	SAS	37.4	42.86%
Wang et al. (2003c)	-1	40	57.71	10.19	SAS	NA	NA
Wang et al. (2003c)	-1	40	41.88	10.57	SAS	NA	NA
Yan et al. (2004)	3	286	36.68	9.65	SAS	33.43	52.80%
Yang et al. (2006a,b)	12	18	31.94	9.23	SAS	34.29	61.11%
Hong et al. (2009)	2	67	26.30	10.90	SAS	35	44.70%
Hong et al. (2009)	2	67	43.00	16.70	SAS	42.9	20.00%
Hong et al. (2009)	7	60	25.50	7.40	SAS	NA	NA
Hong et al. (2009)	7	60	37.50	15.60	SAS	NA	NA
Hong et al. (2009)	10	57	25.60	5.90	SAS	NA	NA
Hong et al. (2009)	10	57	42.90	16.20	SAS	NA	NA
Hong et al. (2009)	20	58	23.60	8.30	SAS	NA	NA
Hong et al. (2009)	20	58	37.10	15.60	SAS	NA	NA
Hong et al. (2009)	46	57	22.70	7.70	SAS	NA	NA
Hong et al. (2009)	46	57	37.20	21.00	SAS	NA	NA

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

Somatization is the tendency to experience physical symptoms of a psychiatric condition such as depression. The weighted mean symptom score for the SCL-90 somatization subscale score was the highest at hospital admission 1.96 (95% CI 1.6–2.33, N = 1034), declined during hospital time to 1.81 (95% CI 1.61–2.01, N = 320), and rebounded at hospital discharge (M = 1.93; 95% CI 1.79–2.08, N = 799), and then dropped during the first two months and maintained at a high level even after 12 months. (see Table 15)

The weighted mean symptom score for the SCL-90 interpersonal sensitivity subscale fluctuated following a similar pattern of depression score. It reached the highest point at hospital discharge 1.79 (95% CI 1.34–2.24, N = 942), and dropped to its lowest level at 12 months after hospital discharge 1.63 (95% CI 1.54–1.73, N = 257). (see Table 16)

The weighted mean symptom score for the SCL-90 hostility subscale score increased to the highest at hospital discharge 1.78 (95% CI 1.56–2, N = 591), and then keep falling and dropped to 1.47 (95% CI 1.39–1.56, N = 257) at 12 months. The weighted mean symptom score for the SCL-90 phobic anxiety subscale score was the highest at hospital admission 1.88 (95% CI 0.72–3.04, N = 942). (see Table 17).

Patients at discharge had the most severe symptoms on obsessive-compulsive disorder: the weighted mean score was 2.01 (95% CI 1.83–2.19, N = 591) (see Table 20). The paranoid ideation and psychoticism symptoms level were relatively low across all time periods compared with other SCL-90 symptom dimensions. (see Tables 18 and 21)

All sub-scores of SCL-90 dropped significantly after release from

**Table 11**  
Studies included in the meta-analysis of SDS score.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Liu et al. (2006)	-1	126	40.80	9.60	SDS	35	NA
Liu et al. (2006)	-1	120	36.80	8.00	SDS	35	NA
Liu et al. (2006)	0	81	47.20	4.80	SDS	35	NA
Liu et al. (2006)	0	85	43.20	9.60	SDS	35	NA
Liu et al. (2006)	12	31	41.60	9.60	SDS	35	NA
Liu et al. (2006)	12	67	38.40	9.60	SDS	35	NA
Xu et al. (2003)	-1	40	57.71	10.19	SDS	NA	NA
Liu et al. (2003)	-1	500	43.10	8.60	SDS	35.5	56.60%
Zhang et al. (2004)	-1	89	41.33	11.47	SDS	NA	50.60%
Wu (2003)	-1	14	56.49	11.85	SDS	37.4	42.86%
Huang et al. (2004)	-1	109	37.76	9.03	SDS	NA	79.80%
Huang et al. (2004)	-1	109	41.28	9.66	SDS	NA	79.80%
Wang et al. (2003c)	-1	40	67.09	7.09	SDS	NA	NA
Wang et al. (2003c)	-1	40	67.25	6.36	SDS	NA	NA
Zhao et al. (2003)	-1	47	NA	NA	SDS	NA	29.79%
Yan et al. (2004)	3	286	40.76	11.59	SDS	33.43	52.80%
Yang et al. (2006a,b)	12	18	40.94	7.30	SDS	34.29	61.11%
Hong et al. (2009)	2	67	33.90	10.30	SDS	35	44.70%
Hong et al. (2009)	2	67	47.40	11.20	SDS	42.9	20.00%
Hong et al. (2009)	7	60	35.10	13.20	SDS	NA	NA
Hong et al. (2009)	7	60	44.30	10.90	SDS	NA	NA
Hong et al. (2009)	10	57	31.50	8.70	SDS	NA	NA
Hong et al. (2009)	10	57	47.00	13.50	SDS	NA	NA
Hong et al. (2009)	20	58	26.10	7.20	SDS	NA	NA
Hong et al. (2009)	20	58	43.70	12.20	SDS	NA	NA
Hong et al. (2009)	46	57	26.10	7.70	SDS	NA	NA
Hong et al. (2009)	46	57	41.10	18.10	SDS	NA	NA

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.

Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

hospital. The effect changes (*d*) from the highest point to the end of the first 12 months were respectively 5.58, 7.93, 6.29, 3.29, 5.74, 3.88, 4.71, 3, 3.61 for anxiety, depression, somatization, interpersonal sensitivity, hostility, phobic anxiety, obsessive-compulsive disorder, paranoid ideation and psychoticism. Depression symptoms improved the most and paranoid ideation symptoms improved the least (though the latter were low throughout, yielding therefore relatively little room for improvement).

To estimate the degree of recovery, we consulted a sample of normal and healthy people in China (N = 1890, year = 2003) (Tong, 2010). The SCL-90 scores of SARs survivors across the studies reviewed here at 12 months after hospital discharge were still slightly higher than the scores of the general population sample at most dimensions. Thus, the mental

health problems diminished over the first year after having SARS but did not entirely disappear even after a year.

We also meta-analyzed the SARS patients' anxiety and depression score with SAS and SDS score, (see Tables 22 and 23). The results showed that the SDS score was the highest in hospital 48.87 (95% CI 42.53, 55.21) (no data at hospital admission was reported) and dropped to the lowest level 33.44 (95% CI 18.75, 48.14) at 12 months after discharge. SDS scores can range from 20 to 80, with most depressed people scoring 50–69, and above 70 indicating severe depression. The SAS score fluctuated in a similar pattern to SDS score and declined from 50.21 (95% CI 42.99–57.42, N = 325) in hospital to 29.72 (95% CI 15.52,43.92) at 12 months after discharge. SAS total scores can range from 20 to 80, and 36 is the cutoff score for clinical screening. The effect of change for SAS and SDS score were *d* = 7.80 and 4.92. These indicate quite large drops in mental health symptoms during the first year after release from hospital.

All 3 subscales of IES-R scores reduced slowly during the first 12 months after hospital discharge, (see Table 24). The changes of subscale scores were not obvious. The effect of change for IES-R avoidance, intrusion, hyperarousal, and total scores were *d* = 1.11, 1.06, 1.13, 3.24. Unfortunately, there were not enough data on PTSD to permit reliable meta-analysis.

### 3.4. Publication bias

We used funnel plot and Egger's test for publication bias at each time point. Only time points with more than 5 effect sizes were analyzed. The funnel plots were symmetrical, and the Egger's tests were not significant. Thus, no evidence of bias was found.(see Tables 25–27).

## 4. Discussion

To our knowledge, this is the first systematic meta-analysis of the long-term mental health status of coronavirus infection on hospitalized patients. Across the 29 studies included in the meta-analyses, mental symptoms were widespread at clinically significant levels upon release from hospital. They declined significantly during the ensuing year, and on average dropped out of the clinically significant range — but the symptoms remained higher than norms for healthy individuals, and some individuals continued to have clinical levels of symptoms beyond a year.

We identified 16 independent studies that reported specific statistics of SARS patients' mental health effect using SCL-90. The SCL-90 scale, consisting of 9 dimensions, is the most widely used psychological inventory in China to measure patient mental health status in 2000s. The 9 dimensions it includes are somatization, obsessive-compulsive disorder, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Among them, somatization, depression, anxiety, phobic anxiety, and obsessive-compulsive disorder are the most severe symptoms that SARS patients reported at the initial stage of infection. SARS patients also experienced a variety of physical symptoms such as shortness of breath and pain.

During the first 12 months after hospital discharge, all 9 dimensions of symptoms declined significantly. The aggregate scores of SDS and SAS likewise dropped sharply during the first 3 months after hospital discharge. There was some evidence of continued improvement (symptom reduction) beyond 12 months. The SAS scores dropped slowly from 31.94 (95% CI 27.68–36.2, N = 18) at 12 months after hospital discharge to 29.72 [15.52–43.92, N = 114] at 46 months after hospital discharge. The SDS scores dropped significantly from 39.98 (95% CI 37.9–42.05, N = 116) at 12 months after hospital discharge to 33.44 [18.75–48.14, N = 114] at 46 months after hospital discharge, suggesting the depression symptoms continued to diminish after the 1st year of hospital discharge.

Data from IES-R scores suggest similar patterns, but there were relatively few studies using this scale, so our findings with it may be less



**Table 12**  
Studies included in the meta-analysis of IRS total and subscale scores.

Author	Time	N	Effect	S.D.	Subscale	Age	Female
Sun (2005)	3	35	20.06	3.44	Total	39.69	54.39%
Sun (2005)	12	35	14.08	2.41	Total	43.69	54.39%
Xu et al. (2005)	3	114	27.07	20.36	Total	36.9	54.39%
Sun (2005)	3	35	11.28	1.93	Intrusion	36.69	54.39%
Sun (2005)	12	35	6.32	1.08	Intrusion	40.69	54.39%
Lee et al. (2007)	12	49	16	7.2	Intrusion	NA	55.10%
Lee et al. (2007)	12	30	8.8	6.4	Intrusion	NA	83.30%
Wu et al. (2005)	1	131	8.96	5.84	Intrusion	NA	NA
Wu et al. (2005)	3	131	7.28	5.92	Intrusion	NA	NA
Yang et al. (2006a,b)	12	18	4.24	4.32	Intrusion	34.29	61.11%
Xu et al. (2005)	3	114	11.37	9.54	Intrusion	36.9	54.39%
Sun (2005)	3	35	6.14	1.07	Hyperarousal	38.69	54.39%
Sun (2005)	12	35	4.75	0.83	Hyperarousal	42.69	54.39%
Lee et al. (2007)	12	49	10.2	6	Hyperarousal	NA	55.10%
Lee et al. (2007)	12	30	6	4.8	Hyperarousal	NA	83.30%
Wu et al. (2005)	1	131	6.3	4.74	Hyperarousal	NA	NA
Wu et al. (2005)	3	131	5.1	4.44	Hyperarousal	NA	NA
Yang et al. (2006a,b)	12	18	2.4	3.24	Hyperarousal	34.29	61.11%
Xu et al. (2005)	3	114	6.55	6.2	Hyperarousal	36.9	54.39%
Sun (2005)	3	35	7.16	1.22	Avoidance	37.69	54.39%
Sun (2005)	12	35	4.33	0.74	Avoidance	41.69	54.39%
Lee et al. (2007)	12	49	12	6.4	Avoidance	NA	55.10%
Lee et al. (2007)	12	30	7.2	6.4	Avoidance	NA	83.30%
Yang et al. (2006a,b)	12	18	6.48	5.04	Avoidance	34.29	61.11%
Xu et al. (2005)	3	114	10.28	7.67	Avoidance	36.9	54.39%

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

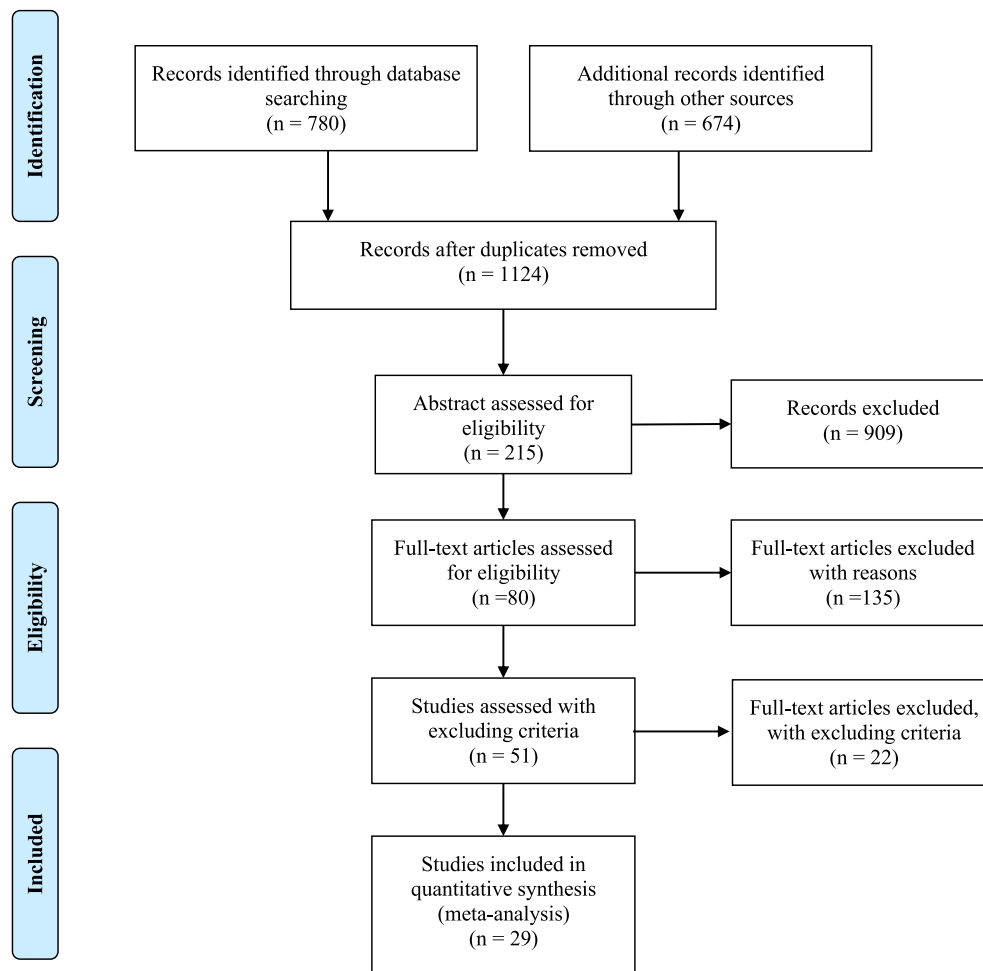


Fig. 1. Flowchart of study selection.

**Table 13**  
Meta-analysis of SCL-90 anxiety subscale score.

Time	K	N	Scores	I2	τ
-2	4	942	2.12[1.24, 3]	99.47	0.89
-1	5	320	1.96 [1.60, 2.31]	97.57	0.39
0	7	591	1.87[1.77, 1.97]	57.69	0.10
3	1	114	1.5[1.38, 1.62]	0.00	0.00
4.5	1	45	1.69[1.41, 1.97]	0.00	0.00
6	4	208	1.70[1.61, 1.79]	0.00	0.00
12	4	257	1.49[1.41, 1.58]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 14**  
Meta-analysis of SCL-90 depression subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.98[1.55,2.41]	97.41	0.43
-1	5	320	2.26 [1.74, 2.77]	99.34	0.58
0	7	591	1.99[1.79,2.2]	88.06	0.25
3	1	45	1.59[1.45,1.73]	0.00	0.00
4.5	1	45	1.64[1.45,1.83]	0.00	0.00
6	4	208	1.88[1.77, 1.99]	0.00	0.00
12	4	257	1.57[1.48,1.67]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 15**  
Meta-analysis of SCL-90 somatization subscale score.

Time	k	N	Scores	I2	τ
-2	5	1034	1.96 [1.6,2.33]	96.73	0.41
-1	5	320	1.81[1.61,2.01]	92.35	0.21
0	8	799	1.93[1.79,2.08]	78.44	0.18
2	1	92	1.63[1.47,1.79]	0.00	0.00
3	1	114	1.6[1.46,1.74]	0.00	0.00
4.5	1	45	1.75[1.49,2.01]	0.00	0.00
6	4	208	1.68[1.57,1.79]	0.00	0.00
12	4	257	1.57[1.47,1.66]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 16**  
Meta-analysis of SCL-90 interpersonal sensitivity subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.79[1.34,2.24]	98.45	0.46
-1	5	320	1.68[1.46,1.91]	97.60	0.25
0	7	591	1.86[1.74,1.98]	67.03	0.13
3	1	114	1.63[1.5,1.76]	0.00	0.00
4.5	1	45	1.52[1.38,1.66]	0.00	0.00
6	4	208	1.68[1.56,1.80]	0.00	0.00
12	4	257	1.63[1.54,1.73]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

stable than with the other measures. All 3 subscales of IES-R scores reduced slowly during the first 12 months after hospital discharge. Unfortunately, we did not find any reports on SARS' patients' IES-R scores beyond 12 months.

**Table 17**  
Meta-analysis of SCL-90 hostility subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.7[1.31,2.09]	97.29	0.39
-1	5	320	1.68[1.46,1.91]	97.60	0.25
0	7	591	1.78[1.56,2]	91.83	0.28
3	1	114	1.44[1.34,1.54]	0.00	0.00
4.5	1	45	1.37[1.27,1.47]	0.00	0.00
6	4	208	1.64[1.53,1.76]	0.00	0.00
12	4	257	1.47[1.39,1.56]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 18**  
Meta-analysis of SCL-90 paranoid ideation subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.52[1.18,1.86]	98.34	0.35
-1	5	320	1.45[1.22,1.68]	98.30	0.26
0	7	591	1.54[1.42,1.66]	82.64	0.15
3	1	114	1.36[1.27,1.45]	0.00	0.00
4.5	1	45	1.46[1.28,1.64]	0.00	0.00
6	4	208	1.49[1.36,1.62]	0.00	0.00
12	4	257	1.39[1.31,1.46]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 19**  
Meta-analysis of SCL-90 phobic anxiety subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.88[0.72,3.04]	99.77	1.18
-1	5	320	1.80[1.20,2.4]	99.75	0.68
0	7	591	1.59[1.5,1.69]	59.83	0.10
3	1	114	1.36[1.25,1.47]	0.00	0.00
4.5	1	45	1.63[1.37,1.89]	0.00	0.00
6	4	208	1.47[1.35,1.60]	0.00	0.00
12	4	257	1.36[1.27,1.45]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 20**  
Meta-analysis of SCL-90 obsessive-compulsive disorder subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.91[1.33,2.49]	0.00	0.59
-1	5	320	1.65[1.46,1.84]	91.93	0.21
0	7	591	2.01[1.83,2.19]	0.00	0.22
3	1	114	1.76[1.62,1.9]	1.00	0.00
4.5	1	45	1.90[1.71,2.09]	0.00	0.00
6	4	208	1.85[1.75, 1.95]	0.00	0.00
12	4	257	1.68[1.59,1.77]	0.41	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

Several recent studies available for COVID-19 patients' mental status currently provide preliminary information about how COVID-19-related psychiatric symptoms develop and change. During their hospital stay, a significantly high proportion of patients reported depression (60.2%), anxiety (55.3%) (Guo et al., 2020) and PTSD (96.2%) (Bo et al., 2020).

**Table 21**  
Meta-analysis of SCL-90 psychoticism subscale score.

Time	k	N	Scores	I2	τ
-2	4	942	1.61[1.19,2.04]	98.90	0.43
-1	5	320	1.39[1.24,1.53]	92.81	0.16
0	7	591	1.62[1.46,1.77]	88.53	0.19
3	1	114	1.4[1.32,1.48]	0.00	0.00
4.5	1	45	1.18[1.07,1.29]	0.00	0.00
6	4	208	1.48[1.37,1.59]	0.00	0.00
12	4	257	1.4[1.33,1.47]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 22**  
Meta-analysis of SAS score.

Time	k	N	Scores	I2	τ
-1	6	325	50.21[42.99,57.42]	97.49	8.89
2	2	134	34.58[18.21,50.94]	97.87	11.68
3	1	286	36.68[35.56,37.8]	0.00	0.00
7	2	120	31.37[19.61,43.13]	96.55	8.34
10	2	114	34.13[17.18,51.09]	98.26	12.13
12	1	18	31.94[27.68,36.2]	0.00	0.00
20	2	116	30.24[17.01,43.47]	97.05	9.40
46	2	114	29.72[15.52,43.92]	95.83	10.04

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 23**  
Meta-analysis of SDS score.

Time	k	N	Scores	I2	τ
-1	10	1187	48.87[42.53,55.21]	99.26	10.14
0	2	166	45.3[41.38,49.22]	91.45	2.70
2	2	134	40.64[27.41,53.87]	98.10	9.46
3	1	286	40.76[39.42,42.1]	0.00	0.00
7	2	120	39.75[30.73,48.77]	94.23	6.31
10	2	114	39.19[24.54,38]	98.12	10.86
12	3	116	39.98[37.9,42.05]	32.28	1.05
20	2	116	34.85[17.61,52.1]	98.88	12.38
46	2	114	33.44[18.75,48.14]	96.98	10.45

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 24**  
Meta-analysis of IRS-R avoidance score.

Time	k	N	Scores	I2	τ
1	1	35	8.96 [7.96, 9.96]	0.00	0.00
3	3	280	9.95 [7.11, 12.79]	95.51	2.44
12	4	132	8.8 [4.51, 13.10]	96.84	4.29

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

Liu et al. (2020a,b) found that the prevalence rate of clinically significant depression, anxiety, and PTSD symptoms for hospital discharged COVID-19 patients are respectively 19%, 10.4%, and 12.4%, which is a significant drop compared with Bo's finding. But no longer-term follow-up data after hospital discharge are available for COVID, because the pandemic is still less than a year old. Differences may emerge

**Table 25**  
Meta-analysis of IRS-R intrusion score.

Time	k	N	Scores	I2	τ
1	1	35	8.96 [7.96, 9.96]	0.00	0.00
3	3	280	9.95 [7.11, 12.79]	95.51	2.44
12	4	132	8.8 [4.51, 13.10]	96.84	4.29

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 26**  
Meta-analysis of IRS-R hyperarousal score.

Time	k	N	Scores	I2	τ
1	1	35	6.3 [5.49, 7.11]	0.00	0.00
3	3	280	5.9 [3.31,8.26]	70.92	0.56
12	4	132	5.79[5.13, 6.66]	94.17	2.42

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

**Table 27**  
Meta-analysis of IRS-R total score.

Time	k	N	Scores	I2	τ
3	2	149	23.33 [16.48, 30.18]	91.91	4.75
12	1	35	14.08 [13.28, 14.88]	0.00	0.00

Note: -2 refers to hospital admission; -1 refers to in hospital; 0 refers to hospital discharge.  
Time = months after hospital discharge; N = sample size; Female = female proportion in the sample.

between SARS and the more recent COVID-19, but for now, the data on SARS provide a basis for speculatively predicting what will happen to people suffering from COVID-19 in the coming months.

#### 4.1. Limitations

This study provides a comprehensive data set of mental health outcomes and changes of coronavirus infected patients. Nevertheless, several limitations must be acknowledged. Most studies included in our analyses were of low to moderate quality. All studies used Chinese adult samples, which limits the generalizability of our findings. In particular, no adolescent or child samples were available. Most studies were cross-sectional and lacked baseline psychiatric assessments before coronavirus infection. Most studies collected data on patients' mental health status within the 1st year after hospital discharge, so longer-term data beyond 12 months were scarce.

The data mainly concern people who were hospitalized and thus presumably had severe forms of the illness. With COVID, many people have no or minimal physical symptoms (while others become intensely sick), and it seems reasonable to assume that the people with the worst physical symptoms will also be at risk for the most severe mental health symptoms. In other words, our findings should not be generalized to everyone who is infected with the coronavirus but rather only to the more severe cases.

We relied on the most commonly used measures, but inevitably these omit mental health issues that depend on other measures. In our view, the most serious gap in the literature we reviewed was PTSD. Our sample did not have enough PTSD data to analyze. Future work should attend particularly to PTSD, given that these symptoms sometimes last far longer than others.

## 5. Conclusion

The coronavirus causes physical illness, but it also has lasting mental health consequences (at least for people whose illness is severe enough to warrant hospitalization). The present data cannot address the important question of what causes these mental health problems. They may be due to direct action by the virus on the brain and central nervous system. Alternatively, they may arise from the stresses caused by hospitalization with poorly understood illness amid widespread societal concern, and/or experiences such as exposure to deaths of other hospital patients and family members.

Our review of studies done on people afflicted with the 2002 SARS coronavirus found that people who were hospitalized with that virus retained significantly elevated levels of mental illness symptoms even 12 months after hospital discharge — although, fortunately, all symptoms declined by substantial amounts during that first year, and the majority of people were no longer in the clinically significant range after one year. The problems were not confined to one particular symptom but

rather were diverse, indeed covering all nine subscales of the SCL-90 measure (though paranoid ideation and psychoticism scores were generally lower than the others). Nearly all symptoms were worst at or before hospital discharge, so there is a general trend toward improved mental health over the months after discharge. Nevertheless, it seems fair to conclude that the mental symptoms stemming from coronavirus infection endure much longer than the physical symptoms of the disease.

## Declaration of competing interest

All authors declare that they have no conflicts of interest.

## Acknowledgements

This study is supported by fund for building world-class universities (disciplines) of Renmin University of China. Project No. KYGJA2020001 and the project of Journalism Research Center, Renmin University of China (RMXW2018A005).

## Appendix

### Studies quality assessment

**Table A1**

Assessment of Study Quality included in the Analysis

ID	Author	Year	Title	Quality category: Low 0–3 Medium 4–6 High 7–9
1	Li	2004	Coping style, anxiety and nursing of SARS patients	Low
2	Wang	2003	Analytical report on SCL-90 of 103 SARS patients	Medium
3	Liu	2006	Cohort Study on Relationship between Psychological Health Status and Clinical Features in Patients with Severe Acute Respiratory Syndrome	Medium
4	Wang	2003	Clinical psychological intervention model and efficacy evaluation of SARS patients	High
5	Sun	2003	The psychological analysis for the medical staffs suffered with SARS	High
6	Xu	2003	A Comparative Study on mental health between anti-SARS first-line medical workers and SARS patients	Medium
7	Gao	2005	Follow-up study on mental health status of SARS patients	High
8	Lin	2004	Mental Status of Recovered SARS Patients	Medium
9	Xu	2006	Follow-up study on psychiatric symptoms of SARS patient	High
10	Xue	2005	Follow-up study on mental symptoms of SARS patients	High
11	Liu	2003	Psychological health status among 500 SARS patients	Medium
12	Yang	2003	Analysis of anxiety in 78 SARS patients	Low
13	Zhang	2004	An analysis of depression and anxiety in 89 SARS patient	Low
14	Duan	2005	Study on somatization disorders and related factors in SARS patients at different stages	Medium
15	Wu	2003	Investigation of mental health status of SARS patients	Low
16	Huang	2004	A study on the differences of emotion and depression between patients as doctor/nurse and others occupation with severe acute respiratory syndrome	Low
17	Gao	2006	A path analysis of mentality for the SARS patients after discharge	High
18	Liu	2007	Changes of the stress state of patients with Severe Acute Respiratory Syndrome (SARS)	Medium
19	Wang	2003	Comparison of Psychological Status between Patients with SARS and Physicians, Nurses Treating SARS	Low
20	Yan	2004	Survey on Mental Status of Subjects Recovered from SARS	Low
21	Peng	2005	Investigation of Mental Health Level and Correlative Factors of Fever Patients in Period of SARS at Outpatient Department	Medium
22	Yang	2006	The Impact of the SARS on the Mentality and Behavior of the Different Population	Low
23	Yang	2004	Exploration of response of psychology and psychological nursing intervention of SARS patients	High
24	Hong	2009	Posttraumatic stress disorder in convalescent severe acute respiratory syndrome patients: a 4-year follow-up study	Medium
25	Lee	2007	Stress and Psychological Distress among SARS Survivors 1 Year After the Outbreak	Low
26	Sun	2005	Follow-up study on PTSD among SARS patients and its relative factors	High
27	Lee	2007	Stress and Psychological Distress Among SARS Survivors 1 Year After the Outbreak	Low
28	Wu	2005	Posttraumatic Stress after SARS	Low
29	Xu	2005	Control Study on Posttraumatic Stress Response in SARS Patients and the Public in SARS Prevalent Area	Medium

## References

### Studies included in the Meta-analysis

- Bo, H.X., Li, W., Yang, Y., Wang, Y., Zhang, Q., Cheung, T., Wu, X., Xiang, Y.T., 2020. Posttraumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China. *Psychol. Med.* 1–2 <https://doi.org/10.1017/S0033291720000999>.
- (\*) Duan, H.J., Xu, Y., Liu, Z.G., et al., 2005. Study on somatization disorders and related factors in SARS patients at different stages. *Chin. Public Health* 21, 516–517.

- (\*) Gao, H.S., Chen, Z.F., Liu, S.H., et al., 2005. Follow-up study on mental health status of SARS patients. *Chin. J. Rehabil. Med.* 20, 602–603.
- Gao, H., Hui, W.L., Lan, X.X., Wei, J., Hu, Y.L., Li, Q., Zhang, Z.Q., Yuan, S.T., Jiao, Z.S., 2006a. A follow-up study of post-traumatic stress disorder of SARS patients after discharge. *Chin. J. Rehabil. Med.* 21 (11), 1003–1004.
- (\*) Gao, H.S., Lan, X.X., Liu, S.H., et al., 2006b. A path analysis of mental symptom influencing factor path for SARS patients after discharge. *Chin. J. Rehabil. Med.* 21, 832–834.

- Guo, Q., Zheng, Y., Shi, J., Wang, J., Li, G., Li, C., et al., 2020. Immediate psychological distress in quarantined patients with COVID-19 and its association with peripheral inflammation: a mixed-method study. *Brain, Behav. Immun.* <https://doi.org/10.1016/j.bbi.2020.05.038>.
- Hong, X., Currier, G.W., Zhao, X., Jiang, Y., Zhou, W., Wei, J., 2009a. Posttraumatic stress disorder in convalescent severe acute respiratory syndrome patients: a 4-year follow-up study. *Gen. Hosp. Psychiatr.* 31 (6), 546–554.
- (\*) Hong, Xia, Currier, G.W., Zhao, X.H., et al., 2009b. Posttraumatic stress disorder in convalescent severe respiratory syndrome patients: a 4-year follow-up study. *Gen. Hosp. Psychiatr.* 31, 546–554.
- (\*) Huang, W., Hua, Q., Wu, H., et al., 2004. A study on the psychological state of SARS patients. *Chin. J. Epidemiol.* 25, 23–26.
- Lam, M.H.B., Wing, Y.K., Yu, M.W.M., Leung, C.M., Ma, R.C., Kong, A.P., et al., 2009. Mental morbidities and chronic fatigue in severe acute respiratory syndrome survivors: long-term follow-up. *Arch. Intern. Med.* 169 (22), 2142–2147.
- (\*) Lee, Antoinette, M., Wong, J.G., McAlonan, G., et al., 2007. Stress and psychological distress among SARS survivors 1 year after the outbreak. *Can. J. Psychiatr.* 52 (4), 233–240.
- (\*) Li, L.Y., Diao, L.Y., Yin, Q., 2014. Coping style and anxiety analysis and psychological nursing of SARS patients. *J. Naval Gen. Hosp.* 17, 56–57.
- (\*) Lin, Z.Z., Zuo, X.P., Zhong, S.Q., 2004. Mental status of recovered SARS patients. *Chin. J. Ment. Health* 18, 129–131.
- (\*) Liu, L.S., Li, X.W., Hua, Q., et al., 2003. Investigation and analysis of mental health status of 500 SARS patients. *J. Cap. Med. Univ.* 24, 116–118.
- (\*) Liu, Z.H., Hua, Q., Zhang, J., 2006. A cohort study on the mental health status of mild and severe SARS patients. *J. Cap. Univ. Med. Sci.* 27, 82–85.
- (\*) Liu, S., Gao, H., Hu, Y., 2007. Changes of the psychological stress of SARS patients. *Mod. Prev. Med.* 3447–3452.
- Liu, D., Baumeister, R.F., Veilleux, J.C., Chen, C., Liu, W., Yue, Y., Zhang, S., 2020a. Risk factors associated with mental illness in hospital discharged patients infected with COVID-19 in Wuhan, China. *Psychiatr. Res.* 292 (2020) <https://doi.org/10.1016/j.psychres.2020.113297>. Article 113297.
- Liu, D., Wang, Y., Wang, J., et al., 2020b. Characteristics and outcomes of a sample of patients with COVID-19 identified through social media in Wuhan, China: observational study. *J. Med. Internet Res.* 22 (8), e20108 <https://doi.org/10.2196/20108>. Aug.
- Mao, L., Jin, H., Wang, M., Hu, Y., Chen, S., He, Q., et al., 2020. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol.* 77 (6), 683–690. <https://doi.org/10.1001/jamaneurol.2020.1127>.
- (\*) Lu, L., Xue, Y., Liang, Z., Xu, Y., Zhang, K., 2006. Status of mental health among patients with SARS. *Chin. J. Health Educ.* 22 (9), 701–706.
- (\*) Peng, Y.E., He, G.P., 2005. Investigation of mental health level and correlative factors of fever patients in period of SARS at out-patient department. *Mod. Nurs.* 11, 1682–1684.
- Rogers, J.P., Chesney, E., Oliver, D., Pollak, T.A., McGuire, P., Fusar-Poli, P., et al., 2020. Psychiatric and neuropsychiatric presentations associated with severe coronavirus infections: a systematic review and meta-analysis with comparison to the COVID-19 pandemic. *Lancet Psychiatr.* [https://doi.org/10.1016/S2215-0366\(20\)30203-0](https://doi.org/10.1016/S2215-0366(20)30203-0).
- (\*) Sun, H., Meng, Q.H., Yang, F.C., Zhang, H.W., Ren, X., 2003. Analysis of psychological status of medical staff in SARS patients. *Chin. J. Behav. Med. Sci.* 12, 74–75.
- (\*) Sun, Y., 2005. Follow-up Study on PTSD among SARS Patients and its Relative Factors. Shanxi Medical University. Master thesis.
- Tong, H., 2010. A research of twenty years' vicissitude: SCL-90 and its norm. *Psychol. Sci.* 33 (4), 928–930.
- (\*) Wang, W.D., Wu, L., Zhao, T., et al., 2003a. Analysis of SCL-90 factor characteristics of 103 patients with SARS convalesce. *Chin. J. Behav. Med. Sci.* 12, 548–551.
- (\*) Wang, Z.Q., Zhu, Z.H., Zhu, H.W., et al., 2003b. Clinical psychological intervention model and efficacy evaluation of SARS patients. *Chin. J. Ment. Health* 17, 587–590.
- (\*) Wang, F.Q., Xu, J.Y., Liu, Q.A., et al., 2003c. Comparison of psychological status between patients with SARS and physicians, nurses treating SARS. *Chin. J. Ment. Health* 17, 532–533.
- (\*) Wu, W.Q., 2003. Investigation of mental health status of SARS patients. *Chin. Gen. Pract.* 7, 82.
- (\*) Wu, K.K., Chan, S.K., Ma, T.M., 2005. Posttraumatic stress after SARS. *Emerg. Infect. Dis.* 11 (8), 1297–1300. <https://doi.org/10.3201/eid1108.041083>.
- (\*) Xu, Y., Zhang, K.R., Yang, H., et al., 2006. Follow-up study of psychological symptoms in patients with severe acute respiratory syndrome. *Chin. J. Behav. Med. Sci.* 15, 237–239.
- (\*) Xue, Y.Z., Lu, L., Zhao, H.W., et al., 2005. Follow-up study on psychological symptoms of SARS patients. *Chin. Public Health* 21, 523–524.
- (\*) Yan, F., Dun, Z., Li, S.R., Yan, J., Liu, M., 2004. A survey of mental health status of recovered patients. *Chin. J. Ment. Health* 18, 675–677.
- (\*) Yang, H., 2004. Research on Psychological Stress Response and Psychological Nursing Intervention of SARS Patients, PhD dissertation. Shanxi Medical University.
- (\*) Yang, S.L., Liu, L.J., Dai, L., et al., 2003. Analysis of anxiety in 78 SARS patients. *South. J. Nurs.* 10, 27–28.
- (\*) Yang, C.H., Wang, Y.F., Pan, J.Y., Wen, S.L., 2006a. The Impact of the SARS on the Mental Health of the Different Population, pp. 159–161.
- (\*) Yang, C.H., Wang, Y.F., Pan, J.Y., Wen, S.L., 2006b. The impact of the SARS on the mentality and behavior of the different population. *J. Trop. Med.* 6, 159–161.
- (\*) Zhang, Z.Y., Tong, X.L., Li, A.G., Chen, X.L., Duan, J., 2004. An analysis of depression and anxiety in 89 SARS patients. *Med. Res. Newsl.* 33, 47–49.
- (\*) Zhao, M., Yang, A.J., He, X.J., Feng, X.L., Zhang, R.Z., 2003. Psychological characteristics and psychological nursing of SARS and suspected SARS patients. *J. Gen. Hosp. Air Force* 19 (3), 169–170.