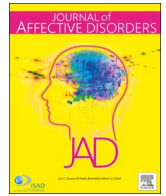




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Research paper

The mental health of frontline and non-frontline medical workers during the coronavirus disease 2019 (COVID-19) outbreak in China: A case-control study



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ABSTRACT

Background and objective: Coronavirus disease 2019 (COVID-19) is a new infectious disease with high transmissibility and morbidity. It has caused substantial mental distress to medical professionals. We aimed to compare the psychological impact of the COVID-19 outbreak between frontline and non-frontline medical workers in China.

Methods: This case-control study recruited 1173 frontline and 1173 age- and sex-matched non-frontline medical workers during the COVID-19 outbreak (February 11 to 26, 2020). A set of online questionnaires were used to measure mental problems (i.e., anxiety, insomnia, and depressive symptoms), and help-seeking behavior and treatment for these mental problems.

Results: Frontline medical workers had higher rates of any mental problem (52.6% vs. 34.0%, adjusted OR = 1.88, 95% CI = 1.57–2.25), anxiety symptoms (15.7% vs. 7.4%, adjusted OR = 1.95, 95% CI = 1.46–2.61), depressed mood (marginally insignificant; 14.3% vs. 10.1%, adjusted OR = 1.32, 95% CI = 0.99–1.76) and insomnia (47.8% vs. 29.1%, adjusted OR = 1.96, 95% CI = 1.63–2.36) than non-frontline medical workers. No significant difference was observed in terms of suicidal ideation (12.0% vs. 9.0%, adjusted OR = 1.25, 95% CI = 0.92–1.71), help-seeking (4.5% vs. 4.5%, adjusted OR = 1.00, 95% CI = 0.53–1.87) or treatment (3.4% vs. 2.3%, adjusted OR = 1.38, 95% CI = 0.54–3.52) for mental problems.

Limitations: The case-control nature of the data precludes causal inferences, and there is a possibility of bias related to self-reports.

Conclusions: Frontline medical workers had more mental problems but comparable help-seeking behaviors and treatment for these problems than non-frontline medical workers. These findings highlight the timely mental support and intervention for medical workers, especially for those on the frontline.

1. Introduction

Coronavirus disease 2019 (COVID-19) was first reported in Wuhan, Hubei Province, China, in December 2019 (Phan, 2020), followed by an

outbreak throughout the country and beyond. As of February 27, 2020, a total of 3019 medical workers were infected in China with novel coronavirus (including confirmed cases, suspected cases, clinically diagnosed cases, and asymptomatic infected persons), 1688 medical

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workers have been confirmed to be infected, with 247 (14.6%) critical cases and 5 (0.3%) deaths (Epidemiology Working Group for NCIP Epidemic Response, 2020). Medical workers, especially those who are working in the frontline, may suffer a huge amount of stress during the fight against COVID-19.

Several studies have reported that individuals exposed directly or indirectly to life-threatening situations may have a high risk of psychological morbidities (Bills et al., 2008; Chan and Huak, 2004; Ji et al., 2017; Mak et al., 2009; Ofner-Agostini et al., 2006; Sim et al., 2004; Wang et al., 2009; Wu et al., 2009). For example, during the outbreak of severe acute respiratory syndrome (SARS) in 2003, it was shown that health care workers had a higher rate of SARS infection than other people (Ofner-Agostini et al., 2006), and they were emotionally affected and traumatized during the outbreak (Chan and Huak, 2004; Wu et al., 2009). At present, the severe acute respiratory syndrome from coronavirus 2 (SARS-CoV-2), which has been reported to have more severe transmissibility than SARS-CoV (Liu et al., 2020b), puts medical workers, especially the frontline medical staff at very high health risk. With an increasing number of patients, long hours of intensive work and less sleep time, inadequate protection from contamination, and the risk of infection at any time, medical workers have a high risk of physical and mental exhaustion, resulting in a variety of mental health problems. The mental health of medical workers has gained tremendous attention. As this outbreak has highlighted the fragility of psychological resilience, we also need to pay attention to the psychological state of health care workers during epidemics (Ho et al., 2020). The government and hospitals have formulated a series of measures to address this problem (Kang et al., 2020a).

A recent study found that nearly one-sixth of 4679 medical staff had psychological distress and therefore needed to seek help from psychological or psychiatric professionals. The prevalences of psychological distress, anxious symptoms, and depressive symptoms were 15.9%, 16.0%, and 34.6%, respectively (Liu et al., 2020a,b,c). Another study investigating the mental health status of 224 medical staff found that 29.9% of the medical staff that fought against COVID-19 in Wuhan had a high score of anxiety compared with medical staff in Xian (Zhang et al., 2020a,b). However, the deficiency lies in the lack of systematic assessment of mental problems between frontline and non-frontline medical workers during the COVID-19 outbreak. Since an increasing number of newly infected cases among the medical staff have been observed to date, and since the arduous task of the fight against the COVID-19 might be far from over, timely mental health care for medical staff during the COVID-19 outbreak is urgently needed. The present study attempted to compare the immediate psychological impact of the COVID-19 outbreak on frontline and non-frontline medical workers in China.

2. Methods

2.1. Participants and data collection

This case-control study was conducted between February 11 to 26, 2020, which was approved by the Clinical Research Ethics Committee of Zhongnan Hospital of Wuhan University (Ref. No.: 2,020,030). This study was conducted through a program called Questionnaire Star. The sample was obtained based on a non-probability sampling design. All medical workers participated in the survey through the link or Quick Response (QR) code of Questionnaire Star, which is a bar code that can store the website link of the questionnaire used in this study. Once the questionnaire was submitted, the data would be saved on the questionnaire star server, and the questionnaire creator can download or analyze the data. The requirement for written consent from subjects was waived by the Research Ethics Committee. No identifiable information was collected.

A set of questionnaires were sent to medical workers working in hospitals in China via the QR code of Questionnaire Star. The medical

workers included physicians, nurses, and other healthcare workers (e.g., medical technicians, respiratory therapists, or emergency room attendants). Medical workers dealing with COVID-19 were considered frontline medical workers. Otherwise, they were categorized into the non-frontline medical workers group. Other inclusion criteria were as follows: 1) age 18 to 80 years old and 2) Chinese-speaking residents of China. A total of 1173 eligible frontline medical workers and 2118 eligible non-frontline medical workers participated in this study. 55.4% of the non-frontline medical workers ($n = 1173$) were selected and matched to frontline medical workers by age and sex. The matching was performed using the "MatchIt" package in R (Version 3.5.1; R Foundation for Statistical Computing, Vienna, Austria) (Ho et al., 2007).

2.2. Measures and tools

The study instrument was a structured questionnaire that comprised demographic details, three main self-reported rating scales that have broad credibility, and information about whether the participant sought help or treatment for mental problems. The detailed explanation is as follows.

2.2.1. Demographic information

Participants' demographic characteristics, including age, sex, education level, marital status, jobs, annual household income, living status, and geographic origin, were obtained. The epidemic parameters for the COVID-19 of the areas where the subjects stayed were used to estimate the levels of exposure to the epidemic. The epidemic parameters, including the number of cumulative cases, number of new daily cases, prevalence, and daily incidence, were obtained from the official online platform for controlling the COVID-19 epidemic in China.

2.2.2. Three main rating scales measuring mental health status

The Beck Anxiety Inventory (BAI) was used to measure anxiety symptoms over the last seven days (Beck et al., 1988; Chinese version: Che et al., 2006). This scale has a total of 21 self-report items with responses rated on a 4-point Likert scale ranging from 0 (not at all) to 3 (severely). Higher scores reveal a higher level of anxiety. The following cut-off scores were used to assess different levels of anxiety: (1) scores between 0 and 7 denote no anxiety; (2) scores between 8 and 15 denote mild anxiety; (3) 16–25 denotes moderate anxiety; (4) 26–63 denote severe anxiety (Ahmed et al., 2020). The presence of anxiety was defined as a BAI score > 15 in our study.

The Insomnia Severity Index (ISI) was used to assess participants' perceptions of insomnia over the past two weeks (Chahoud et al., 2017). It has seven items targeting the subjective symptoms and daytime consequences of insomnia, as well as the degree of distress caused by these difficulties. Each item of this scale is rated on a 5-point Likert scale of 0–4, and higher scores indicate greater insomnia severity (Morin et al., 2011; Chinese version: Li et al., 2019). The optimal cut-off point of ISI for detecting clinical insomnia in the Chinese population was a total score of 9 (Chung et al., 2011). Therefore, an ISI score higher than nine was chosen as the cut-off for insomnia for this study.

The Patient Health Questionnaire-9 (PHQ-9) was used to measure depressive symptoms over the past two weeks (Michel and Gordon, 2014). All nine items are scored from 0 to 3, and the total scores range from 0 to 27, with a higher score indicating more severe symptoms (Kroenke et al., 2001; Chinese version: Min et al., 2013). Scores of 0–4 indicate no depression, scores of 5–9 indicate mild depression, scores of 10–14 indicate moderate depression, scores of 15–19 indicate moderately severe depression, and scores of 20–27 indicate severe depression (Xia et al., 2019). Participants with a PHQ-9 > 10 were defined as depressed in our study.

The Chinese versions of the three abovementioned rating scales have been proven to have satisfactory reliability and validity (Chung et al., 2011; Liang et al., 2018; Wang et al., 2014). In addition,

suicidal ideations were measured by one question: “Over the past two weeks, have you ever had suicidal thoughts?” The responses to this question were “Once/several times” or “Never” (Hassan, 2015).

2.2.3. Help-seeking or treatment for mental health during the COVID-19 outbreak

Whether participants sought help or received treatment for mental problems, including anxiety symptoms, depressed mood, suicidal ideation, and insomnia, during the COVID-19 outbreak was recorded. The question “Have you ever sought help from psychiatrists or clinical psychologists since the outbreak of COVID-19 began?” was used to estimate help-seeking behavior. The question “Have you ever received any treatment for psychiatric or psychological problems since the outbreak of COVID-19 began?” was used to measure treatment history for mental problems.

2.3. Statistical analysis

Mann–Whitney *U* test and *t*-test were used to compare means of two groups of non-normally and normally distributed variables, respectively. Chi-square test was used to compare the inter-group differences for categorical variables. Univariate and multivariate logistic regressions were performed to evaluate the relationships of frontline medical workers (vs. non-frontline medical workers) with mental problems, and help-seeking behaviors and treatment for mental problems. A value of two-tailed $P < 0.05$ was considered statistically significant. In Table 2, *P* values for multivariate logistic regressions were further adjusted using a false discovery rate (FDR) method (Bernhard, 2019). An FDR of 5% using *q* values would mean that 5% of results called significant ($P < 0.05$) are false-positives (Benjamini and Hochberg, 1995). All statistical tests were performed using SPSS version 24.0 for Windows (Armonk, NY: IBM Corp) and R (version 3.5.1).

3. Results

A total of 2346 participants were enrolled in our study, including 1173 frontline workers and 1173 age- and sex- matched non-frontline medical workers. Table 1 presents the demographic characteristics of the participants. There were no differences in education years and unmarried status between non-frontline and frontline medical workers

Table 1
Demographic characteristics and the exposure of the COVID-19 epidemic of non-frontline and frontline medical workers.

	Non-frontline medical workers(<i>n</i> = 1173)	Frontline medical workers(<i>n</i> = 1173)	Degree of freedom (df)	<i>P</i> value
Male	348 (29.7)	354 (30.2)	1	0.79
Age (years)	30.5 ± 8.7	30.6 ± 8.8	2344	0.83
Education years	16.8 ± 2.2	16.8 ± 2.1	2344	0.49
Unmarried status	259 (22.1)	265 (22.6)	1	0.77
Jobs			1	< 0.01
Medical staff	1095 (93.4)	1156 (98.6)		
Other medical workers	78 (6.6)	17 (1.4)		
Annual household income < 11,255 (USD, per head)	787 (67.1)	843 (71.9)	1	0.01
Living alone	205 (17.5)	363 (30.9)	1	< 0.01
Geographic origin			2	< 0.01
Wuhan City	169 (14.4)	264 (22.5)		
Hubei province (excluding Wuhan City)	690 (58.8)	809 (69.0)		
Other areas in China ^a	314 (26.8)	100 (8.5)		
The exposure of the COVID-19 epidemic ^b				
Number of cumulative cases	13,886.6 ± 10,018.7	17,982.0 ± 9021.0	2344	< 0.01
Number of daily new cases	2766.6 ± 4419.5	3994.0 ± 5104.9	2344	< 0.01
Prevalence (% _{cc})	7.0 ± 12.1	10.3 ± 14.1	2344	< 0.01
Daily incidence (per 10,000)	2.3 ± 5.2	3.5 ± 6.1	2344	< 0.01

Data are presented as mean ± standard deviation or *n* (%).

Abbreviations: *Other medical workers*: support staff, patient care staff and so on; COVID-19: Coronavirus Disease 2019; *Medical staff*: mainly including doctors and nurses;.

^a Other areas in China: including 22 provinces, 5 autonomous regions, 4 municipalities and 2 special administrative regions.

^b The participants' exposure to the COVID-19 epidemic was estimated by the regional epidemic parameters.

(all $P > 0.05$). However, frontline medical workers had a higher proportion of medical staff (mainly including doctors and nurses) than non-frontline medical workers (98.6% vs. 93.4%, $P < 0.01$). Frontline medical workers showed higher proportions of annual household income of < 11,255 USD per head (71.9% vs. 67.1%, $P = 0.01$) and living alone (30.9% vs. 17.5%, $P < 0.01$) than non-frontline medical workers. Compared with non-frontline medical workers, frontline medical workers had higher proportions of participants from Wuhan and Hubei province (excluding Wuhan) ($P < 0.01$). In addition, frontline medical workers had higher exposure levels of the COVID-19 epidemic, including larger numbers of cumulative cases and daily new cases, higher prevalence, and higher daily incidence than subjects from other areas (all $P < 0.01$).

Table 2 shows the comparison in mental problems, help-seeking behavior and treatment for mental problems between the two groups. Compared with non-frontline medical workers, frontline medical workers had higher rates of any mental problems (52.6% vs. 34.0%, adjusted OR = 1.88, 95% CI = 1.57–2.25), anxiety symptoms (15.7% vs. 7.4%, adjusted OR = 1.95, 95% CI = 1.46–2.61), depressed mood (marginally insignificant; 14.3% vs. 10.1%, adjusted OR = 1.32, 95% CI = 0.99–1.76), and insomnia symptoms (47.8% vs. 29.1%, adjusted OR = 1.96, 95% CI = 1.63–2.36). However, there was no significant difference in suicidal ideation (12.0% vs. 9.0%, adjusted OR = 1.25, 95% CI = 0.92–1.71), help-seeking (4.5% vs. 4.5%, adjusted OR = 1.00, 95% CI = 0.53–1.87) and treatment for mental problems (3.4% vs. 2.3%, adjusted OR = 1.38, 95% CI = 0.54–3.52) between the two groups (Table 2).

4. Discussion

The psychological impact of acute infection outbreaks on medical workers has aroused considerable concern from the government, the public, and medical professionals. The current study has shown that frontline medical workers directly dealing with patients confirmed or suspected of having COVID-19 had a higher level of various mental problems than those non-frontline medical workers. In addition, the two groups had comparable low rates of help-seeking behaviors and treatment for their mental problems.

Data from the present study showed that the mental health of frontline medical workers was particularly worrying. The rate of mental

Table 2
Mental disorders, help-seeking and treatment for mental problems of medical workers during COVID-19.

	Non-frontline medical workers (n = 1173)	Frontline medical workers (n = 1173)	Crude odds ratio [95% confidence interval]	Adjusted odds ratio [95% confidence interval] ^a	q value ^c
Any mental problems ^b	399 (34.0)	617 (52.6)	2.15 [1.82–2.54]	1.88 [1.57–2.25]	< 0.01
Anxiety symptoms (BAI score > 15)	87 (7.4)	184 (15.7)	2.32 [1.77–3.04]	1.95 [1.46–2.61]	< 0.01
Depressed mood (PHQ-9 > 10)	119 (10.1)	168 (14.3)	1.48 [1.15–1.90]	1.32 [0.99–1.76]	0.06
Suicidal ideation	105 (9.0)	141 (12.0)	1.39 [1.06–1.82]	1.25 [0.92–1.71]	0.16
Insomnia symptoms (ISI > 9)	341 (29.1)	561 (47.8)	2.24 [1.89–2.65]	1.96 [1.63–2.36]	< 0.01
Help-seeking for mental problems ^b	18/399 (4.5)	28/617 (4.5)	1.01 [0.55–1.84]	1.00 [0.53–1.87]	0.99
Treatment for mental problems ^b	9/399 (2.3)	21/617 (3.4)	1.53 [0.69–3.37]	1.38 [0.54–3.52]	0.51

Data are presented as n (%).

Abbreviations: COVID-19; Coronavirus Disease 2019; BAI: the Beck Anxiety Inventory; PHQ-9: the 9-item Patient Health Questionnaire; ISI: the Insomnia Severity Index.

^a Adjusted for jobs, income level, living alone, geographic origin, prevalence of the COVID-19.

^b Mental problems include anxiety symptoms, depressed mood, suicidal ideation, and insomnia.

^c q values: P values adjusted by false discovery rate (FDR) method. A q value of 5% would mean that 5% of results called significant (P values < 0.05) are false-positives.

problems, such as anxiety, depression, and insomnia, was significantly increased in frontline medical workers, compared with non-frontline medical workers. In this study, about 15.7% of enrolled frontline medical workers experienced anxiety symptoms, and the prevalence is lower than the general population during the COVID-19 outbreak (28.8% experienced moderate to severe anxiety symptoms) (Wang et al., 2020a,b). Similarly, about 14.3% of enrolled frontline medical workers experienced depressive symptoms, and the prevalence is slightly lower than the general population during the COVID-19 outbreak (16.5% reported moderate to severe depressive symptoms) (Wang et al., 2020a,b). The higher prevalence of anxiety and depression in the general public could be due to less access to personal protection equipment as compared to frontline medical workers.

A great deal of evidence demonstrates the dramatic psychological impact of the epidemic on healthcare workers, and the importance of dedicated interventions to deal with mental problems, such as stress, anxiety, depressive symptoms (Xiang et al., 2020; Kang et al., 2020a,b; Samantha et al., 2020; Liu et al., 2020a,b,c). Our findings are consistent with those reported Zhu et al., who found a significant percentage of psychiatric symptoms during the COVID-19 pandemic, 29.8% for stress, 13.5% for depression, and 24.1% for anxiety among healthcare workers (Zhu et al., 2020). A recent study indicated poor sleep quality among frontline clinical nurses fighting with the COVID-19 (Wu et al., 2020). In contrast, a recent study conducted in Singapore found that there was a higher prevalence of anxiety among non-medical healthcare workers compared to medical personnel (Tan et al., 2020). The opposite findings in Singapore could be due to the fact that COVID-19 was a less severe problem in Singapore as compared to China and frontline healthcare workers encountered lower level of anxiety and depression.

Compared with non-frontline medical workers, frontline medical workers might be exposed to much more physical and mental stresses, which may contribute to their higher rates of mental problems. For example, frontline medical workers have had to be extra vigilant when working in the fever clinics or infectious wards, ensuring that suspected patients were timely identified and transferred to the designated hospital to reduce exposure risk for others. In addition, the rapid increase of the infected patients and the uncertainty of transmission in the early stage of the outbreak increased the enormous workload and psychological burden of medical workers (Yang et al., 2020). During the COVID-19 outbreak, many medical staff were infected (Wang et al., 2020a,b), which may have increased the psychological stress of their colleagues. Moreover, inadequate protective materials against the virus, negative emotions from the patients, quarantine, and lack of contact with their families also added to the psychological burden of frontline medical workers. Furthermore, mental problems could interact with each other. For example, sleep disorders were reported to be related to anxiety (Bélanger et al., 2004; Papadimitriou and Linkowski, 2005).

Our results showed poor mental health among frontline medical workers, but contrary to our expectation, we did not observe significantly higher rates of seeking help or receiving treatment for mental problems among these subjects. The phenomenon that medical workers have difficulty accepting and disclosing emotions is not unique to the COVID-19 outbreak (Fridner et al., 2012; King et al., 1992; Tyssen et al., 2004). Emotional distress is common among hospital doctors, many of whom do not seek professional help or support from their colleagues, because they either think they did not need or are embarrassed to seek help and worried about confidentiality (Fridner et al., 2012). These findings remind future psychological intervention providers should pay more attention to medical workers with mental health problems.

The mental health status of medical workers presented in the current study prompts the need for appropriate measures and timely treatment for COVID-19-related psychological problems. According to previous experience with severe infectious diseases (such as SARS and EVD), medical workers with a good awareness of the disease developed relatively fewer psychological symptoms (Chua et al., 2004;

Huang et al., 2004; Ji et al., 2017). Therefore, authoritative knowledge about COVID-19 should be disseminated among medical workers as early as possible. Mental health professionals should be deployed in the medical teams to provide psychological support. Furthermore, external material and spiritual support were crucial to confronting psychological symptoms, including virus prevention implementation, living and medical supplies, as well as spiritual support from colleagues, team leaders, family, and friends (Nasser and Overholser, 2005).

Since the start of the COVID-19 outbreak, the Chinese government, hospitals, and psychological and psychiatric centers have taken measurements to address mental health problems (Bao et al., 2020). A national guideline for psychological crisis intervention during the COVID-19 outbreak, in which psychological protection measures for medical workers were provided (National Health Commission of the People's Republic of China 2020b). Psychological intervention teams were set up to deliver mental health services to medical staff. In addition, a variety of online mental health services through communication programs, such as WeChat, Weibo, and TikTok, were gradually put into practice for people in need (Liu et al., 2020a; Zhang et al., 2020a,b). As the development of the epidemic, further psychological support and measurements should be provided, especially for frontline medical workers.

There were several limitations to our study. First, medical workers participated in the investigation via the Internet without random sampling, so the response rate was hard to estimate. However, the relatively large number of participants reduced this potential sampling bias. Second, the mental health status of the participants before the COVID-19 outbreak was not available, making it difficult to know whether their pre-existing mental health status also impacted the posttraumatic morbidity of COVID-19. Third, this study did not address other potential confounding factors, such as personality traits, family history of mental disorders, life events, and social support. Fourth, the case-control nature of the present study did not allow us to make any conclusions regarding causality.

5. Conclusions

The present study highlighted the mental health problems and unmet needs of medical workers during the COVID-19 epidemic in China, especially among frontline medical workers. Further strategies should be provided urgently to alleviate the mental distress of medical workers. Long-term surveillance should be provided to monitor the mental health of frontline and non-frontline medical workers.

Contributors

Qi Cai, Hongliang Feng: involved in study design, performing the study, drafting and revising the manuscript. Meiyao Wang, Qunfeng Wang, Xuanzhen Lu, Jing Pan, Qin Li, Beibei Fu, Yongchao Deng: involved in distributing and recycling questionnaires. Jing Huang, Yu Xie, Xing Wang, Zhenxing Liu, Botong Hou, Keni Ouyang: involved in data analysis. Yumin Liu: involved in study design, revising the manuscript.

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Declaration of Competing Interest

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References

- Ahmed, M.Z., Ahmed, O., Aibao, Z., Hanbin, S., Siyu, L., Ahmad, A., 2020. Epidemic of COVID-19 in China and associated psychological problems. *Asian J. Psychiatr.* 51, 102092. <https://doi.org/10.1016/j.ajp.2020.102092>.
- Bao, Y., Sun, Y., Meng, S., Shi, J., Lu, L., 2020. 2019-nCoV epidemic: address mental health care to empower society. *Lancet* 395 (10224), e37–e38. [https://doi.org/10.1016/S0140-6736\(20\)30309-3](https://doi.org/10.1016/S0140-6736(20)30309-3).
- Beck, A.T., Epstein, N., Brown, G., Steer, R.A., 1988. An inventory for measuring clinical anxiety: psychometric properties. *J. Consult. Clin. Psychol.* 56 (6), 893–897. <https://doi.org/10.1037//0022-006x.56.6.893>.
- Bélanger, L., Morin, C.M., Langlois, F., Ladouceur, R., 2004. Insomnia and generalized anxiety disorder. *J. Anxiety Disord.* 18 (4), 561–571. [https://doi.org/10.1016/S0887-6185\(03\)00031-8](https://doi.org/10.1016/S0887-6185(03)00031-8).
- Benjamini, Y., Hochberg, Y., 1995. Controlling the false discovery rate - a practical and powerful approach to multiple testing. *J. R. Stat. Soc. B* 57 (1), 289–300. <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>.
- Voelkl, B., 2019. Multiple testing: correcting for alpha error inflation with false discovery rate (FDR) or family-wise error rate? *Anim. Behav.* 155, 173–177. <https://doi.org/10.1016/j.anbehav.2019.07.001>.
- Bills, C.B., Levy, N.A., Sharma, V., Charney, D.S., Herbert, R., Moline, J., Katz, C.L., 2008. Mental health of workers and volunteers responding to events of 9/11: review of the literature. *Mount Sinai J. Med.* 75 (2), 115–127. <https://doi.org/10.1002/msj.20026>.
- Chan, A.O., Huak, C.Y., 2004. Psychological impact of the 2003 severe acute respiratory syndrome outbreak on health care workers in a medium size regional general hospital in Singapore. *Occup. Med. Lond.* 54 (3), 190–196. <https://doi.org/10.1093/occmed/kqh027>.
- Che, H.-H., Lu, M.-L., Chen, H.-C., Chang, S.-W., Lee, Y.-J., 2006. Validation of the Chinese version of the beck anxiety inventory (in Chinese). *Formosan J. Med.* 10 (4), 447–454. [https://doi.org/10.6320/FJM.2006.10\(4\).05](https://doi.org/10.6320/FJM.2006.10(4).05).
- Chua, S.E., Cheung, V., Cheung, C., McAlonan, G.M., Wong, J.W., Cheung, E.P., ... Tsang, K.W., 2004. Psychological effects of the SARS outbreak in Hong Kong on high-risk health care workers. *Can. J. Psychiatry* 49 (6), 391–393. <https://doi.org/10.1177/070674370404900609>.
- Chung, K.F., Kan, K.K., Yeung, W.F., 2011. Assessing insomnia in adolescents: comparison of insomnia severity index, Athens insomnia scale and sleep quality index. *Sleep Med.* 12 (5), 463–470. <https://doi.org/10.1016/j.sleep.2010.09.019>.
- Epidemiology Working Group for NCIP Epidemic Response, 2020. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *Chin. J. Epidemiol.* 41, 145–151. <https://doi.org/10.3760/cma.j.issn.0254-6450.2020.02.003>.
- Fridner, A., Belkic, K., Marini, M., Gustafsson Senden, M., Schenck-Gustafsson, K., 2012. Why don't academic physicians seek needed professional help for psychological distress? *Swiss Med. Wkly.* 142, w13626. <https://doi.org/10.4414/smw.2012.13626>.
- Hassan, Areej, 2015. *Adolescent Mental Health: Connections to the Community*. Apple Academic Press ISBN9781771881036.
- ...Huang, W., Hua, Q., Wu, H., Xu, W.-y., Tian, J.-h., Chen, H., Zhang, J., 2004. [A study on the differences of emotion and depression between patients as doctor/nurse and others occupation with severe acute respiratory syndrome]. *Chin. J. Epidemiol.* 25 (1), 23–26.
- Ho, C.S., Chee, C.Y., Ho, R.C., 2020. Mental Health Strategies to Combat the Psychological Impact of COVID-19 Beyond Paranoia and Panic. *Annals of the Academy of Medicine, Singapore* 49 (3), 155–160.
- Ho, D., Imai, K., King, G., Stuart, E., 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Polit. Anal.* 15 (3), 199–236. <https://doi.org/10.1093/pan/mpl013>.
- ...Ji, D., Ji, Y.J., Duan, X.Z., Li, W.G., Sun, Z.Q., Song, X.A., Duan, H.J., 2017. Prevalence of psychological symptoms among Ebola survivors and healthcare workers during the 2014–2015 Ebola outbreak in Sierra Leone: a cross-sectional study. *Oncotarget* 8 (8), 12784–12791. <https://doi.org/10.18632/oncotarget.14498>.
- ...Kang, L.J., Li, Y., Hu, S.H., Chen, M., Yang, C., Yang, B.X., Liu, Z.C., 2020a. The mental health of medical workers in Wuhan, China dealing with the 2019 novel coronavirus. *Lancet Psychiatry* 7 (3), e14. [https://doi.org/10.1016/S2215-0366\(20\)30047-X](https://doi.org/10.1016/S2215-0366(20)30047-X).
- ...Kang, L.J., Ma, S.M., Chen, M., Yang, J., Wang, Y., Li, R.T., Liu, Z.C., 2020b. Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: a cross-sectional study. *Brain Behav. Immun.* <https://doi.org/10.1016/j.bbi.2020.03.028>.
- King, M.B., Cockcroft, A., Gooch, C., 1992. Emotional distress in doctors: sources, effects and help sought. *J. R. Soc. Med.* 85 (10), 605–608.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. *J. Gen. Intern. Med.* 16 (9), 606–613. <https://doi.org/10.1046/j.1525-1497.2001.016009606.x>.
- Liang, Y., Wang, L., Zhu, J., 2018. Factor structure and psychometric properties of Chinese version of Beck Anxiety Inventory in Chinese doctors. *Health Psychol.* 23 (5), 657–666. <https://doi.org/10.1177/1359105316658971>.

- Li, E.Z., Li, W.X., Xie, Z.T., Zhang, B., 2019. Psychometric property of the Insomnia Severity Index in students of a commercial school. *Neurosci. Ment. Health* 19 (3), 268–272. <https://doi.org/10.3969/j.issn.1009-6574.2019.03.012>.
- Liu, S., Yang, L., Zhang, C., Xiang, Y.-T., Liu, Z., Hu, S., Zhang, B., 2020a. Online mental health services in China during the COVID-19 outbreak. *Lancet Psychiatry*. [https://doi.org/10.1016/S2215-0366\(20\)30077-8](https://doi.org/10.1016/S2215-0366(20)30077-8).
- ...Liu, T., Hu, J., Xiao, J., He, G., Kang, M., Rong, Z., Ma, W., 2020b. Transmission dynamics of 2019 novel coronavirus (2019-nCoV). *BioRxiv*. <https://doi.org/10.1101/2020.01.25.919787>.
- Liu, Z.R., Han, B., Jiang, R.M., Huang, Y.Q., Ma, C., Wen, J., Zhang, T.T., Wang, Y., Chen, H.G., Ma, Y.C. (2020c). Mental Health Status of Doctors and Nurses During COVID-19 Epidemic in China (3/4/2020). Available at SSRN:<https://ssrn.com/abstract=3551329> or doi: 10.2139/ssrn.3551329.
- Mak, I.W., Chu, C.M., Pan, P.C., Yiu, M.G., Chan, V.L., 2009. Long-term psychiatric morbidities among SARS survivors. *Gen. Hosp. Psychiatry* 31 (4), 318–326. <https://doi.org/10.1016/j.genhosppsych.2009.03.001>.
- Chahoud, M., Chahine, R., Salameh, P., Sauleau, E.A., 2017. Reliability, factor analysis and internal consistency calculation of the insomnia severity index (ISI) in French and in English among Lebanese adolescents. *eNeurologicalSci* 7, 9–14. <https://doi.org/10.1016/j.ensci.2017.03.003>.
- Michel, A.T., Gordon, J.G.A., 2014. The PHQ-9 assesses depression similarly in men and women from the general population. *Personal. Individ. Differ.* 56, 149–153. <https://doi.org/10.1016/j.paid.2013.08.039>.
- Min, B.Q., Zhou, A.H., Liang, F., Jia, J.P., 2013. Clinical application of patient health questionnaire for self-administered measurement (PHQ-9) as screening tool for depression. *J. Neurosci. Ment. Health* 13 (6), 569–572. <https://doi.org/10.3969/j.issn.1009-6574.2013.06.009>.
- Morin, C.M., Belleville, G., Belanger, L., Ivers, H., 2011. The Insomnia severity index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep* 34 (5), 601–608. <https://doi.org/10.1093/sleep/34.5.601>.
- Nasser, E.H., Overholser, J.C., 2005. Recovery from major depression: the role of support from family, friends, and spiritual beliefs. *Acta Psychiatr. Scand.* 111 (2), 125–132. <https://doi.org/10.1111/j.1600-0447.2004.00423.x>.
- National Health Commission of the People's Republic of China. (2020b). The Guideline of Psychological Crisis Intervention for 2019-nCoV Pneumonia. Retrieved from <http://www.nhc.gov.cn/jkj/s3577/202001/6adc08b966594253b2b791be5c3b9467.shtml>.
- ...Ofner-Agostini, M., Gravel, D., McDonald, L.C., Lem, M., Sarwal, S., McGeer, A., Simor, A., 2006. Cluster of cases of severe acute respiratory syndrome among Toronto healthcare workers after implementation of infection control precautions: a case series. *Infect. Control Hosp. Epidemiol.* 27 (5), 473–478. <https://doi.org/10.1086/504363>.
- Papadimitriou, G.N., Linkowski, P., 2005. Sleep disturbance in anxiety disorders. *Int. Rev. Psychiatry* 17 (4), 229–236. <https://doi.org/10.1080/09540260500104524>.
- Phan, T., 2020. Novel coronavirus: from discovery to clinical diagnostics. *Infect. Genet. Evol.* 79, 104211. <https://doi.org/10.1016/j.meegid.2020.104211>.
- Samantha, K.B., Rebecca, K.W., Louise, E.S., Lisa, W., Simon, W., Neil, G., Gideon, J.R., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 1–9. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8).
- Sim, K., Chong, P.N., Chan, Y.H., Soon, W.S.W., 2004. Severe Acute Respiratory Syndrome-Related Psychiatric and Posttraumatic Morbidities and Coping Responses in Medical Staff Within a Primary Health Care Setting in Singapore. *J Clin Psychiatry* 65 (8), 1120–1127. <https://doi.org/10.4088/jcp.v65n0815>.
- Tan, B.Y.Q., Chew, N.W.S., Lee, G.K.H., et al., 2020. Psychological Impact of the COVID-19 Pandemic on Healthcare Workers in Singapore. *Ann. Intern. Med.* M20–1083. <https://doi.org/10.7326/M20-1083>. In press.
- Tysen, R., Rovik, J.O., Vaglum, P., Gronvold, N.T., Ekeberg, O., 2004. Help-seeking for mental health problems among young physicians: is it the most ill that seeks help? A longitudinal and nationwide study. *Soc. Psychiatry Psychiatr. Epidemiol.* 39 (12), 989–993. <https://doi.org/10.1007/s00127-004-0831-8>.
- Wang, C., Pan, R., Wan, X., et al., 2020a. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health* 7 (5), 1729. <https://doi.org/10.3390/ijerph17051729>. Published 2020 March 6.
- ...Wang, D., Hu, B., Hu, C., Zhu, F., Liu, X., Zhang, J., Peng, Z., 2020b. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. <https://doi.org/10.1001/jama.2020.1585>.
- Wang, L., Zhang, Y., Shi, Z., Wang, W., 2009. Symptoms of posttraumatic stress disorder among adult survivors two months after the Wenchuan earthquake. *Psychol. Rep.* 105 (3 Pt 1), 879–885. <https://doi.org/10.2466/PRO.105.3.879-885>.
- ...Wang, W., Bian, Q., Zhao, Y., Li, X., Wang, W., Du, J., Zhao, M., 2014. Reliability and validity of the Chinese version of the patient health questionnaire (PHQ-9) in the general population. *Gen. Hosp. Psychiatry* 36 (5), 539–544. <https://doi.org/10.1016/j.genhosppsych.2014.05.021>.
- Wu, J.J., S. X., C. F., D. Y.J., C. D.C.H., J. X.C., G. X.L., 2020. Investigation on sleep quality of first-line nurses in fighting against novel coronavirus pneumonia and its influencing factors. *Nurs. Res. China* 34 (4), 1–5.
- ...Wu, P., Fang, Y., Guan, Z., Fan, B., Kong, J., Yao, Z., Hoven, C.W., 2009. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. *Can. J. Psychiatry* 54 (5), 302–311. <https://doi.org/10.1177/070674370905400504>.
- Xia, N.G., Lin, J.H., Ding, S.Q., Dong, F.R., Shen, J.Z., Du, Y.R., Wang, X.S., Chen, Y.Y., Zhu, Z.G., Zheng, R.Y., Xu, H.Q., 2019. Reliability and validity of the Chinese version of the patient health questionnaire 9 (C-PHQ-9) in patients with epilepsy. *Epilepsy Behav.* 95, 65–69. <https://doi.org/10.1016/j.yebeh.2019.03.04>.
- Xiang, Y.T., Yang, Y., Li, W., Zhang, L., Zhang, Q., Cheung, T., Ng, C.H., 2020. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry* 7 (3), 228–229. [https://doi.org/10.1016/S2215-0366\(20\)30046-8](https://doi.org/10.1016/S2215-0366(20)30046-8).
- ...Yang, Y., Lu, Q., Liu, M., Wang, Y., Zhang, A., Jalali, N., Fang, L., 2020. Epidemiological and clinical features of the 2019 novel coronavirus outbreak in China. *MedRxiv*. <https://doi.org/10.1101/2020.02.10.20021675>.
- Zhang, J., Wu, W., Zhao, X., Zhang, W., 2020a. Recommended psychological crisis intervention response to the 2019 novel coronavirus pneumonia outbreak in China: a model of West China Hospital. *Precis. Clin. Med.* <https://doi.org/10.1093/pcmedi/pbaa006>.
- Zhang, Y., Zhang, X.J., Peng, J.X., Fang, P., 2020b. A survey on mental health of medical staff fighting 2019 novel coronavirus diseases in Wuhan. *J. Trop. Med* ISSN 1672-3619, CN 44-1503/R. <http://kns.cnki.net/kcms/detail/44.1503.R.20200311.0813.002.html>.
- Zhu, Z., Xu, S., Wang, H., Liu, Z., Wu, J., Li, G., Miao, J., Zhang, C., Yang, Y., Sun, W., Zhu, S., Fan, Y., Hu, J., Liu, J., Wang, W., 2020. COVID-19 in Wuhan: immediate Psychological Impact on 5062 Health Workers. Cold Spring Harbor Laboratory Press, Yale. <https://doi.org/10.1101/2020.02.20.20025338>. medRxiv 2020.02.20.