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Different prevalence trend of depression and anxiety among healthcare workers and general public before and after the peak of COVID-19 occurred in China: A meta-analysis

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ABSTRACT

Objective: We aim to evaluate the prevalence of depression and anxiety among general public and healthcare workers during COVID-19 in China and the changes of prevalence before and after the peak of the epidemic occurred. Methods: Studies were searched from following database: PubMed, Web of Science, Cochrane Library, China National Knowledge Infrastructure (CNKI), WANGFANG DATA, from inception to 1st May 2020. Random-effects model was applied to pool the prevalence. Comparative analysis was also applied to evaluate the changes of prevalence before and after the peak of the epidemic occurred. Results: 34 articles were finally included. Prevalence of depression and anxiety was higher among healthcare worker than general public. Among general public, 26 % (95 %CI: 17 %–36 %) were suffering from depression and 22 % (95 %CI: 15 %–30 %) were having anxiety during COVID-19, while the prevalence of depression and anxiety among healthcare workers was 31 % (95 %CI: 25 %–37 %) and 40 % (95 %CI: 33 %–46 %) respectively. Comparative analysis showed healthcare workers (depression: 40 %, anxiety: 38 %) had higher percentage of having depression and anxiety than the general public (depression: 33 %, anxiety: 24 %) before the peak. Then a descended prevalence among healthcare workers (depression: 22 %, anxiety: 22 %) was detected compared with that before, while the prevalence among the general public raised (depression: 62 %, anxiety: 44 %) after the peak occurred. Conclusion: The COVID-19 epidemic had a potential psychiatric impact on general public and healthcare workers in China, which is more severer among healthcare workers. However, the psychiatric status of the general public trend to deteriorated, while healthcare workers trend to improve after the peak of epidemic.

1. Introduction

In December 2019, a cluster of cases of “pneumonia of unknown cause” were first detected in Wuhan, China, which has been identified as coronavirus-related pneumonia with continuously increasing number of cases later on in many Chinese cities and in other countries around the world (Li et al., 2020a; Munster et al., 2020). It was proclaimed as the infectious diseases outbreak of Corona Virus Disease 2019 (COVID-19) epidemic by the World Health Organization (WHO), causing 34 million confirmed cases and 1 million deaths globally by October 2020. (World Health Organization (WHO), 2020a, 2020b).

As a highly infectious and fatal disease, COVID-19 not only impairs physical health but also has impact on the mental health of healthcare workers and the general public (Chew et al., 2020). Faced with the stress of interpersonal isolation for minimizing the risk of infection and the worries of virus exposure to oneself and loved ones, high prevalence of depression and anxiety may be detected in the general population due to stressful situation, which can be especially severe among the healthcare workers, who fight in the frontline (Yeen and Ning, 2020; Maunder, 2009). Emerging outcomes of the mental health status of the general public and healthcare workers are reported in China. With higher risk of being infected and exposure to long and distressing work shifts to meet health requirements during COVID-19 epidemic, healthcare workers may be more psychologically affected than the general public (Zhang...
During the initial phase of COVID-19 outbreak in China, a nationwide study observed 30 % of the general public were having depression and 37 % were suffering from anxiety (Wang et al., 2020a). Another study conducted at the same time reported that among healthcare workers, the prevalence of depression and anxiety was 50 % and 45 % respectively in China (Lai et al., 2020).

On February 8th, 2020, the peak of the epidemic occurred with 37,251 cases confirmed infection in China, and then there was a rapid decline in the number of new and suspected cases and the downturns continued afterward, with recovered cases substantially increasing (Wang et al., 2020b; World Health Organization (WHO), 2020b). Compared with studies conducted before the peak occurred, different trend was discovered in the later studies. After February 8th, 2020, the prevalence of depression and anxiety were 62 % and 44 % respectively among the general public according to an observational study (Zhang et al., 2020a), while a cross-section study showed that 12 % healthcare workers were having depression and 26 % were having anxiety (Lu et al., 2020).

Outcomes of the reported prevalence vary widely and the status trend of the general public and healthcare workers are inconsistent before and after the peak. However, few comprehensive studies summarized the comparable overall prevalence and the trend changes among general public and healthcare workers pre- and post- the peak in China.

In present study, a systematic review and meta-analysis was performed to assess the prevalence of depression and anxiety among the general public and healthcare workers in China during COVID-19 epidemic. Moreover, comparative analysis was also conducted to evaluate the changes of prevalence before and after the peak of the epidemic occurred among both populations.

2. Method

This systematic review and meta-analysis were conducted according to PRISMA (Moher et al., 2015) statement.

2.1. Search strategy and selection process

Our search strategy was decided by consensus. In present study, we searched PubMed, Web of Science, Cochrane Library, China National Knowledge Infrastructure (CNKI), WANGFANG DATA from database inception to 1st May 2020, with language restricted to Chinese and English. Two independent researchers identified published studies that are relevant to the prevalence of depression and anxiety among the general public and healthcare workers during the COVID-19 pandemic in China, using following keywords: novel coronavirus pneumonia, NCP, 2019-ncov, COVID-19, coronavirus disease-2019, SARS-CoV-2, mental health, depression, stress, psycho.".

A study would be included if: 1) The population group consists of the general public or healthcare workers or both. 2) Prevalence of anxiety, depression or relative symptoms is evaluated. 3) It is cross-sectional study, cohort study, case control study or other type of observational study. 4) Its symptomatic evaluation data is available. 5) Study area restricts in China.

Case reports, systematic reviews, meta-analyses and other secondary hand studies were excluded. Studies without available full text were also excluded. Duplicates were removed.

For initial selectivion, two author YD and YC examined titles and abstracts and excluded irrelevant studies according to selective criteria independently. After that, full texts were obtained for further details to complete final inclusion. Any conflict would be discussed and determined by the third author (BZ). All studies were imported into EndNote X7 software (Thomson Reuters, NY, US) to conduct selection process.

2.2. Quality assessment

Quality of included studies was evaluated using an 11-item checklist, which was recommended by the Agency for Healthcare Research and Quality (AHRQ) (Hu et al., 2015). If the answered was ‘NO’ or ‘UN-CLEAR’, an item would be scored ‘0’, while the item would score ‘1’ when the answer was ‘YES’. An article would be rated as: 1) high quality if total score equals 8–11; 2) moderate quality if total score equals 4–7; 3) low quality if total score equals 0–3. Studies of low quality would be excluded.

2.3. Data extraction and analysis

We extracted data from the included studies on study name, author, year of publication, the time of the investigation, study type, total number of participants, demographics of the participants, the number of participants with anxiety or depression, rate of anxiety and depression detection.

We used I² to indicate the heterogeneity among the included studies (Higgins and Green, 2011). Due to the huge heterogeneity, random-effects model was applied to pool the prevalence rate. Forest plot was utilized to display the prevalence together with a 95 % confidence interval (95 % CI) and weight for every study. The final pooled prevalence rates were also reflected in the forest plot. Potential publication bias was assessed by funnel plots, whose symmetry was evaluated using egger test (Luo et al., 2013). A P < 0.05 would indicated statistically significant.

Trend of prevalence change before and after the peak was comparatively analyzed by synthesizing related articles from different phases of the epidemic and pooling the final prevalence.

All statistical analyses were done using R package (4.0–2; R foundation for statistical Computing, Vienna, Austria) and Stata 11.0 (Stata Corp., TX, USA).

3. Results

3.1. Study selection

1856 studies were found after searching process (Fig. 1), and 185 duplicates were removed. After screening titles and abstracts, 322 studies were assessed and 288 were excluded due to data unavailability. Finally, 34 articles were included.

3.2. Quality assessment

The quality of all selected studies were assessed using the checklist recommended by AHRQ. The quality of each article was presented in Table 1. Sixteen studies were of high quality and eighteen articles were of moderate quality. No low-quality studies were detected among inclusion.

3.3. Study characteristics

Study characteristics of the 34 included study was displayed in Table 1 (Ahmed et al., 2020; Cai and Yuan, 2020; Chen et al., 2020; Chung and Yeung, 2020; Dong et al., 2020; Gao et al., 2020; Huang et al., 2020; Huang and Zhao, 2020; Lai et al., 2020; Lei et al., 2020; Li et al., 2020b; Li et al., 2020c; Lin et al., 2020; Liu et al., 2020a; Liu et al., 2020b; Lu et al., 2020; Luo et al., 2020; Mu, 2020; Nong et al., 2020; Qi et al., 2020; Sun et al., 2020; Tang et al., 2020; Wang et al., 2020c; Xiao et al., 2020; Xu et al., 2020; Zhang et al., 2020a,b; Zhang et al., 2020c; Zhang et al., 2020d; Zheng et al., 2020; Zhong et al., 2020). The 34 studies comprised 29,996 participants. Of 34 studies, all selected studies were cross-section study. 11 studies were published in English, and 23 were in Chinese. 11 studies evaluated the prevalence of mental symptoms of general public, and 11 reported the status of healthcare workers. Only 1 article assessed both groups. 7 articles conducted assessments before 8th February, 2020, and 5 articles assessed after 8th February. While 6 articles were still conducting evaluation before and after 8th
February, and 16 didn’t provide the exact time of investigation.

3.4. Prevalence of depression and anxiety

Prevalence of depression and anxiety were both higher among healthcare workers than among the general public. The prevalence of depression among the general public for each public ranged from 6% to 62% (Fig. 2) (Ahmed et al., 2020; Gao et al., 2020; Huang and Zhao, 2020; Lei et al., 2020; Li et al., 2020c; Mu, 2020; Wang et al., 2020a; Wang et al., 2020c; Yang et al., 2020; Zhang et al., 2020a). The pooled prevalence was 26% (95%CI: 17%–36%, I² = 99.5%) with 16,094 sample size. While the prevalence of depression among healthcare workers for each public ranged from 4% to 82% (Fig. 3) (Cai and Yuan, 2020; Chen et al., 2020; Chung and Yeung, 2020; Dong et al., 2020; Duan et al., 2020; Huang and Zhao, 2020; Lai et al., 2020; Liu et al., 2020a; Lu et al., 2020; Luo et al., 2020; Nong et al., 2020; Qi et al., 2020; Sun et al., 2020; Tang et al., 2020; Xiao et al., 2020; Xu et al., 2020; Zhang et al., 2020b; Zhang et al., 2020c; Zhang et al., 2020d; Zhong et al., 2020). The pooled prevalence rate was 31% (95%CI: 25%–37%, I² = 98.4%) with 11,438 sample size.

3.5. Publication bias

Funnel plots were used to assess publication bias. Egger’s test was also performed on the prevalence of depression among the general public (p = 0.20) (Fig. 6), depression among healthcare workers (p = 0.78) (Fig. 7), anxiety among general public (p = 0.11) (Fig. 8), anxiety among healthcare workers (p = 0.56) (Fig. 9), which shows no publication bias was detected.

3.6. Prevalence before and after the peak

Final pooled prevalence of depression and anxiety among the general public and healthcare workers group pre- or post- peak was displayed in Table 2.

13 articles were available to extract specific time of investigation and were included in subgroup analysis. For the general public group, the prevalence of depression and anxiety before 8th February, 2020 were 33% (95%CI:16%–51%) and 24% (95%CI:17%–31%) respectively. After 8th February, the prevalence was drop among healthcare workers. As shown, the prevalence of depression was 22% (95%CI:13%–31%), and 22% (95%CI:13%–31%) of anxiety (Table 2).
Table 1
Summary of characteristics of final inclusion.

| Author    | The time of the investigation | Study type                | Study group       | Study population | Depression % (n) | Anxiety % (n) | Quality score |
|-----------|-------------------------------|---------------------------|-------------------|------------------|------------------|---------------|---------------|
| Huang, Y. | From February 3rd, 2020 to February 17th, 2020 | Cross-section study | General public | 4986          | 20.22% (1008) | 34.84% (1737) | 35.64% (802) | 7             |
| Zhang, J. | From February 15th, 2020 to February 29th, 2020 | Cross-section study | Healthcare workers | 2250 | 19.82% (446) | 62.24% (61) | 43.88% (43) | 7             |
| Chung, J. | N.A.                           | Cross-section study | General public | 98            | 62.24% (61) | 62.24% (61) |             | 7             |
| Wang, C.  | From January 31st, 2020 to February 2nd, 2020 | Cross-section study | Healthcare workers | 69              | 34.80% (24) | N.A           |             | 5             |
| Ahmed, M. | N.A.                           | Cross-section study | General public | 1210         | 30.30% (367) | 36.70% (444) |             | 7             |
| Gao, J.   | From January 31st, 2020 to February 2nd, 2020 | Cross-section study | General public | 4827         | 48.30% (2331) | 22.60% (1091) |             | 9             |
| Lei, J. B. | From January 29th, 2020 to February 3rd, 2020 | Cross-section study | Healthcare workers | 1257    | 50.40% (634) | 44.60% (561) |             | 8             |
| Lei, L.   | Early February 2020            | Cross-section study | General public | 1593         | 14.60% (233) | 8.30% (133) |             | 6             |
| Lu, W.    | From February 25th, 2020 to February 26th, 2020 | Cross-section study | Healthcare workers | 2299 | 12.10% (278) | 25.50% (586) |             | 9             |
| Wang, Y. N. | From February 6th, 2020 to February 9th, 2020 | Cross-section study | General public | 600          | 17.17% (103) | 6.33% (38) |             | 8             |
| Zhang, W. R. | From February 19th, 2020 to March 6th, 2020 | Cross-section study | General public | 1255         | 9.5% (119) | 8.5% (107) |             | 8             |
| Zhong, Y.P. | In January 2020               | Cross-section study | Healthcare workers | 927         | 12.2% (113) | 13% (121) |             |               |
| Zhang, X. N. | In January to February 2020  | Cross-section study | Healthcare workers | 133       | 42.11% (56) | 58.65% (78) |             | 8             |
| Zhang L.L. | N.A.                          | Cross-section study | Healthcare workers | 89         | N.A           | 58.43% (52) |             | 6             |
| Xu, Y.    | From February 7th, 2020 to February 15th, 2020 | Cross-section study | Healthcare workers | 360       | 38.33% (138) | 18.87% (68) |             | 8             |
| Xiao, C.  | From February 6th, 2020 to February 8th, 2020 | Cross-section study | Healthcare workers | 432       | 22.22% (96) | 12.27% (53) |             | 9             |
| Tang, H.H. | N.A.                           | Cross-section study | Healthcare workers | 44         | 45.40% (20) | 31.80% (14) |             | 8             |
| Xun, X. Y. | N.A.                           | Cross-section study | Healthcare workers | 110       | 16.36% (18) | 22.73% (25) |             | 7             |
| Qi, J.J.  | N.A.                           | Cross-section study      | Healthcare workers | 400       | 24.50% (98) | 31% (124) |             | 5             |
| Nong, Q.X. | From January 31st, 2020 to February 3rd, 2020 | Cross-section study | Healthcare workers | 92         | 48.91% (45) | 56.52% (52) |             | 7             |
| Lin, G.T. | From January 31st, 2020 to February 8th, 2020 | Cross-section study | Healthcare workers | 804       | N.A           | 16.30% (131)|             | 9             |
| Li, Y.F.  | From January 30th, 2020 to February 1st, 2020 | Cross-section study | General public | 977         | 21.70% (212) | 19.20% (188)|             | 9             |
| Li, R.L.  | In January to February 2020    | Cross-section study      | Healthcare workers | 66         | N.A           | 81.81% (54)|             | 8             |
| Huang, J.Z. | From February 7th, 2020 to February 14th, 2020 | Cross-section study | Healthcare workers | 230       | N.A           | 23.04% (53) |             | 8             |
| Chen, Y.N. | In February 2020               | Cross-section study      | Healthcare workers | 711       | 26.02% (185) | 7.59% (54) |             | 6             |
| Cai, F.F. | N.A.                           | Cross-section study      | Healthcare workers | 48         | 4.17% (2) | 87.5% (42) |             | 5             |
| Zheng, C.M. | From February 18th, 2020 to February 21th, 2020 | Cross-section study | Healthcare workers | 373       | 31.37% (117)| N.A           |             | 7             |
| Luo, Q.Y. | N.A.                           | Cross-section study | Healthcare workers | 171       | 39.77% (68) | 49.03% (77)|             | 9             |
| Liu, X. L. | From February 1st, 2020 to February 18th, 2020 | Cross-section study | Healthcare workers | 1097      | 37.19% (408) | 27.53% (302)|             | 7             |
| Yang, L.Q. | In February 2020               | Cross-section study      | General public | 512         | 9.38% (48) | N.A           |             | 8             |
| Mu, C.J.  | From January 31st, 2020 to February 11th, 2020 | Cross-section study | General public | 217         | 5.53% (12) | 7.83% (17) |             | 9             |
| Liu, L.   | N.A.                           | Cross-section study | Healthcare workers | 39         | 84.60% (33) | 20.50% (8) |             | 6             |
| Duan, L.S. | From February 14th, 2020 to February 16th, 2020 | Cross-section study | Healthcare workers | 530       | 33.02% (175) | 26.42% (140)|             | 7             |
| Dong, B.J. | From January 31st, 2020 to February 10th, 2020 | Cross-section study | Healthcare workers | 96         | 11.46% (11) | 70.83% (68)|             | 6             |

Note: N.A. = not available.
In present study, we performed a meta-analysis to evaluate the prevalence of depression and anxiety during COVID-19 in China, and found that the prevalence of depression and anxiety among healthcare workers was higher than the prevalence among general public. More importantly, we observed a different prevalence changing trends among healthcare workers and general public before and after the peak of COVID-19 in China. As present study result shown, after the peak, the prevalence among healthcare workers declined compared before, while
Fig. 5. The prevalence of anxiety among healthcare workers in the included studies.

Fig. 6. Funnel plot of results of prevalence of depression among the general public.

Fig. 7. Funnel plot of results of prevalence of depression among the healthcare workers.
an upward trend of the prevalence among the general public was detected.

Previous studies reported a high prevalence of depression and anxiety among the general public during the severe acute respiratory syndrome (SARS) epidemic outbreak in Beijing and Hong Kong (Liu et al., 2012; Leung et al., 2003). A same phenomenon was detected during COVID-19 outbreak. With the new limitations in daily life and social activities for an unknown period of time, the mental health of the general public was also paid emerging concern by recent studies, whose results suggest the quite significant percentage of general public were suffering from depression and anxiety during COVID-19 pandemic in China (Wang et al., 2020c). Our study confirmed that 26% general public were suffering from depression and 22% were having anxiety. Higher prevalence among healthcare workers was identified. The prevalences of depression and anxiety among healthcare workers were 31% and 40% respectively. Similar to our result, the higher prevalence of psychological symptom among healthcare workers than the general public was reported during the Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak (Alsubaie et al., 2019; Jeong et al., 2016). During an epidemic, healthcare workers were exposed to traumatic situation in their everyday work (Walton et al., 2020). In the fight against COVID-19, an unpredicted and rapidly-spread epidemic, challenges for healthcare workers not only included a high risk of infection, patients with negative emotions and exhaustion, but also the moral injury of making difficult ethical decisions on the rationing of care and lack of social supports under quarantine, which may imply higher risk of

Table 2
Prevalence before and after the peak among general public and healthcare workers.

| Group                  | Mental disorder | Time of the investigation | number of inclusions | Sample size | I^2 (%) | Prevalence(95 %CI)       |
|------------------------|-----------------|----------------------------|----------------------|-------------|---------|--------------------------|
| General public         | Depression      | Before 8th February,2020   | 3^a                  | 7014        | 99.5    | 33 % (95 %CI:16 %-51 %)  |
|                        |                 | After 8th February,2020    | 1^b                  | 98          | –       | 62 % (95 %CI:53 %-72 %)  |
|                        | Anxiety         | Before 8th February,2020   | 4^c                  | 7818        | 97.8    | 24 % (95 %CI:17 %-31 %)  |
| Healthcare workers     | Depression      | Before 8th February,2020   | 3^d                  | 1781        | 98.5    | 40 % (95 %CI:19 %-62 %)  |
|                        |                 | After 8th February,2020    | 4^e                  | 1429        | 98.0    | 22 % (95 %CI:13 %-31 %)  |
|                        | Anxiety         | Before 8th February,2020   | 3^f                  | 1781        | 99.2    | 38 % (95 %CI:12 %-63 %)  |
|                        |                 | After 8th February,2020    | 3^g                  | 3756        | 97.6    | 22 % (95 %CI:13 %-31 %)  |

Note: ^a= (Gao et al., 2020; Li et al., 2020c; Wang et al., 2020a); ^b= (Zhang et al., 2020a); ^c= (Gao et al., 2020; Li et al., 2020c; Lin et al., 2020; Wang et al., 2020a); ^d= (Zhang et al., 2020a); ^e= (Lai et al., 2020; Nong et al., 2020; Xiao et al., 2020); ^f= (Duan et al., 2020; Lu et al., 2020; Zhang et al., 2020c; Zheng et al., 2020); ^g= (Duan et al., 2020; Lu et al., 2020; Zhang et al., 2020c); ^h= (Lai et al., 2020; Nong et al., 2020; Xiao et al., 2020).
mental health problem for healthcare workers (Kang et al., 2020; Walton et al., 2020). Besides, faced with occupational burnout caused by overwork to meet the need of overloaded medical facilities and inadequate protection due to the lack of personal protective equipment, healthcare workers were struggling in mental stress, worries of their health and concerns on spreading the virus to families and friends (Hu et al., 2020).

On February 8th, 2020, the peak of the COVID-19 epidemic occurred in mainland China. After that the number of new and suspected cases was continuously declining and the recovery cases were increasing, which marked the improvement of the epidemic. We observed a different prevalence changing trend among healthcare workers and the general public before and after the peak of COVID-19 occurred in China for the first time. The result showed that before the peak, healthcare workers (depression: 40 %, anxiety: 38 %) had higher percentage of having depression and anxiety than the general public (depression: 33 %, anxiety: 24 %), as same as former result. However, a decreased prevalence among healthcare workers (depression: 22 %, anxiety: 22 %) was detected compared before, while the prevalence among the general public raised (depression: 62 %, anxiety: 44 %) after the peak occurred. This may suggest that healthcare workers have met an upturn in mental health status after the peak of the epidemic while the psychological status of general public deteriorated after the peak. In spite of stressful situation, mental health can be related to cognition, a critical factor for the onset and maintenance of depression and anxiety (Hallion and Ruscio, 2011). Infectious disease causes more psychosocial problems for people lack knowledge about newly emerging diseases (Ko et al., 2006).

Recent survey reported the perceived level of knowledge relatively to COVID-19 and to its related socio-political situation was significantly different between healthcare workers and the general public, and healthcare workers had a higher odd of being properly informed about both COVID-19 and its related social situation, due cognitive bias and baseless rumors on the Internet (Simione and Gagnanrella, 2020). During COVID-19 epidemic, with overwhelmed misinformation and false reports about the COVID-19 bombarded social media, stoked unforeseen fears among general public in China, which led to onset of anxiety and combination of depression and anxiety (Gao et al., 2020).

Above evidences may suggest that the prevalence changing trend among healthcare workers and the general public before and after the peak of COVID-19 occurred in China may be related to different level of cognition. As close experiencers, healthcare workers are equipped with professional medical knowledge may have higher level of cognition on COVID-19 than the general public who lack knowledge about newly infectious disease surrounding with relative misinformation and rumors. As the epidemic progressed, the gap of cognition on COVID-19 between two groups was widening, which may explain the declined prevalence of depression and anxiety among healthcare workers and rise the prevalence among the general public after peak occurred.

Several limitations of this study must be considered. Firstly, all included studies were cross-section studies, and few other types of observational studies were searched. Secondly, our study focused in China whose generalizability might be limited due to different culture between China and western country. Lastly, a high inherent between-study heterogeneity existed when pooling prevalences of each group, probably for the inconsistent scales and cutoff to evaluate prevalence. Further study can be done to evaluate psychological and psychiatric prevalence at other phases of the COVID-19 epidemic in China, other countries or globally. Also, the relationship between cognition about the epidemic and the mental health status can be further studies.

5. Conclusion

The COVID-19 epidemic has a potential psychiatric impact on the general public and healthcare workers in China, which is more severe among healthcare workers illustrated by the higher overall prevalence of depression and anxiety. Moreover, the mental state among the general public deteriorated after the peak of the epidemic, while healthcare workers, who spent more time with novel coronavirus infectors standing in the frontline of this crisis, tended to recover after the peak.

Authors contributions

BZ was responsible for this study. BZ, DY and YC conceived and designed the study. DY and YC participated in the literature searches, titles and abstracts evaluation, data extraction and analysis. DY and BZ participated the interpretation of the results. DY participated in drafting the protocol and preparing the manuscript. All authors read and approved the final manuscript.

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Declaration of Competing Interest

The authors report no declarations of interest.

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