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COVID-19 pandemic increases the occurrence of nursing burnout syndrome: an interrupted time-series analysis of preliminary data from 38 countries

Meng-Wei Ge [a], Fei-Hong Hu [a], Yi-Jie Jia [a], Wen Tang [a], Wan-Qing Zhang [a], Dan-Yan Zhao [a], Wang-Qin Shen [a], Hong-Lin Chen [b,*]

[a] *School of Medicine, Nantong University, Nantong, Jiangsu, PR China*
[b] *School of Public Health, Nantong University, Nantong, Jiangsu, PR China*

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ABSTRACT

Aim: To evaluate the trends in nursing burnout rates before and during the coronavirus 2019 restrictions.
Method: Meta-analysis was used to extract the data on global nursing burnout from 1 Jan. 2010–15 Dec. 2022. An interrupted time-series analysis using segmented ordinary least squares (OLS) regression models was used to explore if the nursing burnout were affected by the epidemic. Newey-West standard error was used to adjust for autocorrelation and heteroskedasticity.
Results: Before the epidemic (April 2020), the nursing burnout rate rose with 0.0007497 (95% CI: 0.0000316, 0.0014677, $t = 2.07$, $P = 0.041$) per month. The trend of nursing burnout rate has increased by 0.0231042 (95 CI %:0.0086818, 0.0375266, $t = 3.18$, $P = 0.002$). The increasing trend of nursing burnout rate after the COVID-19 restrictions is $0.0007497 + 0.0231042 = 0.0238539$ per month.
Conclusion: The study indicated that the Covid-19 restrictions had an impact on nursing burnout, increasing the occurrence of nursing burnout syndrome.

1. Introduction

The COVID-19 restrictions have led to a social and economic crisis and caused much disruption, with long-term impacts on healthcare systems and disrupted delivery of routine healthcare services (Frenk J et al., 2022). After the restrictions, healthcare workers feel more stressful than general population, because they must always face specific challenges and stressors (Chirico et al., 2020). A recent study has shown that nurses suffer more psychological stress from the aftermath of the COVID-19 restrictions, reporting higher depressive symptoms, exhaustion, stress and lower job satisfaction (Lai et al., 2020). Too much psychological stress like exhaustion and low job satisfaction may cause burnout syndrome (Maslach et al., 2018).

Burnout syndrome is a work-related disease defined by the WHO (WHO, 2019), which is a common psychological problem faced by nurses and would have severe negative impacts on their work. For example, Ph. D. Sullivan once summarized that burnout could cause poor overall mental health of nurses, such as chronic stress, anxiety and depression. And these traumas can cause damage to the body through inflammation and metabolic syndrome, leading to more serious diseases such as high blood pressure, cardiovascular disease, stroke and diabetes. Meanwhile, the accumulation of chronic stress may directly affect job satisfaction, patient care and nurse retention (V. Sullivan et al., 2022). Shah MK et al. once found that 31.5% nurses in America wanted to leave their jobs because of burnout (Shah et al., 2021). Before the restrictions, many studies have shown that many nurses suffered from burnout syndrome due to the particularity of hospital work, nurses easily suffer from psychological problems in the environment of high pressure, irregular working hours, shifts and overnight work (Gualano et al., 2021; Woo et al., 2020). During the restrictions, most evidence suggested that nurses were significantly more affected than other professions in the health field. Nurses were demonstrated to have a higher risk of suffering from burnout and be under considerable mental strain, especially those on the frontlines (Badahdah et al., 2021; Pappa et al., 2020). Nurses caring for patients infected with COVID-19 were found deeply troubled by burnout, showing insomnia, depression, somatization, symptoms, anxiety and Post-Traumatic Stress Disorder (Busch et al., 2021; Lavoie-Tremblay et al., 2022). Such psychological trauma

* Corresponding author.
E-mail address: honglinyjs@126.com (H.-L. Chen).

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even led to the suicide of some medical staff. 1500 nurses from 44 countries have died during the COVID-19 restrictions up to 28 Oct. 2020, according to the International Council of Nurses (Galanis et al., 2021).

In recent years, many articles have studied nursing burnout. Before 2019, Woo et al. found that the global nursing burnout syndrome was 11.23%, which indicated a high burnout rate (Woo et al., 2020). During the restrictions, a study found that more than 40% of nurses in Japan experienced burnout (Matsuo T et al., 2020). Women were about 50% more likely to report burnout syndrome than men (Harry et al., 2022). The European Cancer Society has conducted two online surveys and found that the burnout rate of 1520 cancer workers from 101 countries surveyed from 16 April to 3 May, 2020 was 38%, while in the follow-up survey from 16 July to 6 August 2020, it was found that the burnout rate of respondents had reached 49% (Burki, 2020). Ph. D. Sullivan reviewed the history of the restrictions and conducted a comparative study of symptoms of burnout in nurses before and during the epidemic. Nursing burnout was a severe problem, exacerbated by the COVID-19 restrictions (D. Sullivan et al., 2022). However, most studies only described the severe influence of the restrictions on nursing burnout syndrome and the changing trend of nursing burnout before and during the restrictions has not been studied.

In our study, we aimed to evaluate the trends in nursing burnout rates before and during the COVID-19 restrictions using an interrupted time-series analysis.

2. Methods

2.1. Study design

This study evaluated the impact of 'the COVID-19 restrictions' on the nursing burnout rates around the world using an interrupted time-series analysis before and during the restrictions. The meta-analysis was used to obtain the rates of nursing burnout syndrome around the world from 1 Jan. 2010–15 Dec. 2022.

2.2. Definition of the nursing burnout rates

Maslach Burnout Inventory (MBI) was a frequent scale to measure burnout syndrome, which consists of three dimensions: depersonaliza-

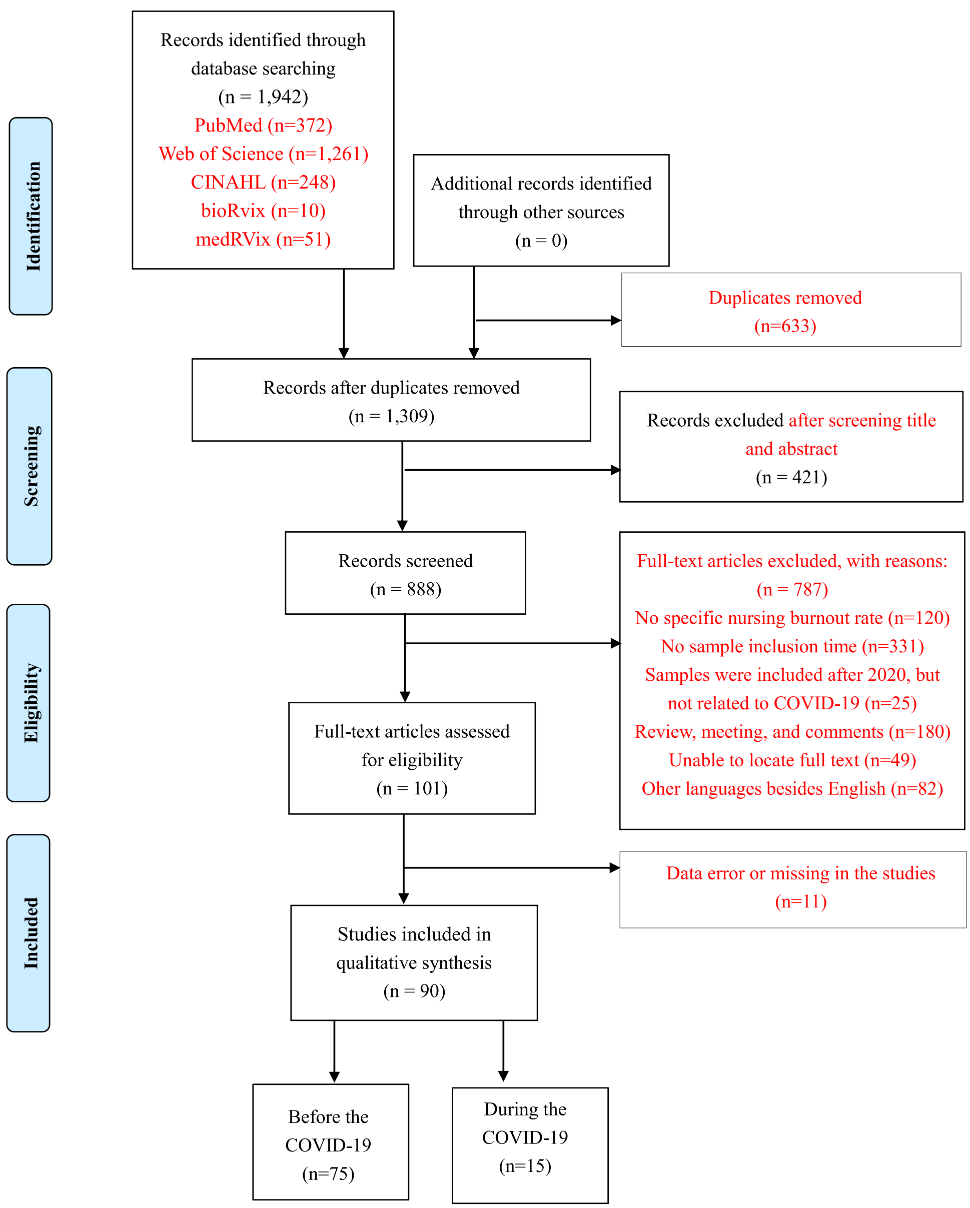

Fig. 1. Flow diagram of the trial selection for the meta-analysis.

Table 1
Baseline description of included studies.

First author, year	Country	Time period	COVID (before/ during)	Age (Year)	Gender (F/M)	Partner (Yes/No)	Specialty	Burnout tool	Sample size	Number of burnout	Nursing Burnout Rate 95% CI	Quality score
Mavrovounis G, 2022	Greece	2021	during	NR	NR	NR	NR	MBI-HSS	140	97	0.69 (0.61–0.77)	7
Dos Santos MA, 2022	Brazil	Jun.-Aug. 2020	during	36.4	508/ 64	NR	NR	MBI	572	99	0.17 (0.14–0.20)	6
Noh EY, 2022	South Korea	2021	during	27.6	143/ 18	12/ 149	NR	CBI	161	90	0.56 (0.48–0.64)	6
Kamali M, 2022	Iran	2020	during	NR	NR	NR	NR	MBI	4409	904	0.12 (0.11–0.13)	8
Zakaria N, 2022	Malaysia	Aug.-Nov. 2019	before	36.9	NR	2023/ 395	NR	MBI	2418	590	0.24 (0.23–0.26)	8
Thumm EB, 2022	US	2017	before	47.6	NR	NR	Obstetrics	MBI	2333	933	0.40 (0.38–0.42)	8
Khan Y, 2022	Belgium	2020	during	39.7	3823/ 729	NR	Multiple specialties	MBI	4552	3205	0.70 (0.69–0.71)	7
Feleke DG, 2022	Ethiopia	2020	during	20–49	206/ 162	157/ 211	Multiple specialties	MBI-HSS	368	207	0.56 (0.51–0.61)	7
Tan KH, 2022	Singapore	2019–2020	before	NR	NR	NR	NR	MBI-HSS	3032	1072	0.45 (0.43–0.47)	6
Membrive-Jimenez MJ, 2022	Spain	2021	during	NR	50/ 36	71/ 15	Multiple specialties	MBI	86	29	0.34 (0.24–0.44)	7
Azoulay E, 2021	France	Oct. 30- Dec. 1, 2020	during	NR	NR	NR	ICU	MBI	412	194	0.47 (0.42–0.52)	7
Zhou LL, 2021	China	Sept.-Oct, 2020	during	20–55	1133/ 0	604/ 529	NR	MBI	1133	682	0.60 (0.57–0.63)	7
Li YX, 2021	China	Dec. 2020-May 2021	during	NR	2831/ 137	2273/ 695	Multiple specialties	MBI	2968	2095	0.71 (0.69–0.72)	8
Ferry AV, 2021	UK	Jun. 2020	during	NR	NR	NR	NR	CBI	286	245	0.86 (0.82–0.90)	6
Butera S, 2021	Belgium	Apr. 2020	during	NR	NR	NR	ICU	MBI	1149	770	0.67 (0.64–0.70)	7
Kakemam E, 2021	Iran	Sept.-Nov. 2020	during	NR	746/ 258	688/ 316	NR	MBI	1004	316	0.31 (0.29–034)	8
Nishimura Y, 2021	Japan	2020	during	NR	NR	NR	Multiple specialties	MBI	21	5	0.24 (0.09–0.39)	7
Zhang XN, 2021	China	2020	during	28	141/ 39	123/ 57	Multiple specialties	MBI-GS	180	27	0.15 (0.10–0.20)	7
Alves MCEC, 2021	Brazil	Mar.-Apr. 2018	before	39.0	92/ 30	79/ 43	ICU	MBI	122	23	0.19 (0.12–0.27)	7
Nicholls M, 2021	New Zealand	9 Mar.– 3 Apr. 2020	before	NR	NR	NR	ED	CBI	711	489	0.69 (0.65–0.72)	7
Moller G, 2021	Brazil	Oct. 2018-Mar. 2019	before	37.3	53/ 9	33/ 29	ICU	MBI	62	3	0.05 (0.01–0.14)	8
Aragao NSC, 2021	Brazil	Jul.-Nov. 2016	before	33.9	59/ 6	36/ 27	ICU	MBI	56	30	0.54 (0.40–0.67)	8
Rubin B, 2021	Canada	27 Nov. 2018–31 Jan. 2019	before	NR	206/ 31	NR	Multiple specialties	WBI	242	188	0.78 (0.72–0.83)	8
Magalhaes AMM, 2021	Brazil	Aug.-Sept. 2020	before	NR	NR	NR	Multiple specialties	MBI	161	28	0.17 (0.12–0.24)	7
Slusarz R, 2021	Poland	Jan.2019-Feb. 2020	before	NR	196/ 10	145/ 61	Surgery	Self-report questionnaire	206	66	0.32 (0.26–0.39)	8
Dyrbye LN, 2021	US	Dec. 2016	before	51.6	894/ 82	713/ 263	Multiple specialties	MBI	976	350	0.36 (0.33–0.39)	8
Butera S, 2021	Belgium	Jan. 2020	before	NR	NR	NR	ICU	MBI	283	145	0.51 (0.45–0.57)	7
Kumar A, 2021	India	Dec. 2019	before	NR	104/ 21	42/ 83	ICU	Questionnaire	125	47	0.38 (0.29–0.47)	8
Simonetti M, 2021	Chile	2017–2018	before	31.6	1204/ 191	NR	Multiple specialties	MBI	1395	484	0.35 (0.33–0.38)	8
Abraham CM, 2021	UK	2018–2019	before	49.5	358/ 38	315/ 81	Multiple specialties	MBI	396	100	0.25 (0.21–0.29)	8
Friganovic A, 2021	Croatia	2017	before	19–62	544/ 76	316/ 304	ICU	MBI	620	72	0.12 (0.09–0.15)	8
De la Fuente-Solana EI, 2021	Spain	2019–2020	before	NR	73/ 22	59/ 36	Pediatric care	MBI-HSS	95	36	0.38 (0.28–0.48)	7
Paiva BSR, 2021	Brazil	2017–2018	before	26–46	297/ 26	184/ 120	Oncology	MBI-HSS	305	4	0.01 (0.00–0.02)	8
Zakaria MI, 2021	Malaysia	2020	before	NR	NR	NR	ED	MBI	142	31	0.22 (0.15–0.29)	6
Quijada-Martinez PJ, 2021	Venezuela	2019	before	24–70	36/ 4	17/ 23	ICU	MBI	40	9	0.23 (0.10–0.36)	7
Ribeiro EKDA, 2021	Brazil	2018	before	NR	73/ 10	42/ 41	ICU	MBI	83	12	0.14 (0.07–0.21)	7

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Table 1 (*continued*)

First author, year	Country	Time period	COVID (before/ during)	Age (Year)	Gender (F/M)	Partner (Yes/No)	Specialty	Burnout tool	Sample size	Number of burnout	Nursing Burnout Rate 95% CI	Quality score
De la Fuente-solana EI, 2021	Spain	2019	before	22–64	118/ 32	45/ 105	Obstetrics	MBI	150	42	0.28 (0.21–0.35)	7
Belay AS, 2021	Ethiopia	2018	before	21–36	144/ 138	106/ 176	NR	MBI-HSS	282	96	0.34 (0.28–0.40)	7
Vitale E, 2020	Italy	Jul. -Aug. 2019	before	37.0	229/ 71	NR	NR	MBI-HSS	300	148	0.49 (0.44–0.55)	8
Clark RRS, 2020	US	2015	before	47.8	1531/ 7	NR	Obstetrics	MBI	1538	381	0.25 (0.23–0.27)	8
Balinbin CBV, 2020	Philippines	Aug.-Nov. 2017	before	30.57	84/ 37	42/ 79	Surgery	PROQOL	121	34	0.28 (0.20–0.37)	8
Zeng LN,2020	China	Oct.-Dec.2017	before	32.6	1167/ 282	908/ 541	Psychiatry Department	MBI-GS	1449	867	0.60 (0.57–0.62)	8
Tsou MT, 2020	China	Dec.2018-Mar. 2019	before	35.2	1685/ 73	NR	Multiple specialties	MBI-HSS	1758	113	0.06 (0.05–0.08)	8
Rudman A, 2020	Sweden	2017–2018	before	NR	2225/ 198	NR	NR	NR	2423	299	0.12 (0.11–0.12)	8
Alvares MEM, 2020	Brazil	2011–2013	before	28–45	109/ 16	63/ 62	ICU	MBI-HSS	125	49	0.39 (0.30–0.48)	7
Jones GAL, 2020	UK	2018	before	NR	1131/ 63	NR	ICU	MBI	1194	594	0.50 (0.47–0.53)	8
Vevodova S, 2020	Czech Republic	2018	before	21–51	230/ 20	NR	NR	MBI	250	96	0.38 (0.32–0.44)	8
Mohammad KI, 2020	Jordan	2018	before	21–50	NR	238/ 83	Obstetrics	CBI	321	121	0.38 (0.33–0.43)	8
Harizanova S, 2020	Bulgaria	2014–2015	before	30–52	206/ 8	136/ 78	NR	MBI	214	18	0.08 (0.04–0.12)	8
das Merces MC, 2020	Brazil	2017–2018	before	27–47	989/ 136	519/ 606	Multiple specialties	MBI	1125	206	0.18 (0.16–0.20)	8
Portero de la Cruz S, 2020	Spain	2016	before	39–56	125/ 46	39/ 132	ED	MBI	171	14	0.08 (0.04–0.12)	8
Kapu AN, 2019	US	Jan.-Feb. 2018	before	38.0	390/ 35	NR	NR	MBI	433	114	0.26 (0.22–0.31)	7
Ramirez-Baena L, 2019	Spain	2017	before	22–61	214/ 87	223/ 50	NR	MBI	301	109	0.36 (0.31–0.41)	7
Zhang WY, 2019	China	Jul. 2016-Jul. 2017	before	NR	49,898/ 1508	34,015/ 16538	NR	MBI	51,406	25,703	0.50 (0.49–0.50)	8
Arimon-Pages E, 2019	Spain	2015	before	28–51	256/ 41	NR	Oncology	ProQOL	297	60	0.20 (0.15–0.25)	8
Berry S, 2019	UK	2014	before	26–47	NR	NR	Internal medicine	MBI-HSS	137	12	0.09 (0.04–0.14)	7
Nobre DFR, 2019	Portugal	2015	before	NR	15/ 17	NR	ED	CBI	32	22	0.69 (0.53–0.85)	5
Chico-Barba G, 2019	Mexico	2016–2018	before	NR	168/ 0	103/ 65	NR	MBI	168	33	0.20 (0.14–0.26)	8
Card EB, 2019(Card, 2019)[3433323130]	US	2014	before	NR	2729/ 108	NR	Surgery	MBI	2837	1474	0.52 (0.50–0.54)	8
Selamu M, 2019	Ethiopia	2014	before	NR	NR	NR	NR	MBI-HSS	75	30	0.40 (0.29–0.51)	8
Vasconcelos EM, 2018	Brazil	Jul. 2014	before	30.82	81/ 10	34/ 57	ICU	MBI	91	13	0.14 (0.08–0.23)	8
Daniel A, 2018	US	May-Jun. 2017	before	24–80	228/ 43	NR	Multiple specialties	A 10-item survey	371	73	0.20 (0.16–0.24)	7
See KC, 2018	Asian multi-country	2015–2016	before	NR	NR	NR	ICU	MBI-HSS	3100	1611	0.52 (0.50–0.54)	7
Sobral RC, 2018	Brazil	2013	before	NR	250/ 25	NR	NR	MBI-HSS	281	16	0.06 (0.03–0.09)	8
Wentzel DL, 2018	South Africa	2016–2017	before	23–65	81/ 2	39/ 44	Oncology	ProQOL	83	51	0.61 (0.51–0.71)	8
Sillero A, 2018	Spain	2014	before	21–65	119/ 11	75/ 55	Surgery	MBI	130	53	0.41 (0.33–0.49)	6
Bhagavathula A, 2018	Ethiopia	2016	before	NR	NR	NR	NR	MBI-HSS	169	23	0.14 (0.09–0.19)	7
Vermeir P, 2018	Belgium	2015	before	30–45	NR	NR	ICU	MBI	299	9	0.03 (0.01–0.05)	7
Fumis RRL, 2017	Brazil	Aug.-Sept.2015	before	NR	NR	NR	Multiple specialties	MBI	191	44	0.23 (0.17–0.30)	7
Creedy DK, 2017	Australia	Sept.2014	before	NR	NR	NR	Obstetrics	MBI	978	72	0.07 (0.06–0.09)	7
De la Fuente-Solana EI, 2017	Spain	2015	before	NR	70/ 31	74/ 27	Oncology	MBI	101	30	0.30 (0.21–0.39)	7
Merces MDC, 2016	Brazil	2015–2016	before	NR	183/ 6	NR	Multiple specialties	MBI	189	20	0.11 (0.07–0.15)	8
Henriksen L, 2016	Norway	2014	before	40–59	NR	511/ 87	Obstetrics	CBI	598	119	0.20 (0.17–0.23)	7
Biksegn A, 2016	Ethiopia	2013	before	NR	NR	NR	NR	MBI-HSS	237	120	0.51 (0.45–0.57)	7
Muliira RS, 2016	Uganda	2012–2014	before	27–41	178/ 46	123/ 101	Obstetrics	ProQOL	224	23	0.10 (0.06–0.14)	8
Abdo SAM, 2016	Egypt	2012–2013	before	20–53	NR	NR	ED	MBI	284	76	0.27 (0.22–0.32)	8

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Table 1 (*continued*)

First author, year	Country	Time period	COVID (before/ during)	Age (Year)	Gender (F/M)	Partner (Yes/No)	Specialty	Burnout tool	Sample size	Number of burnout	Nursing Burnout Rate 95% CI	Quality score
Jang I, 2016	Korea	2013	before	NR	285/ 0	95/ 190	Oncology	ProQOL	285	70	0.25 (0.20–0.30)	7
Maruyama A, 2016	Japan	2010–2011	before	24–48	NR	NR	NR	MBI	523	117	0.22 (0.18–0.26)	8
Markwell P, 2015	US	2013	before	NR	147/ 8	NR	Multiple specialties	ProQOL	158	40	0.25 (0.18–0.32)	7
Berger J, 2015	US	2014	before	NR	231/ 5	NR	Pediatric care	NR	239	70	0.29 (0.23–0.35)	7
Mangoulia P, 2015	Greece	2010–2011	before	29–45	122/ 52	98/ 76	Internal medicine	ProQOL	174	86	0.49 (0.42–0.56)	6
Hegney D, 2015	Australia	2013	before	NR	1487/ 121	NR	NR	ProQOL	1608	405	0.25 (0.23–0.27)	7
das Silva JLL, 2015	Brazil	2010–2011	before	28–41	65/ 65	NR	Multiple specialties	MBI	130	72	0.55 (0.46–0.64)	7
Ferreira Ndo N, 2015	Brazil	2011	before	28–48	452/ 82	300/ 234	NR	MBI-HSS	534	32	0.06 (0.04–0.08)	7
Dolan ED, 2015	US	2012	before	NR	NR	NR	Multiple specialties	MBI	1380	549	0.40 (0.37–0.43)	8
Ariapooran S, 2014	Iran	2013	before	25–39	67/ 106	143/ 30	NR	ProQOL	173	26	0.15 (0.10–0.20)	7
Ribeiro VF, 2014	Brazil	2012	before	NR	16/ 3	NR	Surgery	MBI	188	19	0.10 (0.06–0.14)	6
Yatasa YN, 2014	Ethiopia	2013	before	NR	116/ 59	58/ 117	NR	MBI-HSS	175	33	0.19 (0.13–0.25)	8
Raftopoulos V, 2012	Cyprus	2010–2011	before	NR	1189/ 282	1127/ 337	Multiple specialties	MBI	1482	190	0.13 (0.11–0.15)	7
Mohammadpoorasl A, 2012	Iran	2010	before	27–42	613/ 99	505/ 207	NR	MBI	712	156	0.22 (0.19–0.25)	6

ProQOL: Professional Quality of Life; ICU: Intensive Care Units; ED: Emergency Department; MBI: Maslach Burnout Inventory; MBI-HSS: Maslach Burnout Inventory-Human Services Survey; WBI: MBI-GS: Maslach Burnout Inventory-General Survey; Well- Being Index; SBI: Spanish Burnout Inventory; CBI: Copenhagen Burnout Inventory; NR: Not Reported

tion (DP), low personal accomplishment (PA) and emotional exhaustion (EE) (Maslach et al., 2018). In the DP (5 items), a score of 12 or more is considered high DP; a score of 6–11 is considered medium and below 6 is considered low. In the PA (8 items), a score of 33 or less indicates low PA, a score of 34–39 indicates moderate PA and a score of 40 or above indicates high PA. In EE (9 items), a score of 30 or more is considered high EE; 18–29 is considered medium and under 18 is considered low. The level of burnout syndrome is high when two or three dimensions are considered severe. The resulting data were the prevalence of nursing burnout syndrome, calculated as follows:

$$\text{Rates} = \frac{\text{number of burnout syndrome}}{\text{total number}} * 100\%$$

2.3. *Data on burnout rates extracted through meta-analysis*

Studies published in any language using PubMed, Web of Science (WOS), bioRvix, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and medRVix were searched from1 Jan. 2010–15 Dec. 2022. Search keywords included "nurs* ", "burnout" and "prevalence". Specific search strategies were shown in Supplementary materials.

The type of sample in our study was nurse population, including nurses in any department and nursing assistants etc. Inclusion criteria: (a) sample inclusion time indicated in studies and the time is 2010 and later (preferably month, otherwise year); (b) When the samples mentioned in the studies were included in 2020 or April 2020 or later, the studies must mention the nursing burnout affected by the COVID-19 restrictions. Even if the sample inclusion time is mentioned, those who did not mention the COVID-19 restrictions will not be included; (d) outcome data included the rates of nursing burnout syndrome; (e) studies published in English. Exclusion criteria: (a) data error or missing in the studies; (c) duplicated literature; (e) conference abstracts without full articles and (f) reviews. The Newcastle-Ottawa Scale (NOS) scale was applied to assess the quality of the included studies, which contains three parts: selected population (4 scores), comparability of groups (2 scores) and exposure determination (3 scores). Studies with a score of 7–9 are of high quality; 4–6 are of moderate quality; 0–3 are of low quality.

The sample size and rates of nursing burnout of the included studies were imported into Stata 11.0 for calculations. The rates of the same year or month were combined using the method of literature review and meta-analysis and the forest plots were drawn. The Cochrane I-squared test was used to evaluate the heterogeneity. When I^2 is greater than 75%, the heterogeneity is giant; when between 50% and 90%, it is larger; when between 40%– 60%. it is moderate; when I^2 is less than 40%, it is low (Higgins J, 2022). The random effect model will be selected if the heterogeneity is high (I^2>40%) (Page et al., 2021).

2.4. *Data management*

Because the meta-analysis was used to get data, not all monthly data can meet our requirements. Annual rates were combined from 1 Jan. 2010–15 Dec. 2022 to get annual nursing burnout rates and the combined annual rate averaged 12 months. They were then combined with other collected months with the same monthly data to obtain monthly nursing burnout rates. If there was no data in some months, the average value of annual data was directly selected. However, one of the drawbacks of processing data this way is that it can result in the same rate for several months.

2.5. *Statistical analysis*

An interrupted time series analysis using segmented ordinary least squares (OLS) regression models was used to research if the Covid019 restrictions had an impact on the rates and the trends of nursing burnout syndrome in the world. The COVID-19 restrictions were the

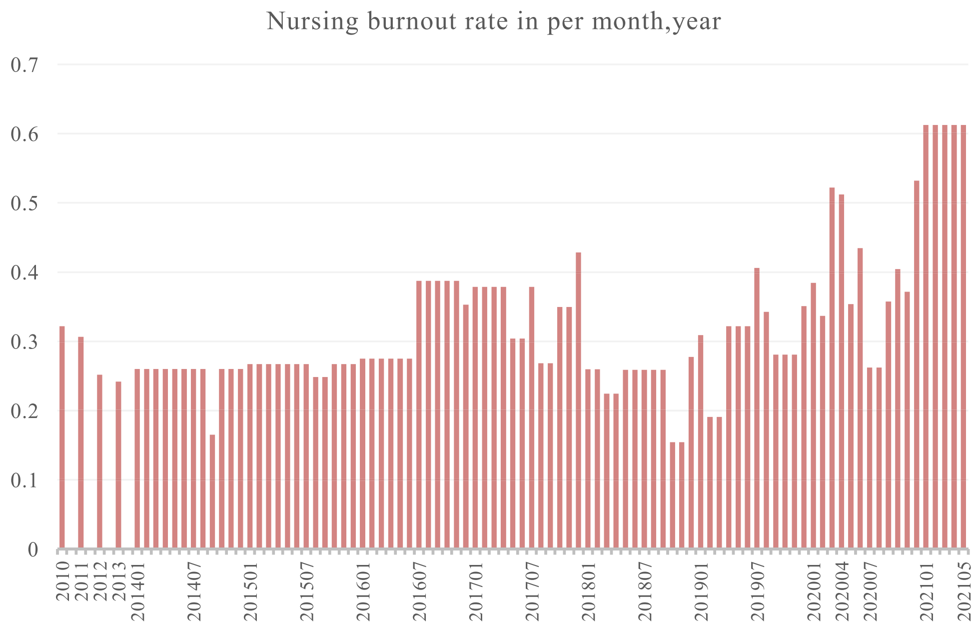


Fig. 2. Summary of nursing burnout rates in each month from 2010 to May 2021.

'intervention' of interest in this study. Newey-West standard errors with a lag of order one were used to adjust for autocorrelation and heteroskedasticity (A, 2015).

$$Y_t = \beta_0 + \beta_1 * T_t + \beta_2 * X_t + * P_t + S_t$$

The above formula was used in our study. Yt represents the nursing burnout syndrome monthly rate at time t; β0 is the baseline level; β1 represents the monthly nursing burnout rate slope before the COVID-19 restrictions; Tt refers to the time since the beginning of the study in months; β2 represents the changes in the rate in the month of the restrictions; Xt is a virtual (indicator) variable representing COVID-19 (the period before the restrictions is 0; otherwise it is 1); Pt is a continuous variable used to calculate the number of months. St represents the variable 0 that controls seasonality. Stata software 17.0 was used to analyze results.

3. Results

3.1. Study characteristics

Ninety studies with 113,438 nurses from 38 countries were included from 1 Jan. 2010–15 Dec. 2022 (Supplementary material references). The specific selection process is shown in Fig. 1. In these studies, only 28 reported sample inclusion time as the month and others reported years. Almost half of the studies stated the age of the nurses. Nearly a third of the studies did not report the gender of the nurses. Half of the studies reported whether the nurses had partners. Among different specialties, 15 were from the Intensive Care Unit (ICU); 20 studies were from

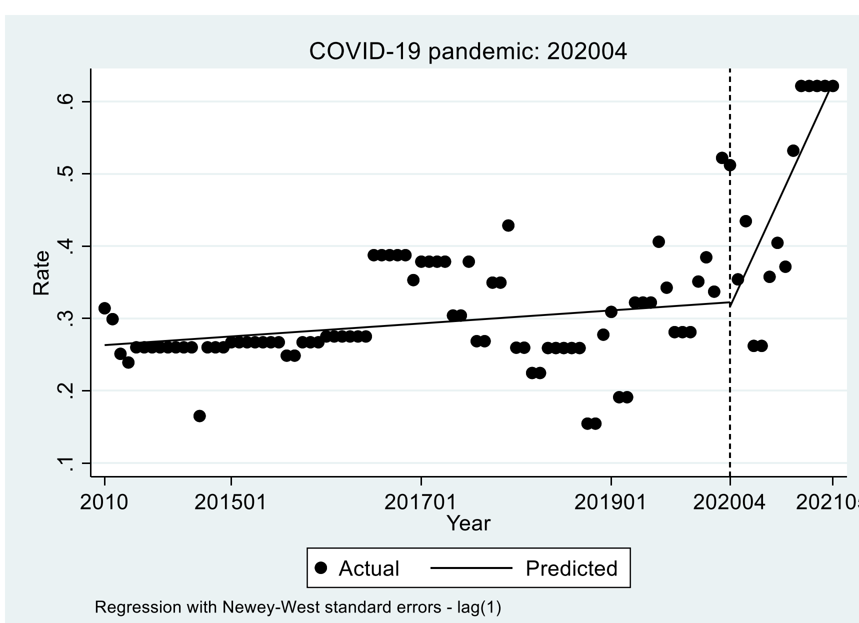


Fig. 3. Trends in monthly nursing burnout syndrome rate around the world (pre-COVID-19 pandemic trend: 0.0007497, 95%CI: 0.0000316, 0.0014677, t = 2.07, P = 0.041; COVID-19 pandemic change: 0.0238539, 95%CI: 0.0087134, 0.0389943, P < 0.05).

Table 2
The statistical results of interrupted time series regression analyses of the impact of the COVID-19 pandemic on the nursing burnout rate in total region subgroups.

Coefficient, 95%CI				
	Pre-COVID-19 pandemic trend (β1)	Rate change (β2)	COVID-19 pandemic trend (β3)	COVID-19 pandemic change (β1 + β3)
Total (n = 90)	0.0007497 * (0.0000316, 0.0014677)	-0.0061033(−0.1401596, 0.1279529)	0.0231042 * *(0.0086818, 0.0375266)	0.0238539 * (0.0087134, 0.0389943)
Region subgroup				
Occident (n = 56)	0.000603(−0.0005504, 0.0017563)	0.2362564 * *(0.187537, 0.2849757)	-0.0021181(−0.0061508, 0.0019145)	-0.001578(−0.0067012, 0.0036708)
Non-Occident (n = 34)	0.0017584 * (0.0003755, 0.0031413)	-0.1694088 * *(−0.243112, −0.0957056)	0.0304174 * *(0.0230258, 0.037809)	0.0321758 * *(0.0234013, 0.0409503)

"Pre-COVID-19 pandemic trend" indicates the pre-pandemic slope of nursing burnout rate and is β1.
"Rate change" indicates the changes in nursing burnout rate in the month of the pandemic outbreak and is β2.
"COVID-19 pandemic trend" indicates the difference of the slope of nursing burnout rate after the onset of the pandemic and is β3.
"COVID-19 pandemic change" indicates the slope in nursing burnout rate after the onset of the pandemic and is the sum of β1 and β3.
$^*P < 0.05$, $^{**}P < 0.001$

Multiple specialties. 76.7% of studies used MBI to measure the nursing burnout syndrome (Table 1).

3.2. The burnout rate based on each year and each month

Fig. 2 A shows the summaries of nursing burnout rates from 2010 to May 2021. 2014 was taken as an example to describe our data acquisition process (Supplementary materials Fig. 1E& F). The burnout rate of the samples in 2014 was combined and the result was 0.26 (95%CI: 0.10, 0.42; I^2= 99.2%; z = 3.24; p = 0.001). Then we averaged the burnout rate of 2014 over 12 months and combined with the rates of other months in 2014. The results showed that the nursing burnout rate was 0.20 (95%CI: 0.09, 0.32; I^2=87.2%; z = 3.39; p = 0.001) in July 2014 and 0.16 (95%CI: −0.02, 0.35; I^2= 98.4%; z = 1.72; p = 0.085) in September 2014. Supplementary materials Fig. 1E& F indicated the process of calculating the monthly rates. In 2014, the nursing burnout syndrome rates in other months except July and September were all 0.26. Monthly nursing burnout rates from 2010 to 2013 were not found. The nursing burnout rate was 0.31 (95%CI: 0.21, 0.42; I^2= 97.8%; z = 5.67; p < 0.001) in 2010; 0.30 (95%CI: 0.19, 0.40; I^2= 98.3%; z = 5.59; p < 0.001) in 2011; 0.25 (95%CI: 0.10, 0.40; I^2= 98.3%; z = 3.36; p < 0.001) in 2012; 0.24 (95%CI: 0.17, 0.31; I^2= 96.7%; z = 6.28; p < 0.001) in 2013. The process of obtaining nursing burnout rates in other years was also shown in Supplementary material Fig. 1.

3.3. Interrupted time-series analysis

The global nursing rate is 0.52 (95%CI: 0.19, 0.85) at its highest in Mar. 2020 and 0.16 (95%CI: −0.05, 0.36) at its lowest in Oct. 2018. During the restrictions, the highest nursing burnout rate is 0.62 (95%CI: 0.47, 0.81) from January to May 2021. Fig. 3 showed the long-term trend of the global nursing burnout rates before the COVID-19 restrictions (January 2010 to March 2020) and later (April 2020 to May 2021). The black dot indicated the actual rate of nursing burnout each month and the solid line indicated the trend of nursing burnout before and after the restrictions.

The interrupted time series regression analyses found an increasing trend of nursing burnout rate from baseline (Table 2). Statistically significant changes were found in the nursing burnout rates. Before the epidemic (April 2020), the nursing burnout rate rose with 0.0007497 (95% CI: 0.0000316, 0.0014677, t = 2.07, P = 0.041) every month; in the month of the restrictions (April 2020), the nursing burnout rate decreased by 0.0061033 (95%CI: −1401596, 0.1279529, t = −0.09, P = 0.928); compared with the rising trend of 0.0007497 before the COVID-19 restrictions, the rising trend of nursing burnout rate increased by 0.0231042 (95CI%:0.0086818, 0.0375266, t = 3.18, P = 0.002). The rising trend of nursing burnout rate after the COVID-19 restrictions is 0.0007497 + 0.0231042 = 0.0238539 every month (Table 2).

3.4. Subgroup analysis by regions

In occident countries, no significant difference was found in the trend changes before and during the epidemic (Table 2). The nursing burnout rate rose with 0.000603 (95% CI: −0.0005504, 0.0017563, t = 1.04, P = 0.302) every month before the restrictions; in the month of the restrictions (April 2020), the nursing burnout rate increased by 0.2362564 (95%CI: 0.187537, 0.2849757, t = 9.64, P < 0.0001); compared with the rising trend of 0.000603 before the restrictions, the trend of nursing burnout rate decreased by 0.0021181 (95%CI: −0.0061508, 0.0019145, t = −1.04, P = 0.299). The trend of nursing burnout rate after the COVID-19 restrictions is 0.000603–0.0021181 = −0.001578 every month (Fig. 4A).

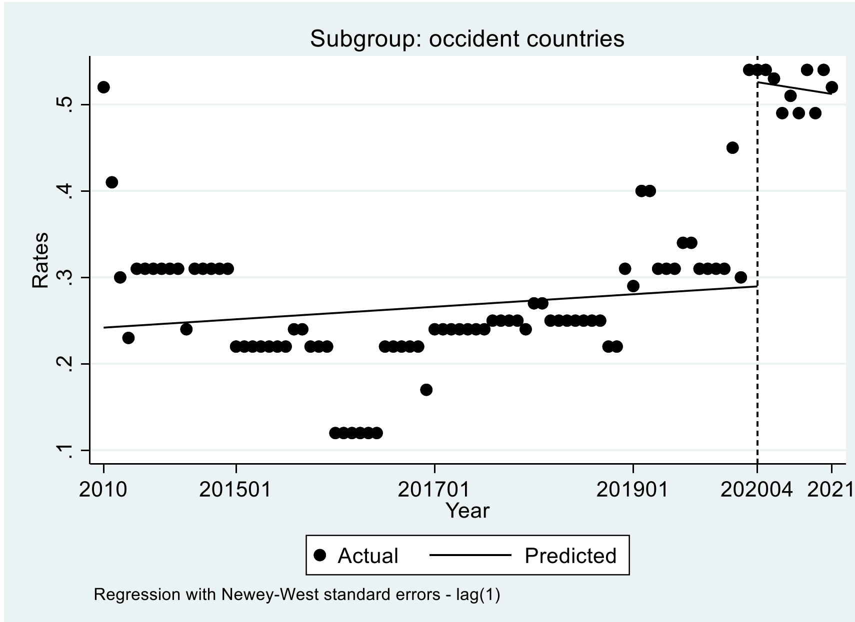
In non-occident countries, there was a statistically significant difference (Table 2). The nursing burnout rate rose with 0.0017584 (95% CI: 0.0003755–0.0031413, t = 2.53, P = 0.013) every month before the restrictions; in the month of the restrictions (April 2020), the nursing burnout rate decreased by 0.1694088 (95%CI: −0.243112,−0.0957056, t = −4.58, P < 0.001); compared with the rising trend of 0.0017584 before the COVID-19 restrictions, the trend of nursing burnout rate increased by 0.0.0304174 (95%CI: 0.0230258, 0.037809, t = 8.19, P < 0.001). The trend of nursing burnout rate after the COVID-19 restrictions is 0.0017584 + 0.0304174 = 0.0321758 every month (Fig. 4B).

4. Discussion

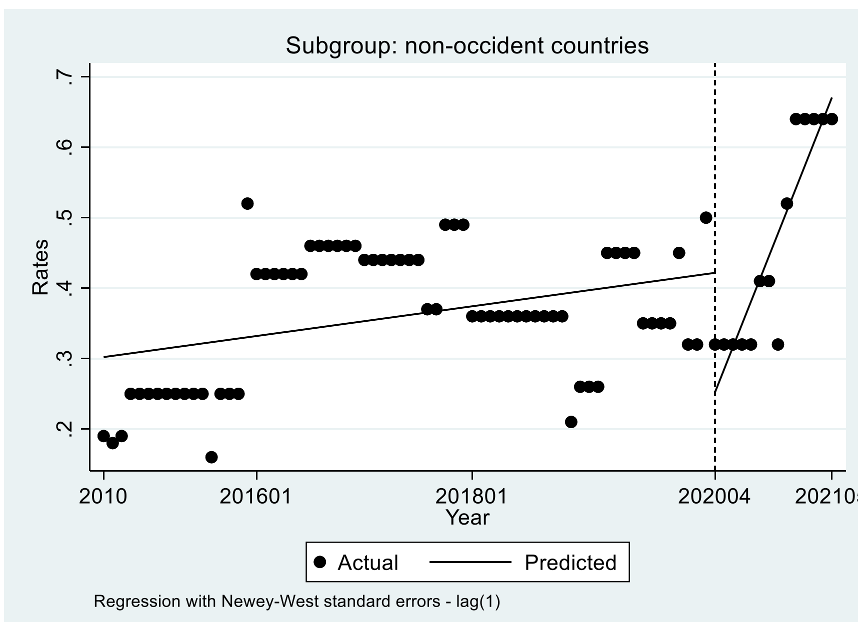
This interrupted time series analysis indicated that the global nursing burnout rate showed a slow upward trend, increasing at 0.0007497 (95% CI: 0.0000316–0.0014677, P = 0.041) per month before the restrictions. After the restrictions, the global nursing burnout rates increased significantly. It grew at a rate of 0.0238539 per month during the restrictions. The restrictions have influenced nursing burnout rates, leading to a rapid increase in nursing burnout rates.

A comparative analysis of nursing burnout before and during the epidemic showed that nurses had a high burnout rate during routine work and that the rate was higher during the COVID-19 restrictions (D. Sullivan et al., 2022), which is consistent with our findings. But the quantity in our study is more and the sample is more sufficient. In addition, another advantage of our study is that the interrupted time series calculated the growth rate of nursing burnout before and after the outbreak of the restrictions, which more intuitively showed the influence of the epidemic on nursing burnout rates.

Before the outbreak of COVID-19 restrictions, nurses were reported high burnout due to the environment of high pressure, irregular working hours, shifts and overnight work (Galanis et al., 2021). After the restrictions, nurses faced even greater challenges. It is well known that nurses play an extraordinary role in combating the COVID-19



(A)



(B)

Fig. 4. Trends in monthly nursing burnout syndrome rate in (A) occident countries (Pre-COVID-19 pandemic trend: 0.000603, 95%CI: −0.0005504, 0.0017563, $t = 1.04$, $P = 0.302$; COVID-19 pandemic change: −0.001578, 95%CI: −0.0056004, 0.0036708, $P = 0.601$); (B) non-occident countries (Pre-COVID-19 pandemic trend: 0.0017584, 95%CI: 0.0003755, 0.0031413, $t = 2.53$, $P = 0.013$; COVID-19 pandemic change: 0.0321758, 95%CI: 0.0234013, 0.0409503, $P < 0.001$).

restrictions among all healthcare professionals. They put their lives at a risk on the front lines, such as infection control units, emergency departments and intensive care units, etc. (Catton, 2020) COVID-19 has placed enormous stress on nurses and exacerbated pre-existing burnout mechanisms (Pappa et al., 2020). The most direct reason is that they felt anxious, such as lack of knowledge about the infection of COVID-19 (Sun et al., 2020), fear that they may be infected with the virus and exhaustion caused by overwork (Tan et al., 2020). At the same time, concerns about the health of their family are also a factor (Sun et al., 2020). Too many psychological problems easily lead to emotional exhaustion. To prevent infecting their relatives or family members, nurses were isolated in different places most of the time during the restrictions, resulting in a lack of social and emotional support for these nurses, which negatively affected their psychosocial status (Mo et al., 2020). In addition, many nurses perceived little support or management response to increased risk and stress (Foli et al., 2021). An online survey of factors related to nursing burnout during the restrictions found that staffing was negatively associated with the occurrence of burnout, with nurses who were adequately paid during the restrictions experiencing less burnout (D. Sullivan et al., 2022). Due to the high acuity and mortality of COVID-19 patients, nurses working in intensive care may experience feelings of powerlessness, low control, insufficient support, or resources (personal protective equipment, rescue equipment, etc.), high job demands. All these factors increased the risk of moral distress and burnout among nurses (Guttormson et al., 2022).

During the restrictions, nursing staff experienced chronic staffing shortages, high turnover and burnout in long-term care environment (Hung, 2021), with significant implications for the nurses themselves and for nursing work as a whole. Nursing burnout should be paid more attention to. Nurses play an essential role in achieving national and global goals related to health priorities and nursing is an indispensable profession in the world (WHO, 2020). According to our study, the nursing burnout rate was higher and the restrictions increased the nursing burnout rates. At present, the global epidemic has come to an end. To prevent the negative impact of similar public health events on nursing burnout once again, relevant management departments should take corresponding measures to reduce nursing burnout and reduce nurse turnover rates and ensure the high quality of nursing work. Studies have shown that a variety of ways to support nurses and reduce burnout, such as mindfulness training (Luberto et al., 2020), access to psychological and psychosocial support (Kakemam et al., 2021), prioritizing rest and breaks (Sarboozi Hoseinabadi et al., 2020), meditation apps (Janeway, 2020) and self-care techniques (Kakemam et al., 2021). However, theses methods still need to be monitored for their effectives and more policies and measures to protect nurses' health need to be developed and implemented, such as considering fostering a culture of respect, appreciation, adequate allocation of resources and appropriate financial compensation for nurses during the restrictions. Adjusting nurses' working hours and providing better psychological support might also good ideas. At the same time, preventive strategies need to be developed to prevent the impact of similar public health events on nursing burnout in the future.

There were some limitations in our study. Firstly, because the data were obtained through the method of meta-analysis, it was inevitable that some data would be missing. According to the data management method in our paper, there were the same data for several months, which was an avoidable limitation. Secondly, due to the limited data, the trend change of nursing burnout rates in various countries or departments cannot be calculated. Thirdly, only papers published in English were included in the study. Therefore, more high-quality research on nursing burnout should be conducted.

In conclusion, the results indicated a slowly rising trend in the nursing burnout rates before the COVID-19 restrictions and the rising trend significantly increased after the restrictions. The COVID-19 restrictions influenced nursing burnout. The study may draw the nursing management departments more attention and provide some basis for changing the phenomenon of nursing burnout.

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CRediT authorship contribution statement

Meng-Wei Ge: Writing – original draft, Data curation, Formal analysis, Writing – review & editing. **Fei-Hong Hu:** Writing – original draft, Formal analysis. **Yi-Jie Jia:** Data curation, Software. **Wen Tang:** Data curation, Software. **Wan-Qing Zhang:** Investigation. **Dan-Yan Zhao:** Formal analysis. **Wang-Qin Shen:** Formal analysis. **Hong-Lin Chen:** Writing – review & editing, Supervision, Data curation.

Conflict of Interest

There was no conflict of interest in our paper.

Acknowledgments

None.

Supplementary material

Supplementary material associated with this article can be found, in the online version at doi:

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.nepr.2023.103643.

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