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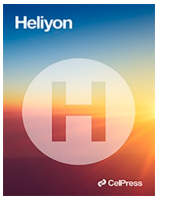

Research article

The recovery of endoscopic activity and cancer detection after the COVID-19 pandemic

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ABSTRACT

Background: The COVID-19 pandemic had a substantial impact on cancer services. The aim of our study was to evaluate the recovery of endoscopic activity and cancer detection after the COVID-19 pandemic.
Methods: Endoscopic data from January 2019 to December 2020 were retrospectively collected to assess the endoscopic activity and cancer detection during the COVID-19 peak period (February 2020) and the post-COVID-19 peak period (March to July 2020).
Results: The COVID-19 pandemic almost brought endoscopic activity and cancer detection to a standstill. Diagnostic procedure and endoscopic resection showed the greatest reduction. With the decline in COVID-19 infections, endoscopic activity gradually returned to previous level in July. However, the detection rate of gastric cancer resumed in September, whereas colorectal cancer resumed in August. The monthly detection rates of gastric and colorectal cancers decreased from their initial peaks of 2.98 % and 6.45 %, respectively, and finally were even lower than the average in 2019. Similarly, the mean age of patients who received endoscopy also declined as the detection rates resumed. The increasing colonoscopies allowed the missing colorectal cancer patients to be caught up. In contrast, it was expected that 6.69 % of gastric cancer patients were missed and did not receive needed endoscopy.
Conclusions: The recovery of cancer detection occurred later than that of endoscopic activity, especially for gastric cancer. Older people were vulnerable to the continuous impact of COVID-19 pandemic than young people for seeking medical services. Urgent efforts are required to recover and maintain cancer services before subsequent waves of the COVID-19 pandemic.

1. Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by SARS-CoV-2. Since the discovery of COVID-19 in Wuhan [1], the disease has become a global pandemic. The COVID-19 pandemic presents a remarkable threat to the health of the general public [2–4].

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Recently, digestive endoscopy has become an essential component of the diagnosis and treatment of gastrointestinal diseases. However, the dramatic increase in COVID-19 patients overwhelmed the ability of healthcare systems worldwide, resulting in a lack of medical supplies, infrastructure and healthcare workers. Severe long COVID further limited the number of patients available for the endoscopy. In addition, endoscopy is considered to be a high-risk procedure for exposure to COVID-19. The invasive nature of endoscopy significantly increases the chances of contact with respiratory droplets, oropharyngeal secretions and patient stool [5]. As a result, nonurgent endoscopic procedures were suspended or cancelled [6–9]. Several studies have shown that endoscopic activity fell by more than 80 % during the COVID-19 pandemic [10–12]. Meanwhile, the decline in endoscopic capacity also caused a loss of potential cases, especially for cancer. A national study in England revealed a 58 % drop in the weekly number of colorectal cancers detected [11]. Delayed recognition and treatment of cancer correlates strongly with poor prognosis.

With the decline in COVID-19 infections, endoscopic practice gradually returned to normal. Potential cancer patients may be more likely to receive previously delayed endoscopy at the earliest opportunity. Although a series of studies have focused on the impact of the COVID-19 peak [11–13], changes in the number of missing cancer cases following increasing endoscopies after the peak of COVID-19 remain unclear. Therefore, our study aimed to evaluate the recovery of endoscopic activity and cancer detection after the COVID-19 pandemic and further determine the number of potential missing cancer patients.

2. Methods

2.1. Study population

We retrospectively collected endoscopic data from January 2019 to December 2020 at the First Affiliated Hospital of Nanchang University, which is the largest endoscopy center in the region with an endoscopic volume of more than 100,000 procedures annually. All diagnostic and therapeutic procedures performed during this period were included in the computation of endoscopy activity. The data were extracted from the endoscopy database and medical records, including the demographics, procedure information, and histopathological results. This study was performed in accordance with the guidelines of the Declaration of Helsinki and was approved by the Medical Research Ethics Committee of the First Affiliated Hospital of Nanchang University ((2022)CDYFYYLK(09–030)). Patient informed consent was waived because of the retrospective and descriptive nature of the study.

2.2. Study period

A total of 129,218 diagnostic and 31,239 therapeutic procedures were included in our study. The outbreak of COVID-19 started in February 2020 in our area. Local and national reports showed that the area was also among the more severely affected regions in the country. The rapid spread of COVID-19 peaked and induced an evident decline in endoscopic practice. With the decline in COVID-19 infections and the increasing demand of patients, we gradually resumed gastrointestinal endoscopy in March and reached previous endoscopic capacity in July. For analytic purposes, the impact of COVID-19 was divided into two periods of COVID-19 peak (February 2020) and post-covid-19 peak (from March to July 2020). We compared these two periods with the corresponding periods of the previous year, calculating endoscopic activity and demographic and histopathological results.

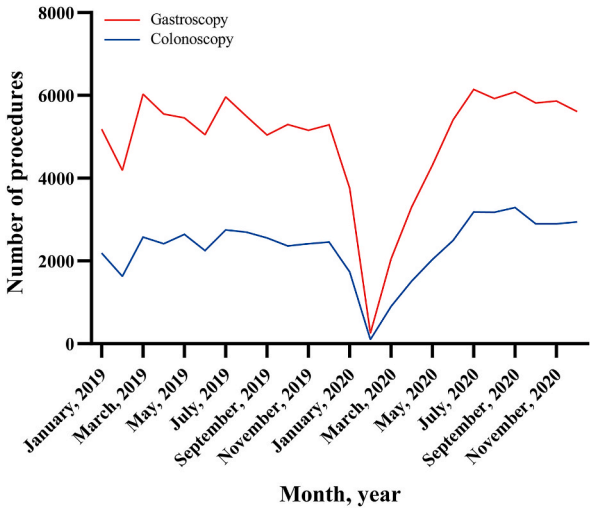

Fig. 1. Trends in the number of diagnostic procedures from January 2019 to December 2020.

2.3. Cancer detection

Both gastroscopy and colonoscopy were included in the analysis of cancer detection. Multiple procedures performed in the same patient for endoscopic review or selective treatment were counted only once based on endoscopic or histopathological results. To determine the changes in number of cancer patients detected, we extended the study period for an additional three months after the recovery of endoscopic activity. The trend in the number of gastrointestinal cancers detected among individual months after the peak of COVID-19 was also further analyzed.

2.4. Statistical analysis

Descriptive statistics were summarized for all clinical variables and are reported as the mean ± standard deviation (SD) or the proportion. Continuous variables were compared by using the *t*-test or Mann–Whitney *U* test. Categorical variables were compared by using the chi-square test or Fisher's exact test. All statistical analyses were performed using SPSS version 24.0 (IBM Corp, Armonk, New York, USA). A two-tailed P value < 0.05 was considered statistically significant.

3. Results

In 2019, an average of 9023 endoscopic procedures were performed in our institution per month. During the peak of COVID-19 in February 2020, diagnostic procedures stagnated (Fig. 1), and therapeutic procedures was significantly reduced (Fig. 2A–C). The study showed the largest decrease in endoscopic resection and diagnostic procedures, with the least decrease in endoscopic hemostasis for nonvariceal bleeding (Table 1).

Endoscopic activity gradually recovered beginning in March. Diagnostic and most therapeutic procedures returned to previous levels in July. With the decline in COVID-19 infections, endoscopic activity gradually recovered, while diagnostic procedures recovered the slowest. The number of gastroscopies and colonoscopies decreased from 28,053 to 12,629 during the pre-COVID-19 period to 21,234 and 10,142 during the post-COVID-19 peak period, with a decrease of 24.3 % and 19.7 %, respectively. For therapeutic procedures, the most significant decrease was observed for endoscopic polypectomy (18.1 %), followed by endoscopic placement of gastrointestinal stents (11.2 %). In contrast, there was a mild increase in the numbers of endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic extraction of foreign bodies after the recovery of diagnostic procedures. Compared with the pre-COVID-19 period, ERCP procedures increased by 14.3 %, and endoscopic extraction of foreign bodies increased by 2.2 %.

When calculating the detection rate of cancer, only the first endoscopy was included according to the purpose of inspection. The mean age of patients in both the COVID-19 peak and post-COVID-19 peak groups was significantly higher than that in the pre-COVID-19 group (Tables 2 and 3). Gastroscopy was more frequently performed in females, while colonoscopy was more common in males. Compared with the pre-COVID-19 period, cancer detection rates increased significantly. During the peak period, the detection rate of gastric cancer increased from 1.6 % to 2.6 %, and the detection rate of colorectal cancer increased from 2.8 % to 5.6 %. After the peak of COVID-19, the detection rate of colorectal cancer increased from 2.7 % to 3.3 %. Despite a slight increase in the detection rate of gastric cancer, the absolute number of cancer patients decreased without rebound.

Given the continuous impact of COVID-19, we investigated the trend in the number of cancers detected by month (Table 4). In fact, the recovery of cancer detection occurred later than that of endoscopic activity. The detection rate of gastric cancer returned to its previous level in September, whereas colorectal cancer returned in August.

During the actual recovery period, the detection rates of gastric and colorectal cancers gradually decreased from their peaks of 2.98 % and 6.45 %, respectively, and were even lower than their averages in 2019. Similarly, the mean age of patients who received endoscopy also declined as the detection rates resumed. When detection rates of cancer returned to their 2019 averages, the increasing capacity in colonoscopy allowed the missing colorectal cancer patients to be followed up. In contrast, approximately 43 gastric cancer patients with a rate of 6.69 % were expected to be missed and did not receive needed endoscopy in the recovery period.

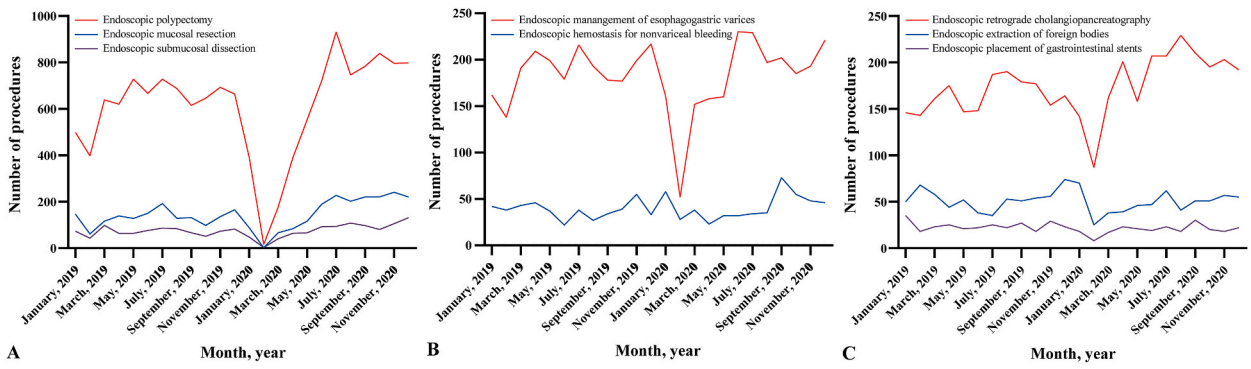

Fig. 2. Trends in the number of endoscopic resections (A), endoscopic hemostasis (B) and other therapeutic procedures (C) from January 2019 to December 2020.

Table 1
The impact of COVID-19 on endoscopic activity.

	Pre-COVID-19[a]	COVID-19 peak	Percent change	Pre-COVID-19[a]	Post-COVID-19 peak	Percent change
Gastroscopy	4188	257	−93.9 %	28053	21234	−24.3 %
Colonoscopy	1628	104	−93.6 %	12629	10142	−19.7 %
Endoscopic polypectomy	398	16	−96.0 %	3382	2770	−18.1 %
Endoscopic mucosal resection	61	2	−96.7 %	725	683	−5.8 %
Endoscopic submucosal dissection	43	3	−93.0 %	388	356	−8.2 %
Endoscopic management of esophagogastric varices	138	52	−62.3 %	994	929	−6.5 %
Endoscopic hemostasis for non-variceal bleeding	38	28	−26.3 %	186	169	−9.1 %
Endoscopic retrograde cholangiopancreatography	143	87	−39.2 %	818	935	14.3 %
Endoscopic extraction of foreign bodies	68	25	−63.2 %	227	232	2.2 %
Endoscopic placement of gastrointestinal stents	18	8	−55.6 %	116	103	−11.2 %

[a] Pre-COVID-19 periods refer to the same periods of February and March to July in 2019, respectively.

Table 2
Cancer detection during the COVID-19 peak period and pre-COVID-19 period.

	Gastroscopy			Colonoscopy		
	Pre-COVID-19 N = 3906	COVID-19 peak N = 308	P value	Pre-COVID-19 N = 1698	COVID-19 peak N = 124	P value
Age, mean (SD)	48.0 (13.9)	51.1 (14.8)	< 0.001	48.2 (13.3)	49.9 (13.3)	0.200
Sex, female	2079 (53.2 %)	156 (50.6 %)	0.383	744 (43.8 %)	60 (48.4 %)	0.322
Cancer detection						
Esophageal cancer	27 (0.7 %)	5 (1.6 %)	0.080	–	–	–
Gastric cancer	64 (1.6 %)	8 (2.6 %)	0.211	–	–	–
Duodenal cancer	4 (0.1 %)	2 (0.6 %)	0.014	–	–	–
Colorectal cancer	–	–	–	48 (2.8 %)	7 (5.6 %)	0.077

Table 3
Cancer detection during the post-COVID-19 period and pre-COVID-19 period.

	Gastroscopy			Colonoscopy		
	Pre-COVID-19 N = 25910	Post-COVID-19 peak N = 19539	P value	Pre-COVID-19 N = 12712	Post-COVID-19 peak N = 10522	P value
Age, mean (SD)	48.4 (14.1)	49.4 (14.2)	< 0.001	49.5 (13.4)	50.3 (13.4)	< 0.001
Sex, female	13510 (52.1 %)	9967(51.0 %)	0.017	6040 (47.5 %)	5191 (49.3 %)	0.006
Cancer detection						
Esophageal cancer	143 (0.6 %)	146 (0.7 %)	0.010	–	–	–
Gastric cancer	404 (1.6 %)	380 (1.9 %)	0.002	–	–	–
Duodenal cancer	21 (0.1 %)	23 (0.1 %)	0.213	–	–	–
Colorectal cancer	–	–	–	338 (2.7 %)	342 (3.3 %)	0.008

4. Discussion

The COVID-19 pandemic has had a substantial impact on healthcare systems. Most management approaches to disease have been severely disrupted during COVID-19 [14–16]. The burden of COVID-19 impaired the delivery of appropriate endoscopic services. In response to pandemic precautions, the priority of routine endoscopic activity was reduced, and protective measures limited the number of patients in the endoscopy clinic. The potential medical requirements of many patients have not been satisfied.

The longer the duration and wider the range of the COVID-19 pandemic became, the more severe the damage to medical services. We evaluated this impact of COVID-19 by separating the peak phase from the post-peak phase. Endoscopic practice almost completely ceased shortly during the COVID-19 pandemic. As COVID-19 infections decline, endoscopic capability will be gradually restored until plateauing at a fixed volume. Our study showed that essentially all endoscopic procedures returned to a stable level by July. Even during the recovery phase, patients were reluctant to travel to the hospital for nonurgent examinations, leading to a significant decline in diagnostic procedures. Therapeutic procedures were more readily accepted by patients after balancing concerns about COVID-19 infection with treatment benefits. Among them, when diagnostic endoscopy returned to normal, ERCP in therapeutic procedures not only reached the previous level but also eliminated some of the potential backlog.

The backlog of endoscopy adversely affected the timely diagnosis of cancer. Survival from cancer was closely correlated with the stage of the disease, with approximately 90 % of those diagnosed with gastric cancer at stage I surviving 5 years compared with 14 % at stage IV [17]. Delayed diagnosis prompted the continuous growth and development of tumors [18,19]. Only patients with severe

Table 4
Monthly number of endoscopic procedures and cancers detected after the COVID-19 outbreak.

	Gastroscopy			Gastric cancer		Colonoscopy			Colorectal cancer	
	Age, mean (SD)	N	Percent	N	Detection rate	Age, mean (SD)	N	Percent	N	Detection rate
2019 monthly mean	48.3 (14.0)	4984	100.0 %	79	1.59 %	49.4 (13.4)	2359	100.0 %	64	2.71 %
February 2020	51.1 (14.8)	308	6.2 %	8	2.60 %	49.9 (13.3)	124	5.3 %	7	5.65 %
March 2020	51.3 (13.6)	1977	38.2 %	59	2.98 %	51.4 (13.5)	977	38.4 %	63	6.45 %
April 2020	50.9 (13.9)	3048	58.8 %	88	2.89 %	51.1 (13.1)	1585	62.4 %	68	4.29 %
May 2020	50.2 (14.1)	3964	76.5 %	68	1.72 %	50.9 (13.4)	2087	82.1 %	72	3.45 %
June 2020	48.5 (14.2)	4956	95.6 %	91	1.84 %	49.8 (13.3)	2657	104.5 %	63	2.37 %
July 2020	48.1 (14.5)	5594	108.0 %	74	1.32 %	49.6 (13.5)	3216	126.5 %	76	2.36 %
August 2020	47.9 (14.0)	5215	100.6 %	77	1.48 %	48.7 (13.3)	3101	122.0 %	59	1.90 %
September 2020	48.7 (14.2)	5467	105.5 %	64	1.17 %	49.4 (13.5)	3288	129.3 %	90	2.74 %
October 2020	49.1 (14.4)	5233	101.0 %	83	1.59 %	50.4 (13.3)	2969	116.8 %	79	2.66 %
Total reduction during recovery period[a]	–	−5496	−13.4 %	−43	−6.69 %[b]	–	−1008	−5.6 %	12	2.39 %[b]

[a] The recovery periods for gastric cancer and colorectal cancer detection were from March to September and March to August, respectively.
[b] Expected percent reduction for cancers detected during recovery periods.

conditions, such as cancer, were willing to provide early visits to the hospital for gastrointestinal endoscopy. The increased number of cancers detected at this phase was also a compensation response for the loss during the peak of COVID-19 to some extent. As a result, the recovery period of endoscopic activity showed a relative increase in the detection rate of cancer. The smaller magnitude of increase in the detection rate of gastric cancer compared with colorectal cancer may be related to the lack of early specific symptoms and simple screening tests, such as fecal immunochemical examination.

Notably, the recovery of cancer detection occurred later than that of endoscopic activity. The reduction in cancer detection would be underestimated based on the recovery period of endoscopic activity alone [11,13,20]. In fact, the cancer detection rates gradually decreased from the initial highest value to even lower than the pre-COVID-19 level. A further decline in the number of gastric and colorectal cancers detected was observed after the recovery of endoscopic activity. This may be partly associated with the larger proportion of older cancer adults. They were expected to carry a higher infection risk of COVID-19 with poor outcomes [21–23]. The fear of COVID-19 prevented mild or asymptomatic older patients from seeking medical services. In addition, long COVID, COVID-19 testing requirements and a bound in patient visits increased the inconvenience for patients and decreased their compliance [24]. In contrast, young people were less vulnerable to the social impact of COVID-19 than older people, and the rising proportion of

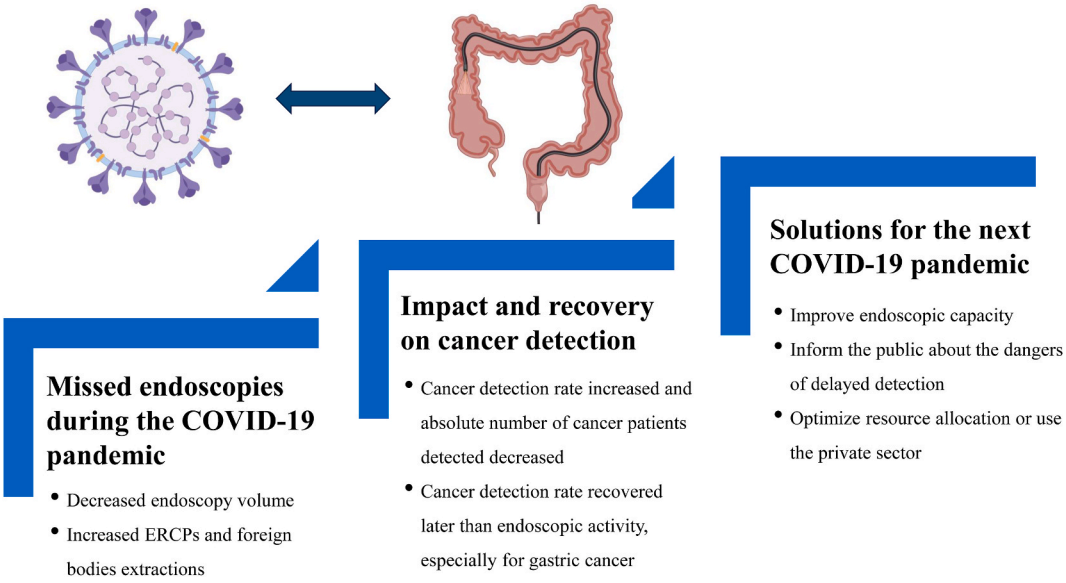

Fig. 3. Solutions for the next COVID-19 pandemic.

individuals undergoing endoscopy increased, resulting in a gradual reduction in the detection rates of cancer. A longer period of stabilization is required to intensify patients' willingness for endoscopy. Only when these potential cancer patients change their minds can endoscopic practice truly return to normal levels.

Due to the greater decline in gastroscopy, improvement of endoscopic capacity above the normal level made the resolution of backlog in colonoscopy significantly faster than in gastroscopy. When detection rates of cancer return to their 2019 averages, the increasing colonoscopies allows the missing colorectal cancer patients to be seen. The number of cancers detected recovered more slowly in gastric cancer until the previous backlog was resolved. The public should be informed about the importance of cancer screening and the dangers associated with delayed detection before subsequent waves of the COVID-19 pandemic (Fig. 3). Of course, this possibly imposes an excessive burden on the healthcare system again. Optimizing resource allocation or using the private sector can provide additional capacity to follow up with patients who delayed endoscopy [25–27]. Although adjusting the threshold for endoscopy and reassigning screening schedules can temporarily release some endoscopic capacity, the benefits of endoscopy need to be carefully weighed against the risks of patients waiting. Leveraging data analytics and predictive modeling techniques provides valuable insights into forecasting future demand for endoscopic services [28–30]. Moreover, implementing telemedicine and remote monitoring platforms to facilitate virtual consultations and triage serves as an alternative method for maintaining essential services during periods of disruption.

Our study offers valuable insights into the recovery of endoscopic activity and cancer detection following the peak of the COVID-19 pandemic. With a large and comprehensive dataset of endoscopic data, we provide a robust assessment of the impact of the pandemic on endoscopic practices and cancer screening. Specifically focusing on cancer detection, our analysis sheds light on the potential number of missing cancer cases, a critical aspect for healthcare planning and resource allocation in post-pandemic settings. By addressing both immediate challenges faced by healthcare systems during the pandemic and the long-term consequences, particularly in terms of cancer care and prognosis, our study contributes significantly to understanding the broader healthcare implications of the crisis.

The limitations of our study arise mainly from the retrospective observational design and shorter pandemic study period. Our results of tertiary referral centers with a high volume of endoscopy may not be extrapolated to other regions with more limited resources. Psychological distress caused by COVID-19 makes patients exaggerate their symptoms, leading to potential under ascertainment. Moreover, endoscopic biopsy alone was not sufficient to determine the stage of the tumor and prevented adequate assessment of trends in relation to cancer characteristics.

5. Conclusion

In conclusion, the COVID-19 pandemic induced a significant reduction in endoscopic activity and cancer detection. The recovery of cancer detection occurred later than that of endoscopic activity, especially for gastric cancer. Older people were vulnerable to the continuous impact of COVID-19 pandemic than young people for seeking medical services. Even if endoscopic activity returns to normal levels, the number of missing cancer patients would continue to increase unless the potential backlog is resolved. Urgent efforts are required to recover and maintain cancer services before subsequent waves of the COVID-19 pandemic.

Ethics statement

This study was performed in accordance with the guidelines of the Declaration of Helsinki and was approved by the Medical Research Ethics Committee of the First Affiliated Hospital of Nanchang University ((2022)CDYFYYLK(09–030)). Patient informed consent was waived because of the retrospective and descriptive nature of the study.

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Data availability statement

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

CRediT authorship contribution statement

Feng Zhou: Writing – original draft, Formal analysis, Data curation. **Jinhua Fu:** Data curation. **Nanzhen Wu:** Data curation. **Yang Liu:** Data curation. **Yong Xie:** Writing – review & editing, Project administration, Conceptualization. **Xiaojiang Zhou:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to

influence the work reported in this paper.

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