



Risk Factors of Peptic Ulcer in Military Personnel: A Systematic Review of the Literature

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Abstract

Background and objective: In recent years, there has been a significant increase in the incidence of peptic ulcer cases among military personnel. It is important for clinicians to identify the risk factors of peptic ulcer and then implement the appropriate prophylactic measures in a timely manner. This study aims to systematically review the risk factors of peptic ulcer in military personnel.

Methods: We searched literature from the PubMed, EMBASE, Wanfang, China National Knowledge Infrastructure, and VIP databases up to November 17, 2019. Eligible studies analyzed at least one risk factor of peptic ulcer in military personnel with descriptive or comparative data. The risk factors' data were then extracted and tabulated.

Results: Of the 1,008 studies initially identified, 11 were eligible for the present study. The total sample size was 29,925 (ranging from 203 to 10,046). The study population included military officers and soldiers, pilots, armed policemen, and firefighters. The most studied risk factor of peptic ulcer was history of smoking ($n = 8$), followed by high-intensity training ($n = 5$), mental stress ($n = 5$), family history of peptic ulcer ($n = 4$), history of alcohol drinking ($n = 4$), and use of non-steroidal anti-inflammatory drugs ($n = 4$).

Conclusions: Several major risk factors of peptic ulcer have been systematically identified, of which some are modifiable. In the future, proper intervention of these modifiable risk factors may be helpful in preventing military personnel from the development of peptic ulcer.

Introduction

Peptic ulcer develops mainly in the stomach or proximal duode-

num. Development of peptic ulcer is primarily due to destruction of the protective mechanisms of the gastrointestinal mucosa, such as the secretion of mucus and bicarbonate, by gastric acid and pepsin.¹ The prevalence of peptic ulcer in the general population is 5–10%,² being an important source of morbidity and mortality worldwide.³ Non-steroidal anti-inflammatory drugs (NSAIDs), *Helicobacter pylori* (HP) infection, and smoking have been identified as major risk factors of peptic ulcer in the general population.⁴

Soldiers and military officers are often under high pressure and in complex environments for a long time,⁵ and it seems that the incidence of peptic ulcer is higher in military personnel than in the general population.⁶ Knowledge regarding the risk factors of peptic ulcer in military personnel is of great significance to guide prevention and treatment of peptic ulcer and improvement in the combat effectiveness of the army. At present, there are only scattered studies on the management of peptic ulcer in military personnel. Herein, we describe our systematic review of the literature to explore the risk factors of peptic ulcer in military personnel.

Keywords: Army; Military; Gastric; Duodenal; Ulcer; Risk factors.

Abbreviations: HP, *Helicobacter pylori*; NOS, Newcastle-Ottawa scale; NSAIDs, non-steroidal anti-inflammatory drugs; OR, odds ratio.

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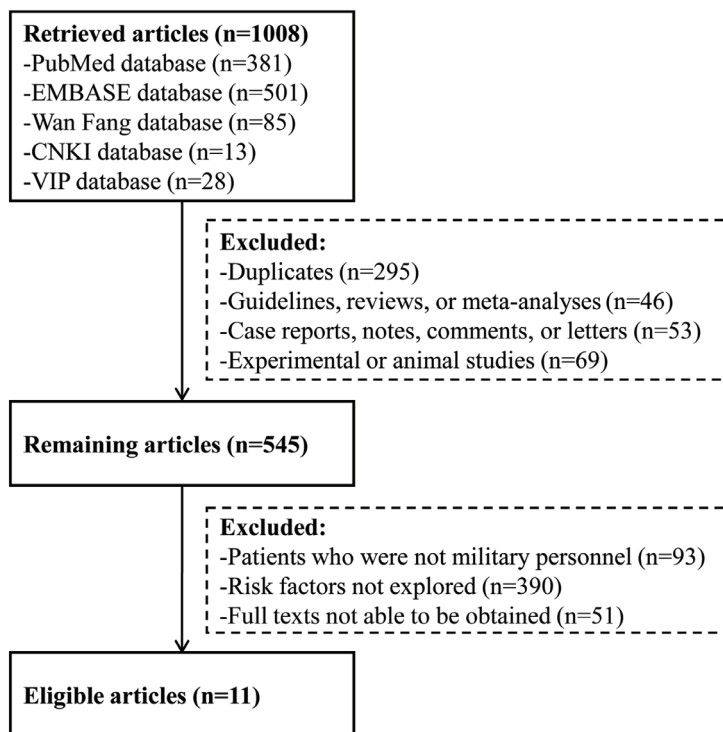


Fig. 1. A flowchart of study inclusion.

Methods

This systematic review was conducted according to the PRISMA Guidelines.⁷ The PRISMA checklist is shown in the [Supplementary Material Table 1](#).

Registration

This work was registered in the PROSPERO database.

Search strategy and study selection

We retrieved all papers via the PubMed, EMBASE, Wanfang, China National Knowledge Infrastructure, and VIP databases. Study publication date, status, and language were not limited, as mentioned by Zhang *et al*.⁸ The interval was from the earliest available publication until November 17, 2019. A combination of the following keywords was used: ((military) OR (soldier)) AND ((peptic ulcer) OR (gastric ulcer) OR (duodenal ulcer)). The inclusion criteria were as follows: 1) the study participants should be diagnosed with peptic ulcer, including gastric ulcer and/or duodenal ulcer; and 2) the eligible studies should analyze the risk factors of peptic ulcer. Exclusion criteria were as follows: 1) duplicates; 2) case reports, notes, comments, or letters; 3) guidelines, reviews or meta-analyses; 4) experimental or animal studies; 5) patients were not military personnel; 6) risk factors were not explored; and 7) full texts were not able to be obtained.

Data collection

The following information was extracted from each study: first

author; year of publication; study design; enrollment period; total number of military personnel evaluated; incidence of peptic ulcer in military personnel; and risk factors of peptic ulcer.

Study quality assessment

The quality of the included studies was evaluated using the Newcastle-Ottawa scale (NOS), a widely used tool for assessing the quality of observational/non-randomized studies.⁹ The NOS scale includes the selection of study population, comparability of study groups, and ascertainment of the exposure.

Results

Characteristics of studies

We identified 1,008 studies through the PubMed, EMBASE, Wanfang, China National Knowledge Infrastructure, and VIP databases. Finally, 11 studies, which employed endoscopy to diagnose peptic ulcer, were included (Fig. 1). The characteristics of these included studies are listed in Table 1.^{6,10-19} The included studies were published between 2000 and 2017. The study population mainly included military officers and soldiers, pilots, armed policemen, and firefighters. There were 10 Chinese-language articles and 1 English-language article. Seven studies used random sampling methods to select the study population. Six studies used logistic regression analyses to explore the risk factors of peptic ulcer. The most studied risk factor in all articles was history of smoking, followed by high-intensity training, mental stress, family history of peptic ulcer, history of alcohol drinking, and use of NSAIDs

Table 1. Characteristics of studies.

| First author (year) | Study design | Enrollment period | Characteristics of patients | Number of patients | Incidence of ulcers | Risk factors for ulcers |
|-----------------------------|-----------------------|-------------------|--|--------------------|---|---|
| Li (2000) ¹⁰ | Cross-sectional study | 1978–1997 | Soldiers who presented with abdominal pain and underwent endoscopic examination | 10,046 | Gastric ulcer 1.96%; Duodenal ulcer 22.9%; Compound ulcer 0.54% | Age; Arm of the services; Smoking and drinking; Diet and environmental changes; Military age |
| Havashi (2003) ⁶ | Cross-sectional study | 1996–1999 | Pilots who completed a questionnaire and underwent endoscopic examination | 955 | Gastric ulcer 2.3–3.1%; Duodenal ulcer 1.7–4.4% | Smoking (gastric ulcer) |
| Wang (2006) ¹⁵ | Cross-sectional study | NA | Soldiers who completed a questionnaire on peptic ulcer symptoms and risk factors and underwent endoscopic examination and HP examination | 6,160 | Peptic ulcer 12.78% | Drive a combat vehicle; HP infection; Smoking; High-intensity training; Mental stress; Irregular diet; Drinking; Family history of peptic ulcer; Interpersonal tension; Use of NSAIDs |
| Yang (2007) ¹⁴ | Cross-sectional study | 2006 | Armed police who completed a health-related behavior questionnaire for officers of the Chinese armed police and self-reported peptic ulcer | 2,205 | Peptic ulcer 7.6% | High psychological pressure; Highly frequent drinking; Highly frequent smoking; High-intensity training |
| Mou (2008) ¹¹ | Cross-sectional study | NA | Soldiers who completed a questionnaire on peptic ulcer risk factors and have a clear diagnosis of peptic ulcer by endoscopic examination | 346 | Gastric ulcer 43.9%; Duodenal ulcer 47.1%; Compound ulcer 9.0% | Eating unaccustomed; Weather unaccustomed; Use of NSAIDs; High work pressure; Mental stress; Tired military training; Irregular life and diet; Smoking |
| Jia (2011) ¹⁶ | Cross-sectional study | NA | Soldiers who completed a questionnaire on peptic ulcer symptoms and risk factors, underwent endoscopic examination and HP examination | 1,608 | Peptic ulcer 8.21% | HP infection; History of physical trauma; History of bacillary dysentery; Family history of peptic ulcer; High-intensity training |
| Li (2011) ¹² | Cross-sectional study | NA | Firefighters who completed a questionnaire on duodenal symptoms | 400 | Duodenal ulcer 23.25% | Mental stress; Irregular diet; Overwork |
| Xing (2012) ¹⁷ | Cross-sectional study | NA | Soldiers who completed a questionnaire on peptic ulcer symptoms and risk factors | 7,345 | Peptic ulcer 13.6% | Mental stress; Smoking; High-intensity training; Unclean diet; Drinking; Family history of gastropathy |
| Guo (2013) ¹⁸ | Cross-sectional study | 2010 | Soldiers who completed a questionnaire on digestive system health and related risk factors, and underwent endoscopic examination | 357 | Peptic ulcer 17.4% | Family history of peptic ulcer; Use of NSAIDs; Emotional irritability; Mental stress |
| Hou (2015) ¹³ | Cross-sectional study | 2012–2014 | Firefighters who completed a questionnaire on peptic ulcer incidence factors and psychological factors, and underwent endoscopic examination | 300 | Peptic ulcer 21% | Military age; Smoking; Psychological pressure |
| Bai (2017) ¹⁹ | Cross-sectional study | 2012–2015 | Armed police who completed a questionnaire on risk factors and underwent endoscopic examination | 203 | Peptic ulcer 38.4% | Military age; Nature of work; Family history of peptic ulcer; Smoking; Use of NSAIDs; Irregular life |

HP: *Helicobacter pylori*; NA: not available; NSAIDs: non-steroidal anti-inflammatory drugs.

Table 2. Risk factors of peptic ulcers in soldiers and military officers and their frequency.

| Risk factors | Number of papers which explore such risk factors | Percentage of papers which explore such risk factors |
|--------------------------------|--|--|
| History of smoking | 8 | 14.04% |
| High-intensity training | 5 | 8.77% |
| Mental stress | 5 | 8.77% |
| Family history of peptic ulcer | 4 | 7.02% |
| History of alcohol drinking | 4 | 7.02% |
| Use of NSAIDs | 4 | 7.02% |
| Irregular diet | 3 | 5.26% |
| Military age | 3 | 5.26% |
| HP infection | 2 | 3.51% |
| High psychological pressure | 2 | 3.51% |
| Irregular life | 2 | 3.51% |
| High work pressure | 1 | 1.75% |
| Age | 1 | 1.75% |
| Arm of the services | 1 | 1.75% |
| Diet and environmental changes | 1 | 1.75% |
| Drive a combat vehicle | 1 | 1.75% |
| Eating unaccustomed | 1 | 1.75% |
| Emotional irritability | 1 | 1.75% |
| Family history of gastropathy | 1 | 1.75% |
| History of bacillary dysentery | 1 | 1.75% |
| History of physical trauma | 1 | 1.75% |
| Interpersonal tension | 1 | 1.75% |
| Nature of work | 1 | 1.75% |
| Overwork | 1 | 1.75% |
| Unclean diet | 1 | 1.75% |
| Weather unaccustomed | 1 | 1.75% |

NSAIDs: non-steroidal anti-inflammatory drugs.

(Table 2). The quality of these included studies is summarized in Table 3.^{6,10–19} According to the NOS, 4 studies were of moderate to high quality, with a NOS score of ≥ 6 points, and 7 studies were of low quality.

Risk factors based on descriptive data

In 2000, Li *et al.*¹⁰ performed endoscopy on 10,046 soldiers and military officers who had a complaint of upper abdominal pain. The detection rate of peptic ulcer was 25.40%. They found that the most common locations of duodenal ulcers were the anterior wall and the greater curvature and those of gastric ulcers were the gastric antrum. Peptic ulcer might be related to age, arm of the services, smoking and alcohol drinking, dietary and environmental changes, and military age.

In 2008, Mou *et al.*¹¹ selected 346 soldiers and military officers with a clear endoscopic diagnosis of peptic ulcer as the study population. The patients were divided into recruit training group,

daily training group, and field training group. The top three causes of peptic ulcer in the recruit training group were: 1) patients who were tired of military training; 2) patients who were not accustomed to the diet; and 3) patients who did not adapt to the weather. The top three causes of peptic ulcer in the daily training group included: 1) a history of smoking; 2) a history of using NSAIDs; and 3) a high working pressure. The top three causes of peptic ulcer in the field training group included: 1) mental stress; 2) irregular life; and 3) irregular diet.

In 2011, Li *et al.*¹² used a cluster random sampling method to investigate 400 firefighters from 16 provinces. There were 92 patients with duodenal ulcers, which accounted for 23.25% of the total study population. The major cause of duodenal ulcers in professional firefighters was mental stress, followed by irregular diet and overwork.

In 2015, Hou *et al.*¹³ used a multi-stage stratified overall sampling method to select 300 armed police firefighters, and then asked them to fill out a questionnaire and perform endoscopy to diagnose peptic ulcer. The total detection rate of peptic ulcer was

Table 3. Results of quality assessment using the Newcastle–Ottawa scale for case-control studies.

| First author (year) | Selection | | | | Comparability | | Exposure | | Total |
|-----------------------------|-----------|----|----|----|---------------|----|----------|----|-------|
| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | |
| Li (2000) ¹⁰ | * | * | / | / | // | // | / | / | 2 |
| Hayashi (2003) ⁶ | * | / | / | / | // | */ | / | / | 2 |
| Wang (2006) ¹⁵ | * | * | / | / | // | ** | * | * | 6 |
| Yang (2007) ¹⁴ | / | * | / | / | // | */ | / | / | 2 |
| Mou (2008) ¹¹ | * | * | / | / | // | // | / | / | 2 |
| Jia (2011) ¹⁶ | * | * | / | / | // | */ | * | * | 5 |
| Li (2011) ¹² | * | * | / | / | // | */ | / | / | 3 |
| Xing (2012) ¹⁷ | * | * | / | / | // | ** | * | * | 6 |
| Guo (2013) ¹⁸ | * | * | / | * | ** | ** | * | * | 9 |
| Hou (2015) ¹³ | * | * | / | / | // | */ | / | / | 3 |
| Bai (2017) ¹⁹ | * | * | / | * | // | */ | * | * | 6 |

Notes: Q1: Is the case definition adequate? Q2: Representativeness of the cases; Q3: Selection of controls; Q4: Definition of controls; Q5: Comparability of cases and controls on the basis of the design or analysis; Q6: Ascertainment of exposure; Q7: Same method of ascertainment for cases and controls; Q8: Non-response rate.

21%. Among them, 15 patients had gastric ulcers, 45 had duodenal ulcers, and 3 had complex ulcers. They found that military age, smoking, and psychological pressure were closely related to the onset of peptic ulcer.

Risk factors based on comparative data

In 2003, Hayashi *et al.*⁶ obtained data from pilots who filled out a questionnaire to explore the relationship of peptic ulcer with smoking and NSAIDs use. Of the 224 smoking pilots, 27 had open gastric ulcer and 59 had any type of gastric ulcer. Of the 329 non-smoking pilots, 7 had open gastric ulcer and 44 had any type of gastric ulcer. They found a significant association of smoking with each type of gastric ulcer ($p < 0.0005$). However, there was no relationship between smoking and duodenal ulcer. More importantly, none of them took NSAIDs.

Risk factors based on univariate logistic regression analysis

In 2007, Yang *et al.*¹⁴ used a cluster random sampling method to select 2,253 in-service cadres of a certain armed police department as the study population, and then asked them to fill out a questionnaire. The prevalence of self-reported peptic ulcer among the surveyed cadres was 7.6%. Univariate logistic regression analysis revealed that high psychological pressure (odds ratio [OR]: 2.396), highly frequent drinking (OR: 1.226), highly frequent smoking (OR: 1.119), and high-intensity training (OR: 1.184) were significant risk factors of peptic ulcer.

Risk factors based on multivariate logistic regression analysis

In 2006, Wang *et al.*¹⁵ used a multi-stage stratified cluster random sampling method to select 6,160 soldiers and military officers in a Southern army. They were divided into three groups, according to their answers on a questionnaire about peptic ulcer symptoms and risk factors. Fifty people were taken from each group to undergo endoscopy. Based on the endoscopic findings, 68 of the 150 sol-

diers and military officers were diagnosed with peptic ulcer. The multivariate logistic regression analysis found that driving a combat vehicle (OR: 6.0), HP infection (OR: 4.6), history of smoking (OR: 3.8), high-intensity training (OR: 4.3), mental stress (OR: 3.7), irregular diet (OR: 3.2), alcohol drinking (OR: 2.8), family history of peptic ulcer (OR: 2.1), interpersonal tension (OR: 1.8), and use of NSAIDs (OR: 1.2) were risk factors of peptic ulcer among the 150 soldiers and military officers.

In 2011, Jia *et al.*¹⁶ also used a multi-stage stratified cluster random sampling method to select 1,608 soldiers and military officers in the Gobi desert. They were divided into three groups, according to their answers on a questionnaire about peptic ulcer symptoms and risk factors. Thirty people were taken from each group to undergo endoscopy. Based on the endoscopic findings, 33 of the 90 soldiers and military officers were diagnosed with peptic ulcer. The multivariate logistic regression analysis found that HP infection (OR: 3.2), history of physical trauma (OR: 1.9), history of bacillary dysentery (OR: 1.9), family history of peptic ulcer (OR: 2.5), and high-intensity training (OR: 2.3) had a close relationship with the occurrence of peptic ulcer symptoms among the 90 soldiers and military officers.

In 2012, Xing *et al.*¹⁷ used a multi-stage stratified cluster random sampling method to select 7,345 soldiers and military officers in five locations and four arms of services in cold regions. They were divided into three groups, according to their answers on a questionnaire about peptic ulcer symptoms and risk factors. Fifty people were taken from every group to undergo endoscopy. Based on the endoscopic findings, 69 of the 90 soldiers and military officers were diagnosed with peptic ulcer. The multivariate logistic regression analysis found that mental stress (OR: 3.1), history of smoking (OR: 2.8), high-intensity training (OR: 3.5), unclean diet (OR: 4.6), history of alcohol drinking (OR: 2.1), and family history of gastropathy (OR: 3.4) were closely related to peptic ulcer symptoms among the 90 soldiers and military officers.

In 2013, Guo *et al.*¹⁸ used a stratified cluster random sampling method to select 357 soldiers and military officers, and then asked them to fill out a questionnaire and undergo an endoscopic examination. According to the endoscopic findings, patients were divided into a peptic ulcer group and a control group. The mul-

tivariate logistic regression analysis found that family history of peptic ulcer (OR: 3.610), use of NSAIDs (OR: 4.831), emotional irritability (OR: 3.526), and mental stress (OR: 3.317) were risk factors of peptic ulcer.

In 2017, Bai *et al.*¹⁹ conducted a questionnaire survey of 78 patients with peptic ulcer and 125 patients with chronic gastritis diagnosed by endoscopy. The multivariate logistic regression analysis found that military age (OR: 3.591), type of work (OR: 2.432), family history of peptic ulcer (OR: 8.604), history of smoking (OR: 3.907), use of NSAIDs (OR: 4.772), and irregular life (OR: 7.581) were risk factors of peptic ulcer.

Discussion

We systematically reviewed the risk factors of peptic ulcer in military personnel. The major risk factors were history of smoking, followed by high-intensity training, mental stress, family history of peptic ulcer, history of alcohol drinking, and use of NSAIDs. Such a list of potential risk factors for peptic ulcer should be taken into account for clinical management of this disease in military personnel.

Smoking is an important health behavior problem that can harm almost all major organs.²⁰ The use of tobacco in military personnel adversely affects health, combat readiness and performance levels, and increases health care costs. It was reported that military personnel had a higher rate of smoking than the general population (24.0% vs. 21.2%).²¹ Therefore, it is necessary to raise the awareness of soldiers through education and counseling and to provide medical support for quitting smoking.

Military training is helpful for soldiers to develop the physical quality and endurance and to complete the combat, peace-keeping, and relief missions.²² However, sustained intensive training may cause peptic ulcer in soldiers. Therefore, in the future, total training load, nutrition, and recovery should be usually individualized to optimize training adaptation and reduce training-related illness and overtraining.²³

Family history has been identified as a major risk factor of peptic ulcer.²⁴ Due to the biological diversity of the general population, the susceptibility of different individuals to this disease may vary greatly. Additionally, peptic ulcer has obvious familial aggregation, which could be associated with common environmental and genetic factors.²⁵

Massive alcohol drinking can cause gastric mucosal inflammation, erosion, and even ulcer.²⁶ Alcohol could also delay gastric emptying, interfere with gastroesophageal sphincter activity, stimulate gastric secretion, and damage gastric mucosa, especially in combination with aspirin.²⁷ Avoiding alcohol abuse could reduce the incidence of peptic ulcer.

Both HP infection and NSAIDs independently increase the risk for development of peptic ulcer disease.²⁸ HP, a Gram-negative bacterium, is the main human pathogen causing chronic progressive gastric mucosal damage.²⁹ HP infection is caused by an imbalance between bacterial virulence factors, host factors, and environmental factors.³⁰ NSAIDs have analgesic, anti-inflammation, and antipyretic effects, facilitated by their inhibition of the cyclooxygenase enzyme that synthesizes prostaglandins and thromboxane, thereby leading to damage of gastric and duodenal mucosa.^{31,32} Soldiers are often trained with great intensity and more vulnerable to injury and physical pain, which greatly increases the chance of NSAIDs medication. Therefore, eradication of HP infection and exemption from NSAIDs use can potentially reduce the incidence and severity of peptic ulcer in military personnel.

Our study has some limitations. First, the majority of papers analyzed were from China. Second, some of these evaluated risk factors were analyzed in only one study. Third, the interactions between risk factors were not clearly analyzed. Fourth, the quality of these included studies was not satisfying. Fifth, only a small subset of standardized population was selected. Sixth, some of the study populations were highly selective and the processes of case confirmation were largely inconsistent among these included studies. Seventh, 51 articles, which were published from 1946 to 1990, had to be excluded, because their full texts could not be accessed.

Conclusion

History of smoking, high-intensity training, mental stress, family history of peptic ulcer, history of alcohol drinking, and use of NSAIDs were common risk factors of peptic ulcer in military personnel. Comprehensive identification and early intervention of these risk factors are needed to reduce the incidence of peptic ulcer in military personnel. However, considering that most of the included studies were of poor quality and conducted in very heterogeneous populations, more well-designed and large-scale studies are needed.

Future directions

In the future, large-scale population-based studies are needed to validate the effect of these risk factors on peptic ulcer in military personnel. An integration of these risk factors into a predictive model will be valuable to evaluate the risk of peptic ulcer. Close endoscopic screening on high-risk patients and proper interventions of these modifiable risk factors should be considered to improve these patients' outcomes.

Supporting information

Supplementary material for this article is available at <https://doi.org/10.14218/ERHM.2020.00026>.

Supplementary Table 1. PRISMA 2009 Checklist.

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Data sharing statement

No additional data are available.

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Conflict of interest

None.

Author contributions

Conceptualization (XQ), methodology (CW, XQ), validation (XQ, XG), formal analysis (CW, XG, YA, SX, DZ, YQ, XQ), investigation (CW, XG, YA, SX, DZ, XQ), data curation (CW, XQ), writing of the original draft (CW, XQ), writing, review and editing of the manuscript (CW, XG, YA, SX, DZ, YQ, XQ), supervision of the project (XG, XQ), administration of the project (XQ, XG). All authors have made an intellectual contribution to the manuscript and approved the submission.

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