



## Review article

# Bibliometric analysis of Mongolian medicine and medicinal materials in China since 2000

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## ABSTRACT

**Aim of the study:** To analyze the progress in Mongolian medicine and medicinal materials and to highlight its development process, emerging trends, and hotspots.

**Materials and methods:** Papers on Mongolian medicine and medicinal materials from January 2000 to May 2022 were retrieved from the China National Knowledge Infrastructure (CNKI) database. Using the collaboration network analysis of CiteSpace V and VOSviewer software, the cooperation among individuals and institutions in the field of scientific research was analyzed. The functions of frequency analysis, cluster analysis, and burst analysis were employed to conduct bibliometric analysis on research hotspots and trends in the field of Mongolian medicine research. Furthermore, the data visualization function was utilized to clearly display data trends and changes.

**Results:** A total of 8362 papers on Mongolian medicine medicinal materials from CNKI were identified and analyzed. The research on Mongolian medicine has gone through three stages: the initial stage, the exploratory stage, and the developmental stage. The top two institutions in the number of papers are Inner Mongolia Medical University and Inner Mongolia University for Nationalities. Bagenna from Inner Mongolia Medical University is the author with the most papers. “clinical efficacy”, “clinical research”, and “quality standards” were the most frequently used keywords. Research in the field of Mongolian medicine has focused on several diseases, including skeletal system disorders, cardiovascular diseases, and digestive system disorders.

**Conclusion:** Since 2000, there have been growing attention and efforts made in the field of Mongolian medicine and medicinal materials. The research in the field of Mongolian medicine had undergone three stages, namely the initial stage, the exploratory stage, and the developmental stage. The focus shifted from basic research such as the analysis of medicinal ingredients in Mongolian herbs to the application-oriented directions of traditional treatment techniques and

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advantageous diseases in Mongolian medicine. To make breakthroughs in this field, further research is needed to improve the persuasiveness and authority of Mongolian medicine and medicinal materials in terms of mechanism, standardization, and safety, to promote the development of Mongolian medicine and medicinal materials.

## 1. Introduction

As the accumulation and summary of the Mongolian people's experience in fighting against diseases in the long history, combined with their unique cultural beliefs, Mongolian medicine was established [1]. Mongolian medicine is an important part of Asian traditional medicine with distinctive national and regional characteristics [2]. The development of Mongolian medicine and medicinal materials has ushered in a new phase, with a wealth of relevant research articles emerging. However, in the face of a vast number of articles, there is little systematic summary of the overall research in the field of Mongolian medicine and medicinal materials, which makes researchers often lack an overall understanding and are unable to distinguish the research hotspots and frontier in this field, resulting in backward research and the waste of human and material resources, therefore it is essential to analyze the progress of development and cutting-edge trends in the field of Mongolian medicine and medicinal materials.

Bibliometrics is a statistical analysis of papers, that is used to analyze the results of research in specific fields [3]. CiteSpace was developed by Chaomei Chen from the School of Computing and Information at Drexel University [4], and VOSviewer was developed by Van et al. from the Centre for Scientific and Technological Research at Leiden University [5], both of which focus on analyzing and visualizing trends in scientific literature and are widely applied to conduct bibliometric analysis.

Recently, Kim and Kang(2021) [6] performed a global bibliometric analysis based on WoSCC from 1991 to 2021 and found that China contributed the most publications (153 from 234) in the field of Mongolian medicine and medicinal materials, but there was no publication on the development process of Mongolian medicine and medicinal materials in China. Therefore, this study analyzes publications in the field of Mongolian medicine and medicinal materials published in China from January 2000 to May 2022 to obtain the progress of development, research focuses and cutting-edge trends in this field.

## 2. Methods

### 2.1. Search strategy

China National Knowledge Infrastructure(CNKI) is one of the largest databases of Chinese papers and contains all published papers and the vast majority of articles in China, so we chose CNKI as the only database for searching literature. The search strategy for the CNKI is as follows with the academic journals published from January 1, 2000 to May 06, 2022. Export the searched data in Refworks format.

SU% = '蒙医' OR SU % = '蒙药' OR SU % = '蒙医药'

(SU% = 'Mongolian medicine' OR SU % = 'Mongolian medicinal materials' OR SU % = 'Mongolian medicine and medicinal materials')

### 2.2. Data processing

The papers retrieved from CNKI were imported into Microsoft Excel 2019 for classification and statistical analysis. The titles and abstracts were read and the articles were processed according to the inclusion and exclusion criteria. All the progress was performed by one of the authors.

Inclusion criteria: (1) Literature type: The papers were limited to academic journals; (2) language: Chinese.

Exclusion criteria: (1) papers (articles) published in abstract form only; (2) conference papers; (3) introduction of individuals, hospitals, and research institutes; (4) papers with no individual author; and (5) papers (articles) related to Mongolian medicine hospital management and Mongolian medicine education.

Due to the low standardization of nouns in Mongolian medicine and medicinal materials in Chinese, there exists a phenomenon of multiple words with one meaning, so synonyms were merged. For example, “希拉(Xila)” and “协日(Xieri)” were unified and merged into “希拉(Xila)”; “齐素” and “琪素” were both pronounced “Qisu” in Chinese, and they were unified into “齐素”; “扎冲十三味丸(Zhachong shisanweiwan)”, “扎冲-13(Zhachong-13)”, “嘎日迪-13(Garidi-13)” and “蒙药扎冲十三味丸(Mongolian medicine Zhachong shisanweiwan)” were unified into “扎冲十三味丸(Zhachong shisanweiwan)”. The same institution with different names and all the secondary institutions of one university were also merged.

### 2.3. Data analysis

Basic information such as years of papers, journals, participating authors, and institutions were recorded and characterized using Excel. The extracted data were analyzed by descriptive statistics, and the frequencies and composition ratios were described according to their type and characteristics. Key institutions and authors were identified according to  $W\Delta Z (N=0.749Mmax^{1/2})$  [7] ( $Mmax$  is the author/institution with the largest number of publications and  $N$  is the minimum number of papers of key authors/institutions). The

filtered articles were imported into CiteSpaceV(6.1.R2) and VOSviewer(1.6.16) for analysis and visualization. The parameters of CiteSpaceV were as follows: time slicing (2000–2022), years per slice (1), node type (author, institution, keywords), and pruning (Pathfinder and Pruning the Merged Network). The threshold was set to g index,  $k = 10$ , centrality was calculated and cluster analysis was performed.

Due to the particularity of Mongolian names, the repetition rate is very high. Therefore, it is necessary to verify the organization to which the author belongs. For example, if an author's name A belongs to more than one institution at the same time, the name is considered a duplicate name and should be separated as A1, A2, and so on.

### 3. Results

A total of 9698 papers were retrieved, of which 8362 were finally selected for analysis in this study after screening the data. The procedure of data collection and analysis is shown in Fig. 1.

#### 3.1. Publication analysis

The total number of annual papers including both Chinese core journals(CCJ) and non-core journal papers from 2000 to 2022 is shown in Fig. 2. From 2000 to 2006, the number of papers in both CCJ and noncore journals in Mongolian medicine and medicinal materials was very small; and from 2007 to 2016, the total number of papers increased significantly; from 2017 to 2022, the number of annual publications showed a downward trend.

The publications from 2000 to 2022 were distributed in 384 journals, among which the top 20 journals with the largest number of publications are shown in Table 1, with 6816 publications and accounting for 81.51 % of the total number of publications. The Journal of Medicine & Pharmacy of Chinese Minorities published the most papers, with 3856 articles and accounting for taking 46.11 % of the total publications.

The number of papers published in CCJ was 895, accounting for 10.70 % of the total number of publications. Fig. 3 shows that there were 14 CCJ with more than 20 publications, containing a total of 601 publications. There were 19 papers on clinical medicine, 146 papers on animal experiments and 30 papers on *in vitro* experiments. A total of 467 publications mainly focused on the composition, pharmacology, and quality standards of Mongolian medicinal materials and related preparations, 57 publications introduced the traditional therapeutic techniques of Mongolian medicine, classical literature, and theory, and 72 reviews were also included. Naturally, research on some effective components of medicinal materials also includes animal experiments and *in vitro* experiments, while many pharmacological studies can include studies on both animals and *in vitro* experiments. There were few high-level publications in the field of Mongolian medicine and medicinal materials, and the research was mainly focused on Mongolian medicinal materials.

Fig. 2 shows that the number of publications on Mongolian medicine and medicinal materials has slightly increased since 2005 and increased significantly since 2007 in China. This may be closely related to the policy of supporting Chinese ethnomedicine and ethnic

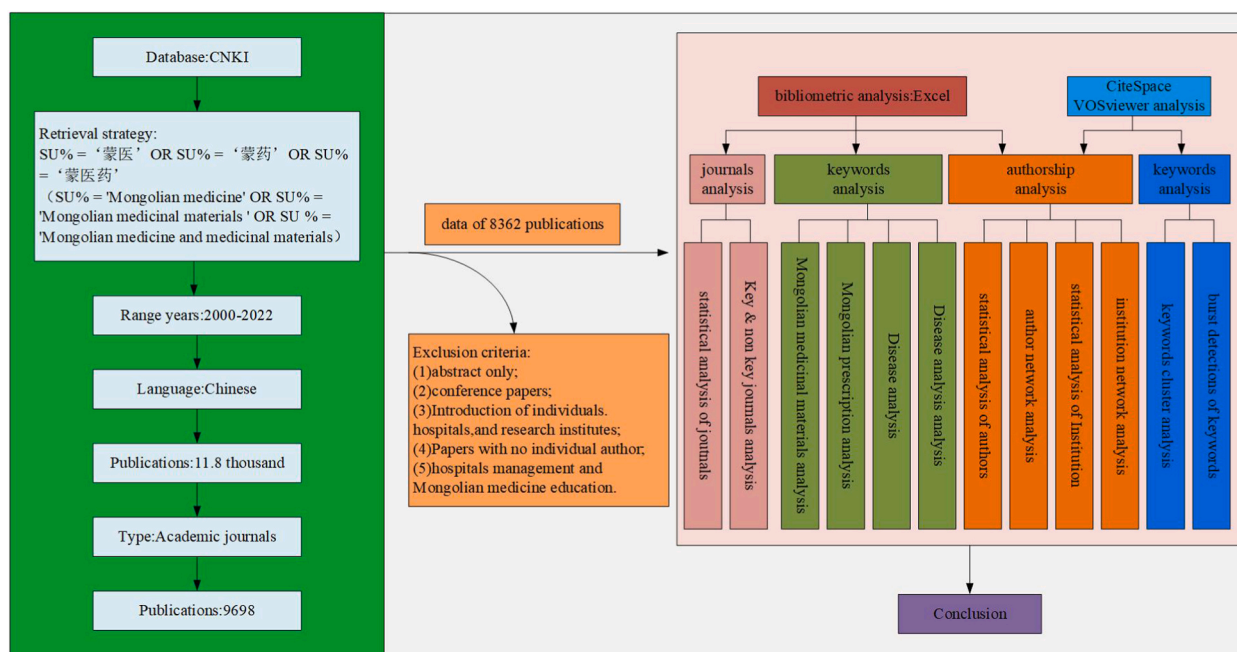


Fig. 1. Flow chart of the procedure of data collection and analysis.

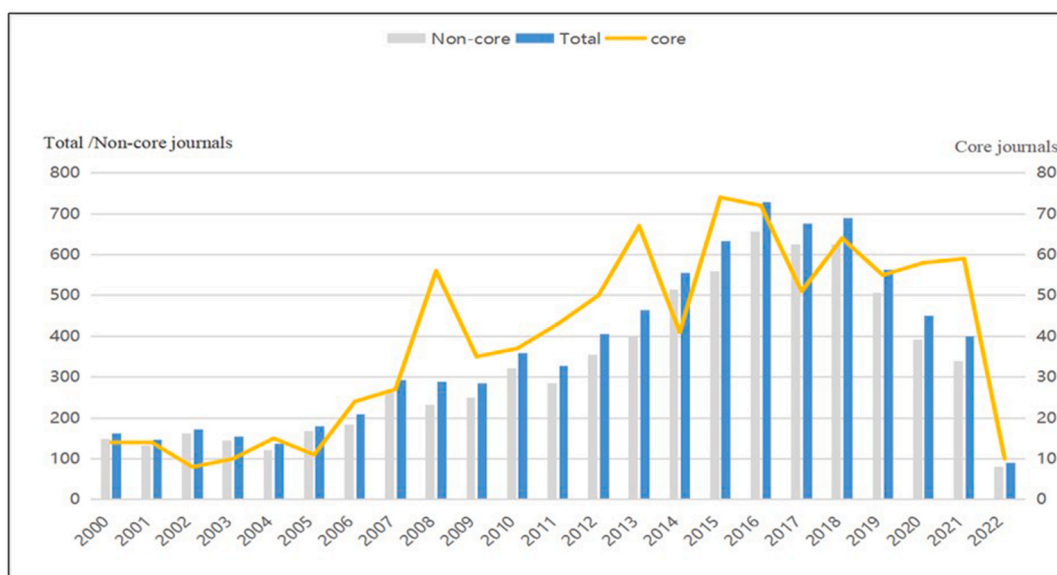


Fig. 2. Annual trend of core/non-core journals of Mongolian Medicine and medicinal materials from 2000 to 2022.

Table 1

Ranking of the top 20 journals with the most publications on Mongolian medicine and medicinal materials.

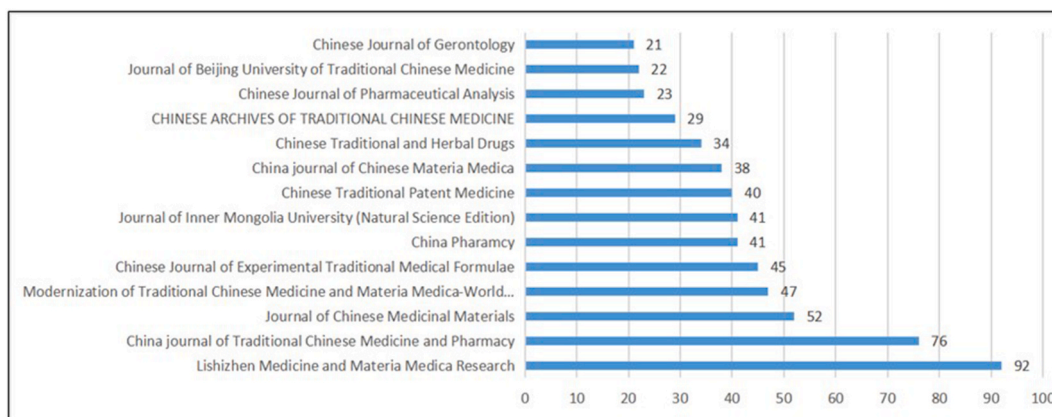
Rating	Journal	Number
1	<i>Journal of Medicine &amp; Pharmacy of Chinese Minorities</i>	3856
2	<i>World Latest Medicine Information</i>	694
3	<i>Chinese Journal of Ethnomedicine and Ethnopharmacy</i>	597
4	<i>Journal of Inner Mongolia University for Nationalities</i>	266
5	<i>Journal of Inner Mongolia Medical University</i>	202
6	<i>Journal of North Pharmacy</i>	211
7	<i>Electronic Journal of Clinical Medical Literature</i>	159
8	<i>Asia-Pacific Traditional Medicine</i>	126
9	<i>China's Naturopathy</i>	105
10	<i>Lishizhen Medicine and Materia Medica Research</i>	92
11	<i>Cardiovascular Disease Journal of Integrated Traditional Chinese and Western Medicine(Electronic)</i>	76
12	<i>China Journal of Traditional Chinese Medicine and Pharmacy</i>	76
13	<i>Journal of Chinese Medicinal Materials</i>	52
14	<i>Liaoning Journal of Traditional Chinese Medicine</i>	47
15	<i>Modernization of Traditional Chinese Medicine and Materia Medica-World Science and Technology</i>	47
16	<i>Chinese Journal of Experimental Traditional Medical Formulae</i>	45
17	<i>Journal of Baotou Medical College</i>	43
18	<i>Journal of Inner Mongolia University(Natural Science Edition)</i>	41
19	<i>China Pharmacy</i>	41
20	<i>Chinese Traditional Patent Medicine</i>	40

medicinal materials released by the Chinese government in 2007 [8] (eleven departments issued guidance to effectively strengthen the development of ethnic medicine, 2007).

With the strong support of the government and the efforts of researchers, the development of Mongolian medicine and medicinal materials in China entered a rapid development stage from 2007 to 2016. From 2017, the annual number of publications began to decline; however, interestingly, the number of publications of CCJ increased significantly after a decline, which indicated that the researchers no longer merely focused on the number of publications but started to pay more attention to the quality of publications, and their pursuit has evolved from quantity to quality. Of course, both the quantity and quality of publications need to be further improved, and more in-depth studies should be performed.

### 3.2. Institutional analysis

Institutions with high quantities of publications on Mongolian medicine and medicinal materials are identified as influential institutions. Among all 1847 institutions, there were 52 institutions with more than 28.40 publications, which were identified as key institutions in the field of Mongolian medicine and medicinal materials according to  $W\Delta Z$ . The top 10 institutions with the most publications in the field of Mongolian medicine and medicinal materials between 2000 and 2022 are listed in Table 2. These 10



**Fig. 3.** Ranking of Chinese core journals with more than 20 articles on Mongolian medicine and medicinal materials.

institutions had 5797 publications, accounting for 69.33 % of the total in this field, so they were identified as the most influential institutions, and their research could represent the research directions in this field in China. It is worth noting that Inner Mongolia Medical University and Inner Mongolia University For Nationalities, the top two most influential institutions, with their affiliated hospitals, occupied 4 of the top 10. In addition, Beijing University of Chinese Medicine was the only institution located outside the Inner Mongolia Autonomous Region.

To identify the distribution and cooperation of institutions, CiteSpaceV was used to analyze the institutions and obtain a bibliometric map, as shown in Fig. 4, which contained 458 nodes and 305 connections, where the nodes represented the institutions, and the lines between the nodes represented the collaboration relationships. The size of the nodes was proportional to the number of publications. Therefore, larger nodes were generally identified as significant nodes that might have greater influence in this field, and the thicker line between two nodes illustrated a closer relationship between two institutions.

The density of the network was 0.0029, which indicated that only 0.29 % of the potential relationships in the network in this field had been realized, and it also indicated the institutions involved were scattered and lacked intensive and stable cooperation relationships. Nevertheless, the characteristics of institutional cooperative relationships can be identified as in Fig. 4. Most of the institutions that engaged in the field of Mongolian medicine and medicinal materials research, such as Inner Mongolia Medical University, Inner Mongolia University For Nationalities, and Mongolian Medical Hospital of Bortala Mongolian Autonomous Prefecture, were located in the Inner Mongolia Autonomous Region and the Mongolian Autonomous Prefecture, where the Mongolian people are concentrated, while the Fuxin Mongolian Medical Research Institute, which is located in Fuxin City, was geographically close to the Inner Mongolia Autonomous Region. As the most influential institutions, Inner Mongolia Medical University and Inner Mongolia University for Nationalities had the closest cooperative relationships with their affiliated hospitals. In addition, the collaboration among institutions usually occurs between different hospitals.

As shown in Fig. 4, most of the institutions are mainly located in the Inner Mongolia Autonomous Region of China, which is due to the fact that Mongolian medicine mainly originated and was further developed in Inner Mongolia. At the same time, the current concentration of Mongolians is also in Inner Mongolia, so the main body of medical treatment and the main applications of Mongolian medicine are in Inner Mongolia.

According to Table 2 and Fig. 4, Inner Mongolia Medical University, Inner Mongolia University for Nationalities, and their affiliated hospitals were the leaders in this field. Alternatively, apart from Beijing University of Chinese Medicine, Minzu University of China, China Academy of Chinese Medical Sciences, and Tianjin University of Traditional Chinese Medicine, other institutions were located in Inner Mongolia Autonomous Region or other areas where Mongolian settlements occur, with scattered distribution. Moreover, they did not form a network, indicating a lack of academic exchange between institutions. Hence, all institutions should strengthen

**Table 2**

Ranking of the top 10 key institutions based on the number of publications on Mongolian medicine and medicinal materials.

Rank	Institutions	Publications	Proportion
1	Inner Mongolia Medical University	1438	17.20 %
2	Inner Mongolia University For Nationalities	1106	13.23 %
3	Affiliated Hospital of Inner Mongolia University For Nationalities	927	11.09 %
4	International Mongolia Hospital of Inner Mongolia	835	9.99 %
5	Inner Mongolia Hospital of Traditional Chinese Medicine	486	5.81 %
6	The Affiliated Hospital of Inner Mongolia Medical University	234	2.80 %
7	Xilin Gol League Mongolian Medical Hospital	207	2.48 %
8	Hohhot Mongolian Chinese Medicine Hospital	191	2.28 %
9	Inner Mongolia People's Hospital	187	2.24 %
10	Beijing University of Chinese Medicine	186	2.22 %



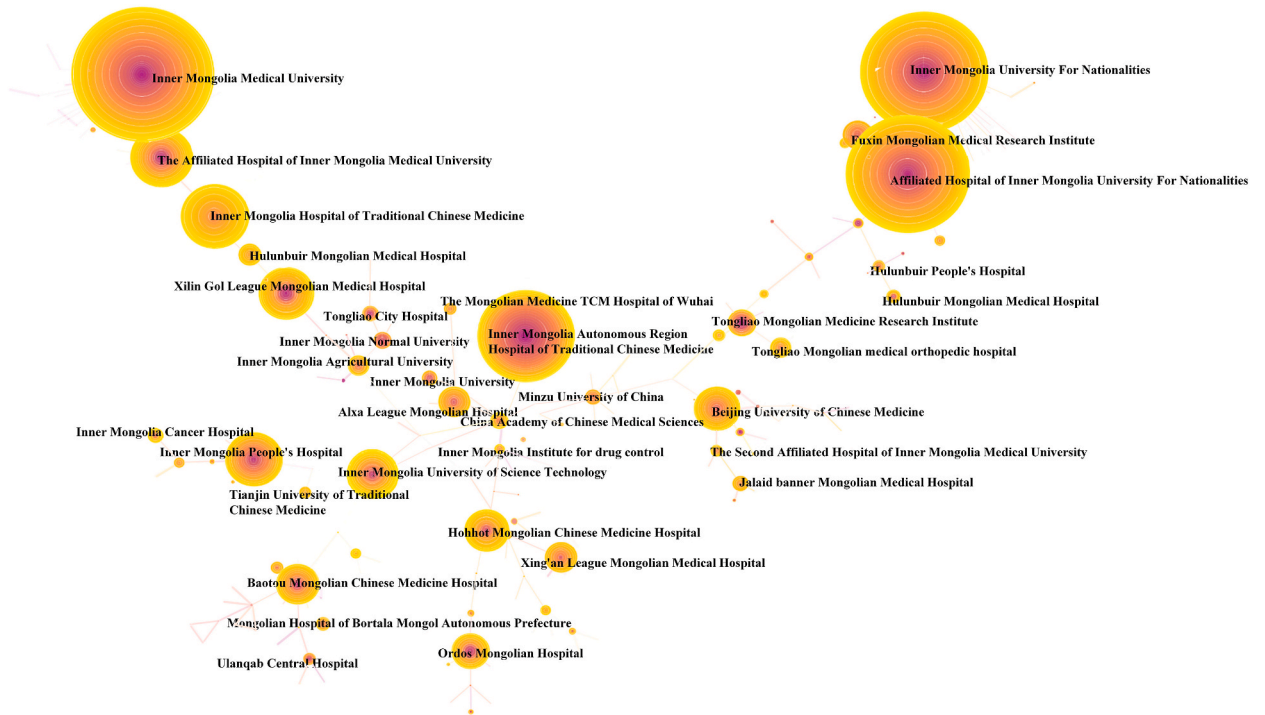


Fig. 4. Institution collaboration network based on publications related to Mongolian medicine and medicinal materials.

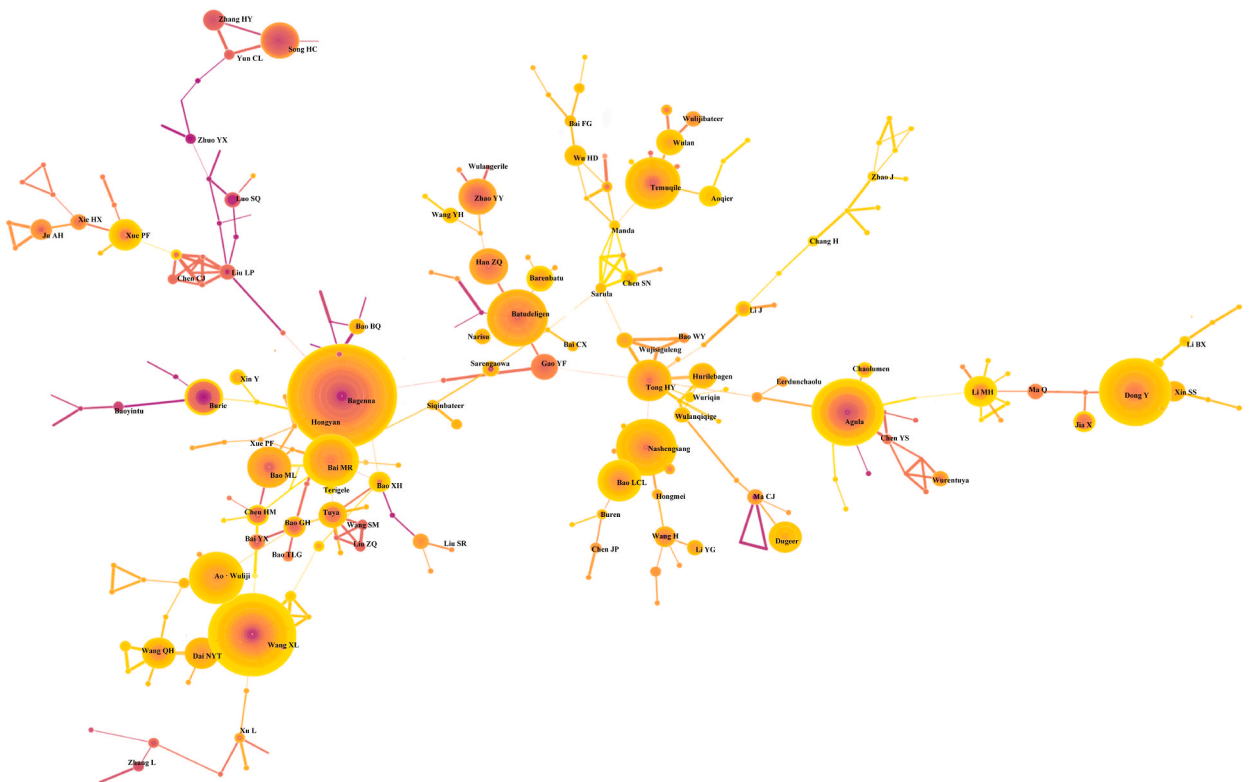


Fig. 5. Author collaboration network based on publications related to Mongolian medicine and medicinal materials.

communication and cooperation with each other and with institutions outside the Inner Mongolia Autonomous Region to promote research and development in this field.

### 3.3. Author analysis

After duplicate names were separated, we found that there were more than 7 thousand authors involved in the publication of literature in the field of Mongolian medicine and medicinal materials. CiteSpaceV was used to analyze the relationships between authors and draw the bibliometric map. The analysis of the co-occurrence of authors is shown in Fig. 5, in which the size of the node represented the number of publications, the link between two nodes indicates the cooperation between authors and the thickness of the link represents the degree of cooperation.

As shown in Fig. 5, there were 439 nodes and 406 lines, and the density of the network was 0.0042, which indicated that firm partnerships among authors have not been formed in this field. Nevertheless, the collaborations between authors could be broadly identified. There were 7 main collaborative groups in total, of which the first group mainly consisted of Bagenna, Bai MR, Bao ML, and Tuya, all from Inner Mongolia University For Nationalities, with the composition and mechanism of Mongolian medicinal materials and prescriptions as the main research content [9,10]. The second group mainly consisted of Agula, Cholmon, Chen YS, and Wurentuya, all from Inner Mongolia University of Science & Technology and Inner Mongolia Medical University, with warm needle acupuncture of Mongolian medicine as the main research content [11]. The third group was composed of Wang XL, Ao-Wuliji, Wang QH, and Dai NYT, all from Inner Mongolia University For Nationalities, and their research focused on the chemical constituents and the processing method of Mongolian medicinal materials [12]. The fourth group was mainly composed of Nashengsang, Baolechaolu, Tong HY, Hurilebagen, and Wujisiguleng, who were from different institutions. Among them, Nashengsang, Baolechaolu, and Hurilebagen were from Inner Mongolia Medical University, Tong HY was from Beijing University of Chinese Medicine, and Wujisiguleng was from International Mongolia Hospital of Inner Mongolia. The research interests of these fourth groups were the pharmacological and toxicological effects of traditional Mongolian medicine prescriptions and component identification of Mongolian medicinal materials [13–15]. The authors from the Affiliated Hospital of Inner Mongolia University For Nationalities named Batudeligen, Gao YF, Han ZQ, and Burenbatu constituted the fifth group, and their major research interest was the pharmacological effects of traditional Mongolian medicine prescriptions [16]. Wulan, Temuqile, Aoqier and Manda, from the International Mongolia Hospital of Inner Mongolia, with Wulijibateer, from Inner Mongolia University For Nationalities, constituted the sixth group, with the clinical research of Mongolian medicine as the main interest [17]. The seventh group was mainly made up of Dong Y, Xin SS, and Jia X. These leading authors were from Inner Mongolia Medical University, with the chemical constituents of Mongolian medicinal materials as the main research content [18]. This indicates that, compared to clinical research in Mongolian medicine, the research areas concerning the components of Mongolian herbal medicines and the pharmacological effects of traditional prescriptions are more inclined towards collaborative efforts among coresearchers. It also indirectly suggests that clinical research in Mongolian medicine may lack multicenter studies and potentially have a risk of research bias.

Similar to the influential research institutions, the number of publications of authors was considered positively correlated with their importance in related fields. Table 3 shows the top 20 key authors with the most publications in the field of Mongolian medicine and medicinal materials, of which the author with the highest number of published papers was Bagenna (110, 1.32 %). Among the top 20 key authors, 11 authors were from Inner Mongolia University For Nationalities. In addition, the centrality of the top 20 key authors was also calculated by CitespaceV and is listed in Table 3. An author with a higher centrality is more significant and more influential in a certain research field [19]. According to the number of publications, Tong HY ranked 16th but had the highest centrality, while Bagenna ranked first but had the second highest centrality. This suggests that Tong HY has a stronger connection with other research entities and is better able to play a role in facilitating information transmission within the field of Mongolian medicine research.

From the perspective of authors, Bagenna (110 articles, 1.32 %) was the one with the most publications. While Tong, HY was the author with the highest centrality, indicating that she played a key role in the network of cooperation, followed by Bagenna. Regarding age structure, in the field of Mongolian medicine and medicinal materials, among the core authors, the inheritance and distribution of the old, the middle-aged, and the young are reasonable and stable, cooperation teams have been formed, and cooperation between different teams is close.

**Table 3**

Top 20 key authors on Mongolian medicine and medicinal ranked by the number of publications and centrality.

Rank	Authors	Publications	centrality	Rank	Authors	Publications	centrality
1	Bagenna	110	0.37	11	WangQH	55	0.02
2	Agula	102	0.18	12	BaoML	43	0.01
3	Dong Y	92	0.05	13	XuePF	42	0.08
4	Wang XL	85	0.11	14	GaoYF	41	0.33
5	Batudeligen	75	0.03	15	Burie	40	0.04
6	Nashengsang	72	0.09	16	Tong HY	39	0.40
7	Temuqile	63	0.04	17	Wang CJ	39	0.00
8	Bai MR	60	0.19	18	Burenbatu	39	0.02
9	Han ZQ	59	0.09	19	Zhao YY	39	0.01
10	Ao· Wuliji	55	0.05	20	Li MH	38	0.10

### 3.4. Keyword analysis

Keywords condense the author's academic viewpoints of publication, and the analysis of keywords can reveal the research hotspots and frontiers of a field. The keywords with high frequency were significant in the research field. The co-occurrence of keywords was also used to analyze the research content in this field.

#### 3.4.1. Keyword frequency analysis

Table 4 and Fig. 6 show the top 20 keywords ranked according to the research frequency. In addition, the top 10 diseases, prescriptions, Mongolian medicinal materials, and traditional therapeutic techniques of Mongolian medicine were also listed according to the frequency in Figs. 7–9. As shown in Table 4, although ranked first, third, and fifth places, Mongolian medicinal materials, Mongolian medicine, and medicinal materials were not taken into consideration because they were retrieval terms. In addition, clinically related research, with clinical efficacy, clinical research, treatment, and clinical experience as the keywords, was a momentous hotspot in the field of Mongolian medicine and medicinal materials. The results demonstrate that current research in Mongolian medicine is gradually shifting toward clinical studies with a focus on application, which better highlights its practical significance.

As shown in Fig. 7, diseases of the skeletal system, including fracture, lumbar disc herniation, and rheumatoid arthritis, were the most studied diseases in Mongolian medicine and medicinal materials. Sa disease is a Mongolian medical name for a disease that is equivalent to cerebrovascular disease in Western medicine, and it is also a widely studied disease. While Eridun-Urile was the most studied prescription (Fig. 8), Kusnezoff Monkshood Root was the most studied Mongolian medicinal material (Fig. 9), and acupuncture therapy of Mongolian medicine was the most studied traditional therapeutic technique of Mongolian medicine (Fig. 10).

In terms of cardiovascular and cerebrovascular disease, it was reported that the prevalence rate in Mongolian people is significantly higher than that in other ethnic groups and is even the leading cause of death among Mongolians, and this phenomenon is attributed to the Mongolian dietary tradition of consuming large amounts of red meat and Baijiu [20]. Gastrointestinal disorders, such as ulcerative colitis [21], caused by disturbances in gastrointestinal homeostasis are also closely related to this Mongolian diet. In addition, the high intake of dairy products and solid oil may be closely related to the onset of rheumatoid arthritis [22].

Among the top 10 Mongolian medicine prescriptions most studied, Eridun-Urile is often used in the treatment of cerebrovascular diseases and osteoarthritis etc. Hepatitis-7 is mainly used to treat ulcerative colitis. Gurigumu-13 mainly treats migraine, allergic rhinitis and eye diseases [23]. Garidi-13 is mainly used to treat cerebrovascular [24] diseases and rheumatic diseases. Sendeng-4 mainly treats joint diseases. Amuri-6 mainly treats indigestion, constipation and other digestive disorders. Xieriga-4 mainly treats diabetes and urinary frequency disorder. Naru-3 mainly treats rheumatoid arthritis and osteoarthritis [25]. Bateri-7 mainly treats acute pancreatitis and ulcerative colitis and other intestinal disorders. Sugemule-5 mainly treats depression, heart diseases, and so on. As can be seen from the above, the main diseases treated by the common formulas in Mongolian medicine include cardiovascular and cerebrovascular diseases, arthritis-like diseases, digestive system diseases and so on. Garidi-13 is often used to treat cerebrovascular diseases, diabetic peripheral lesions and so on.

At the same time, osteopathy, manual reduction, massotherapy, and brain vibration therapy are all traditional therapeutic techniques of Mongolian medicine and are used to treat traumatic injuries such as concussions, fractures, and joint dislocations. This is probably because Mongolians are nomadic, so they often have traumatic brain injuries and joint-type diseases. And it can be seen that there is a strong correlation between the common diseases of Mongolian people and research on treatment, such as Mongolian medicine prescriptions, and traditional therapeutic techniques of Mongolian medicine.

**Table 4**  
Main keywords in Fig. 6 with Chinese name and English name.

Cluster	Main keywords
#1	HPLC, Composition research, Pharmacological action, Thin layer chromatography scanning(TLC), Orthogonal test, Gas chromatography(GS), Processing technology, Extraction technique, Toxicity toxicology, Fingerprinting, Flavone, Gardenoside, Fructus Choerospondiatis, Long Pepper, etc.
#2	Mongolian medicinal materials, Experiment research, Antioxidation, TNF- $\alpha$ , Rat, Immunity, Apoptosis, Tumor, Liver injury, Free radical, Hepatic fibrosis, Blood lipid, Depression, Osteoporosis, Heyi, Digeda-4, Gurigumu-13, Tonglage-5, etc.
#3	Mongolian medicine, Clinical efficacy, Acupuncture and moxibustion therapy, Fracture, Osteopathy, Thermo-acupuncture therapy of Mongolian medicine, Fumigation therapy, Lumbar disc herniation, Spondylosis, Scapulohumeral periarthritis, Manual reduction, Pain, Small splint fixation, etc.
#4	Colitis, Oral ulcer, Zoster, Acne, Pressure ulcer, Combination of Chinese and Mongolian Medicine, Hatagageqi-7, External application therapy, Niruha therapy, Sanzi decoction, Tuberculosis, Cervical erosions, Advantage.
#5	Mongolian medicine and medicinal materials, Clinical experience, Badagan, Nephritis, Calculus, Cholecystitis, Hepatitis B, Diarrhea, Brucellosis, Cirrhosis, Academic thought, Application Therapy, Chronic bronchitis.
#6	Gastritis, Constipation, Functional dyspepsia, Peptic ulcer, <i>Helicobacter pylori</i> , Amuri-6.
#7	Dysfunctional Uterine Bleeding, Dysmenorrhea, Perimenopausal syndrome, Pelvic inflammatory disease, Treatment, Prevention, Uleji-Urile.
#8	Vertigo, Concussion, Migraine, Brain vibration therapy.
#9	Chinese medicine and medicinal materials, Tibetan medicine and medicinal materials, Ethnomedicine and Ethnic medicinal materials, Development, Theory, Comparative study, Gout, Textual research on materia medica.
#10	Stroke, Eridun-Urile, Garidi-13, Diabetes.
#11	Coronary heart disease, Angina pectoris, Chronic heart failure, Arrhythmias, Myocardial ischemia, Heart tingling, Bronchial asthma, Xiong-Agari-8.
#12	Urticaria, Psoriasis, Medicated bath, rheumathritis, Application.

Keywords with the strongest citation bursts are the most cited in a period and can reflect the cutting-edge trend of a field. Table 5 shows the top 30 keywords with the strongest citation bursts, in which the red bars indicate high citations in the corresponding period, while the green bars show the opposite.



**Table 5**  
Top 30 keywords with the strongest citation bursts from 2000 to 2022.

Keywords		Strength	Begin	End	2000–2022
Chinese name	English name				
蒙医药	Mongolian medicine and medicinal materials	19.61	2000	2006	
微量元素	Trace element	11.46	2000	2009	
巴达干	Badagan	10.47	2000	2003	
外敷疗法	External application therapy	7.14	2000	2010	
正交试验	Orthogonal test	13.77	2001	2010	
乙型肝炎	Hepatitis B	5.91	2001	2008	
胡椒碱	Piperine	12.11	2003	2011	
栀子苷	Gardenoside	7.96	2003	2007	
理论	Theory	7.38	2003	2008	
治疗	Treatment	29.04	2004	2011	
定性研究	Qualitative research	5.99	2005	2011	
微波消解	Microwave digestion	7.37	2006	2009	
挥发油	Volatile oil	5.72	2006	2010	
炮制工艺	Processing technology	11.52	2007	2009	
乌头碱	Aconitine	5.72	2007	2010	
药效	Drug efficacy	7.03	2008	2012	
痛经	Dysmenorrhea	5.58	2009	2014	
临床经验	Clinical experience	9.55	2010	2012	
高脂血症	Hyperlipidemia	5.36	2011	2014	
六锐丸	Liurui Pill	5.34	2012	2014	
文献研究	Literature study	5.4	2013	2014	
手法复位	Manual reduction	6.82	2016	2018	
西医药	Western medicine	11.2	2017	2020	
学术思想	Academic thought	6.15	2017	2020	
贴敷疗法	Application therapy	5.89	2018	2020	
蒙医推拿	Massotherapy of Mongolian medicine	6.77	2019	2022	
骨质疏松	Osteoporosis	5.6	2019	2022	
康复疗法	Rehabilitation therapy	5.54	2019	2022	

(continued on next page)



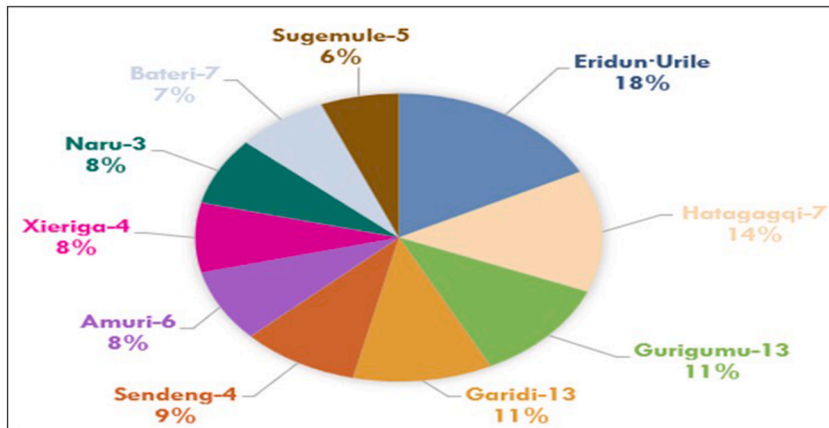


Fig. 8. Top 10 prescriptions on Mongolian medicine and medicinal ranked by frequency.

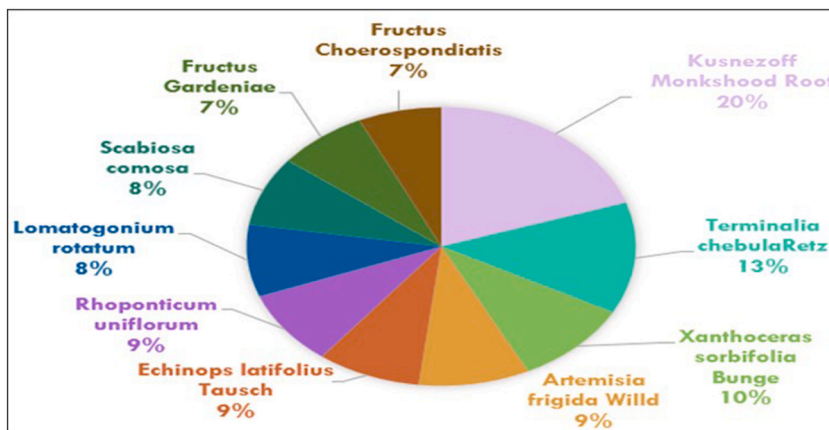


Fig. 9. Top 10 medicinal materials on Mongolian medicine and medicinal ranked by frequency.

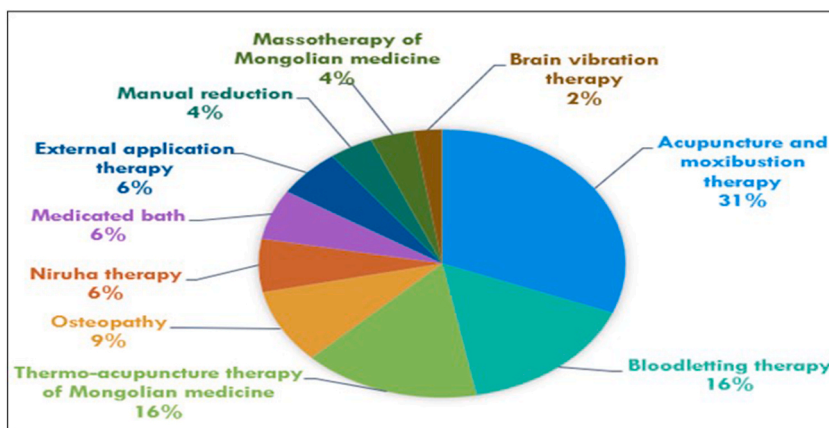


Fig. 10. List of the top 10 traditional therapeutic techniques of Mongolian medicine.

other ethnomedicine and ethnic medicinal materials, such as Chinese medicine and Tibetan medicine. The research on the pharmacological effects of Mongolian prescriptions is primarily represented by cluster #2. #2: animal experimental studies were carried out to explore the pharmacological action of traditional Mongolian prescriptions, such as antioxidation, immune regulation, and apoptosis regulation. The primary therapies and techniques in Mongolian medicine are covered by clusters #3, #4, #8, and #10. #3: Clinical

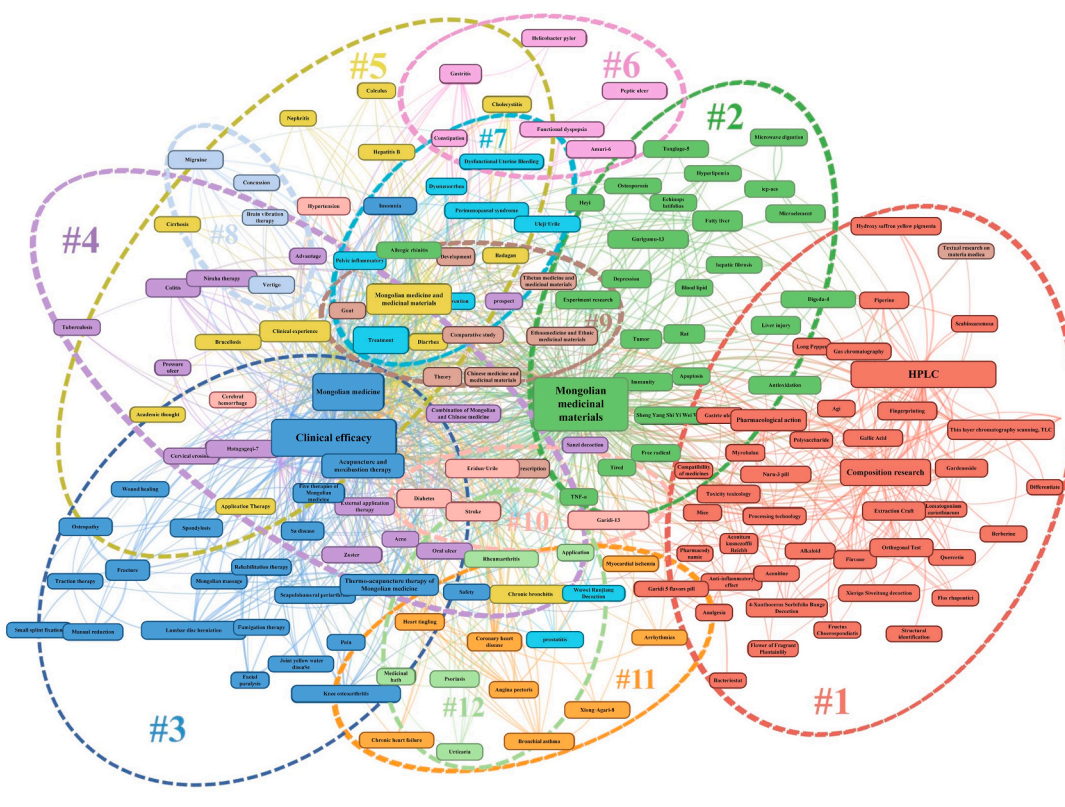


Fig. 11. Cluster of keywords.

research of traditional Mongolian therapeutic techniques, such as acupuncture and moxibustion therapy, osteopathy, and thermoacupuncture therapy, with clinical efficacy as the primary objective. #4: Research, mainly focused on Mongolian medicine, was administered through the skin or mucous membrane to treat colitis, oral ulcer, zoster, acne and other diseases. #8: Studies mainly focused on a traditional Mongolian therapeutic technique, brain vibration therapy, and its indications, such as vertigo, concussion, and migraine. #10: Research on Eridun-Urile and Garidi-13 (two famous traditional Mongolian medicine prescriptions) and their main indication. Other diseases primarily treated in Mongolian medicine include clusters #5, #6, #7, #11, and #12. #5: Clinical research of Mongolian medicine and medicinal materials on treating diseases was mainly hepatobiliary, including cholecystitis, hepatitis B, diarrhea, and cirrhosis. The four remaining clusters were concentrated on different diseases: #6 gastrointestinal disorders, #7 gynecological diseases, #11 heart diseases, and #12 dermatoses.

As a nomadic ethnic group on the grassland, the Mongolians were known as the people on horseback. In production and living activities, Mongolian medicine has accumulated rich experience in the treatment of fracture, dislocation, and other skeletal system-related diseases, as shown in Fig. 11 #3.

According to the visualization analysis of keywords, the research in the field of Mongolian medicine and medicinal materials could be obviously divided into basic research with compositions and pharmacological action of Mongolian medicinal materials and prescriptions as targets (#1 and #2 in Fig. 11), while clinical research with the usage of Mongolian medicine to cure diseases was another important part (#3-#8, and #10-#12 in Fig. 11). In addition, China is a multinational country, and the comparative study between Mongolian medicine and medicinal materials and other ethnomedicine and ethnic medicinal materials is another characteristic part of Mongolian medicine and medicinal materials (#9 in Fig. 11).

The keywords in Table 5 can be broadly divided into three periods: 2000–2007, 2008–2015, and 2016–2022. The research in the first period (2000–2007) mainly focused on the compositions of Mongolian medicinal materials, and clinical research was also a hotspot in this period. Meanwhile, the most studied disease in this period was hepatitis B. In the second period (2008–2015), the researchers attached importance to the summary of clinical experience and literature study. In the third period (2016–2022), academic thought and traditional Mongolian therapeutic techniques, such as manual reduction, application therapy, massotherapy of Mongolian medicine, and rehabilitation therapy, became research hotspots. The research on clinical efficacy, osteoporosis, and *Echinops latifolius* Tausch. might be cited frequently in the coming years and could represent emerging trends.

4. Strengths and limitations

To the best of our knowledge, this is the first bibliometric analysis to investigate the development process of Mongolian medicine

and medicinal materials in China with CiteSpaceV and VOSviewer. We analyzed the journals, keywords, and authorship to generate the development process, emerging trends, and hotspots in this field. Nonetheless, this study also has limitations. The most important limitation is that the publication format of the CNKI database cannot be used for further cocitation analysis and citation analysis by CiteSpace and VOSviewer. Second, with the continuous updating of publications in CNKI, our retrieval results might be different from the actual number of included publications. Finally, although the literature in other databases (e.g., web of science, etc.) is very limited, their inclusion may have had some impact on the results. When merging synonyms, it was found that no unified standard for the Chinese translation of Mongolian medical terminology existed; for example, Shier could be translated into both 协日 (Xieri) and 希拉 (Xila). The nonstandard vocabulary of basic concepts has seriously hindered the dissemination of Mongolian medicine. Similarly, the names of Mongolian medicine prescriptions were nonstandard, which also affected their application and promotion. Although some researchers have proposed the importance and existing problems of Mongolian medicine standardization [27], the overall standardization process is far from sufficient.

## 5. Discussion

In general, research on Mongolian medicine and medicinal materials has gradually increased from 2000 to 2022, especially in the last 10 years, which shows that an increasing number of Chinese researchers are interested in this field. However, some problems have hindered the development of Mongolian medicine and medicinal materials. The standardization of Mongolian medical terminology is the biggest obstacle to communication and cooperation, and it has received little attention. The quality and process standardization of Mongolian herbs have achieved some success [27]. With traditional medicine gaining worldwide increasing attention in recent decades, both Chinese medicine and Ayurveda have undergone great development and are widely used as alternative or complementary medicine in Western countries. However, traditional Mongolian medicine is rarely studied. Based on WoSCC from 1991 to 2021, there were only 234 publications in the field of Mongolian medicine and medicinal materials, and China led the ranking (153 articles, 68 %). There were few studies on Mongolian medicine and medicinal materials worldwide during this period. China was the leading country in this field; therefore, we took the development process in the field of Mongolian medicine and medicinal materials research in China as the representative for analysis.

In China, Mongolian medicine and medicinal materials have always been important branches of Chinese ethnomedicine and ethnic medicinal materials, but the overall analysis of the development process of this field in China is still very scarce. The combination of bibliometrics and visualization analysis of the publications in this field can help researchers sort out and analyze the potential information more scientifically and objectively [28]. This study used bibliometric and visualization software CiteSpace and VOSviewer to comprehensively analyze the content and quantity of 8362 articles in CNKI from 2000 to 2022, aiming to reveal the development process and cutting-edge trends of the nearest years in this research field in China.

In conclusion, research on Mongolian medicine and medicinal materials in China developed rapidly, and the number of articles increased greatly. The research teams cooperated and communicated closely, the distribution of researchers of all ages was reasonable, and the research level was gradually improved.

From 2000 to 2022, the research hotspots in this field in China developed from the simple analysis of compositions to the traditional therapeutic techniques of Mongolian medicine, accentuating the characteristics of Mongolian medicine. These findings might be valuable for researchers in this field to determine future research directions, academic exchanges, and cooperation. This study demonstrates that a comprehensive understanding of the authors, journals, institutions, and other collaborative aspects in the research field of Mongolian medicine can be obtained through bibliometric analysis. Furthermore, analysis of research areas and hotspots such as commonly used drugs and prescriptions and prevalent diseases in Mongolian medicine can also be conducted. The study also identified certain shortcomings and proposed improvement measures in current research on Mongolian medicine, providing foundational support for future research in this field.

### Data availability

Data included in article/supplementary material/referenced in article.

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### Ethical declarations

I testify on behalf of all coauthors that our article submitted to the *Heliyon*. Title: Bibliometric analysis of Mongolian medicine and medicinal materials in China since 2000: An analysis of 8362 papers.

All authors:

- 1) This material has not been published in whole or in part elsewhere;
- 2) The manuscript is not currently being considered for publication in another journal;



- 3) All authors have been personally and actively involved in substantive work leading to the manuscript and will hold themselves jointly and individually responsible for its content.

### CRedit authorship contribution statement

**Ming-Yang Cai:** Writing – review & editing, Writing – original draft, Data curation. **Rui-Kun Wang:** Visualization, Validation. **Zhen-Hong Liu:** Conceptualization. **Xiang-Yun Chen:** Investigation. **Wen Tan:** Investigation. **Yi-Fan Sun:** Investigation. **Xiu-Juan Xu:** Investigation. **Xiao-Min Zhang:** Data curation. **Zhen Yang:** Supervision. **Hai-Ying Tong:** Supervision.

### 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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### References

- [1] National Center for Biotechnology Information, National Library of Medicine, 1981. <https://www.ncbi.nlm.nih.gov/mesh/68008519>. (Accessed 6 May 2022).
- [2] A. Pitschmann, S. Purevsuren, A. Obmann, D. Natsagdorj, D. Gunbilig, S. Narantuya, Ch Kletter, S. Glasl, Traditional Mongolian medicine: history and status quo, *Phytochemistry Rev.* 12 (4) (2013) 943–959, <https://doi.org/10.1007/s11101-013-9321-5>.
- [3] B. Godin, On the origins of bibliometrics, *Scientometrics* 68 (1) (2006) 109–133, <https://doi.org/10.1007/s11192-006-0086-0>.
- [4] Chen, M. C., CiteSpace II: detecting and visualizing emerging trends and transient patterns in scientific literature, *J. Am. Soc. Inf. Sci. Technol.* 57 (3) (2006) 359–377, <https://doi.org/10.1002/asi.20317>.
- [5] Van, N. Eck, L. Waltman, Software survey: VOSviewer, a computer program for bibliometric mapping, *Scientometrics* 84 (2) (2010) 523–538, <https://doi.org/10.1007/s11192-009-0146-3>.
- [6] T.H. Kim, Kang, W. J., Research status quo in traditional Mongolian medicine: a bibliometric analysis on research documents in the web of science database, *Evid. base Compl. Alternative Med.* 2021 (2021), <https://doi.org/10.1155/2021/5088129>.
- [7] D.J. Price, *Little Science, Big science... And beyond*, Columbia University Press, New York, 1986.
- [8] The Central People's Government of the People's Republic of China 2007, Eleven departments issued guidance to effectively strengthen the development of ethnic medicine. [http://www.gov.cn/gzdt/2007-12/24/content\\_841751.htm](http://www.gov.cn/gzdt/2007-12/24/content_841751.htm). (Accessed 6 May 2022).
- [9] H. Wang, Hongmei Tula, Bai, R. M., Bagenna, Zhang, E. H., Effects of Digda-4 Decoction on the expression PXR,CAR of acute liver injury rats induced by pylorus ligation, *China Journal of Traditional Chinese Medicine and Pharmacy* 32 (12) (2017) 5578–5582.
- [10] R. Shuang, Han, J. X., Bai, R. M., Laxinamujila Bagenna, Screening study on the active fraction of Mongolian medicine *Usnea iongissima* Ach. against acute liver injury, *Lishizhen Medicine and Materia Medica Research* 28 (9) (2017) 2067–2068.
- [11] L. Shui, Wuyungerile, J. Lu, Siqin Agula, Galatai, Chen, S. Y., Effects of warm acupuncture of Mongolian medicine on iNOS signaling pathway of chronic fatigue rats and its influence on cytokines expressions in Hippocampus and hypothalamus, *Liaoning Journal of Traditional Chinese Medicine* 48 (9) (2021) 196–198.
- [12] Cao, L. L., Cheng, M. X., Yang, G. L., Wang, L. X., Wuliji Ao, Study on qualitative and quantitative control method for *Echinops gmelini*, *Chin. Tradit. Herb. Drugs* 52 (6) (2021) 1759–1764.
- [13] Cai, Y. M., Z. Yang, Huang, J. X., J. Li, Bao, Y. W., Wulanqiqige Hurilebagen, Wuyunsiriguleng, Cui, W. J., Ma, Q. L., Tong, Y. H., Mongolian medicine areca thirteen pill (GY-13) improved depressive syndrome via upregulating cAMP/PKA/CREB/BDNF signaling pathway, *J. Ethnopharmacol.* 293 (2022) 115310.
- [14] Tong, Y. H., Fan, R. A., J. Li, Wujsiguleng, Y. Zhang, Zhang, Q. S., X. Yu, Hurilebagen, Chen, G. C., Effect of Mongolian betel shisanwei ingredients pill (Gao-You-13) on liver and kidney toxicity of chronic stress depression model rats, *J. South-Cent. Univ. Natl. (Humanit. Soc. Sci.)* 36 (3) (2017) 57–60.
- [15] Sun, J. X., Nashengsang Xilintuya, Li, J. H., Y. Li, Xiang, L. C., X. Li, HPLC fingerprint of *Lomatogonium rotatum*, *Chin. Tradit. Herb. Drugs* 50 (7) (2019) 1703–1707.
- [16] R. Yu, Xu, H. Y., Genyu Batudelig, Han, Q. Z., Study on the anti-inflammatory mechanism of Batari-7 on salpingitis rats, *The Chinese Journal of Clinical Pharmacology* 37 (16) (2021) 2221–2223.
- [17] Temuqile Sarentuya, Sarula Manda, Wulan, Eridengqiqige, Bao, L. S., Observation on the diagnostic value of transcranial Doppler (TCD) combined with blood flow spectrum in various syndrome types of Mongolian Sa disease, *World Latest Medicine Information* 19 (97) (2019) 175–178.
- [18] Xin, S. S., Ji, Y. Z., Du, F. Y., Y. Dong, Simultaneous determination of 6 components in serum from Mongolian medicine compound formula-Shudage-4 by using HPLC, *Journal of Beijing University of Traditional Chinese Medicine* 41 (7) (2018) 593–598.
- [19] Chen, M. C., M. Song, Visualizing a field of research: a methodology of systematic scientometric reviews, *PLoS One* 14 (10) (2019) e0223994.
- [20] Liu, J. W., Zhang, C. J., Wu, Y. C., Cai, F. S., Huang, Q. W., J. Chen, Xi, X. X., Liang, B. Z., Hou, C. Q., B. Zhou, N. Qin, Zhang, P. H., Unique features of ethnic Mongolian gut microbiome revealed by metagenomic analysis, *Sci. Rep.* 6 (1) (2016) 1–13.
- [21] R. Samaneh, Mohammad, S. H., R. Bahram, H. Azita, Dietary protein intakes and risk of ulcerative colitis, *Med. J. Islam. Repub. Iran* 29 (2015) 253.
- [22] R. Masoume, N. Mohammadali, R. Farahnaz, The impact of dietary habits on the pathogenesis of rheumatoid arthritis: a case-control study, *Clin. Rheumatol.* 37 (10) (2018) 2643–2648.
- [23] Q Zhang, W. Wang, Y. Jiang, T Zhang, Z Lu, A. Jiang, Protective effects of a composition of Chinese herbs-Gurigumu-13 on retinal ganglion cell apoptosis in DBA/2J glaucoma mouse model, *Int. J. Ophthalmol* 11 (3) (2013) 363–368.
- [24] L. Chen, S. Gaowa, Q. Qiburi, M. He, T. Ganbold, M. Bao, Q. Bao, M. Da, T. Temuqile, H. Baigude, Mongolian herbal medicine garidi-13 upregulates Igf2 expression in cerebral cortex and attenuates neuronal damage in MCAO rat model, *Asian Journal of Complementary and Alternative Medicine* 6 (19) (2018) 7–20.
- [25] Zhao H.Y., Duan S. S., Shi Y.L., Zhang M. J., Zhang L., Jin Z. Y., Fu W. Y., Xiao W. P., Bai T. H., Zhang X. S., Wang Y. X., (2023) Naru-3 inhibits inflammation, synovial hyperplasia, and neovascularization in collagen-induced arthritis in rats. *Journal of Ethnopharmacology* 311: 116350.
- [26] J. Li, Chen, M. C., *CiteSpace: Text Mining and Visualization in Scientific Literature*, Capital University of Economics and Business Press, Beijing, China, 2016, pp. 149–152.
- [27] Tong, Y. H., Wei, X. L., Wuliji Ao, Bi, T. H., Miao, J. J., Hanggaibateer Nashengsang, Wang, J. Y., Present situation, problems and countermeasures of Mongolian medicine standardization, *Herald of Medicine* 38 (4) (2019) 452–455.
- [28] Chen, M. C., Science mapping: a systematic review of the literature, *Journal of data and information science* 2 (2) (2017) 1–40.