



Publication trends of peroral endoscopic myotomy during 2010–2022: a bibliometric analysis

Xin-Yang Liu^{1,2#}, Wei-Feng Chen^{1,2#}, Meng-Jiang He^{1,2#}, Yun-Shi Zhong^{1,2}, Yi-Qun Zhang^{1,2}, Jian-Wei Hu^{1,2}, Li-Qing Yao¹, Quan-Lin Li^{1,2}, Ping-Hong Zhou^{1,2}

¹Endoscopy Center and Endoscopy Research Institute, Zhongshan Hospital, Fudan University, Shanghai, China; ²Shanghai Collaborative Innovation Center of Endoscopy, Shanghai, China

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[#]These authors contributed equally to this work.

Correspondence to: Ping-Hong Zhou; Quan-Lin Li. Endoscopy Center and Endoscopy Research Institute, Zhongshan Hospital, Fudan University, Shanghai, China; Shanghai Collaborative Innovation Center of Endoscopy, Shanghai, China. Email: zhou.pinghong@zs-hospital.sh.cn; li.quanlin@zs-hospital.sh.cn.

Background: Peroral endoscopic myotomy (POEM) has been rapidly accepted as a safe and effective therapy for achalasia and other esophageal motility disorders, and has inspired novel submucosal tunneling techniques. This study analyzed the trends in POEM research and compared contributions from different countries, regions, institutions, journals, and authors using bibliometric analysis to predict the trends and potential hotspots in POEM research.

Methods: Publications concerning POEM from January 1, 2010 to February 25, 2022, were extracted from the Web of Science database. Book chapters, retrieved manuscripts, news, erratum, non-English language publications, and irrelevant publications were excluded. Data, including keywords for each article, were collected, and network analysis was conducted. Microsoft Excel and VOSviewer were used to collect publication data, analyze publication trends, and visualize relevant results.

Results: A total of 1,853 publications were identified. *Gastrointestinal Endoscopy* has been the most popular journal in this field (n=383, 20.67%). Research from the United States was the largest contributor to POEM research worldwide and has provided a pivotal influence (n=743), followed by research from China (n=346) and Japan (n=223). Showa University (Japan) was the most active institution in the field of POEM research. In terms of authors, Dr. Inoue published the most papers in the field with the highest average citation number. Keywords were categorized into 5 clusters: management and outcomes, POEM-derived new techniques, diagnosis and classification, comparison with other treatment approaches, and fundoplication and POEM in children. Average appearing years of keywords was calculated. The topics of adverse events, gastroparesis, and gastric POEM (G-POEM) appeared most recently.

Conclusions: Researchers from the United States, China, and Japan have published the most articles in the field of POEM research, but there was a disparity between the quantity and quality of publications. Research of management and POEM-derived novel techniques were considered potential areas of focus for future research.

Keywords: Peroral endoscopic myotomy (POEM); bibliometrics; publications

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Introduction

Achalasia is a rare motility disorder of the esophagus with an estimated incidence of 0.3–1.5 per 100,000 per year (1,2). It is characterized by the absence of peristalsis and impaired relaxation of the lower esophageal sphincter (LES), leading to symptoms of dysphagia, regurgitation, chest pain, and weight loss (1,2). The traditional treatment of achalasia primarily aims at relieving obstructive symptoms, including medication, dilation, and Heller surgery (3-5).

Peroral endoscopic myotomy (POEM) is the creation of a submucosal tunnel followed by myotomy of the LES through flexible endoscopy without surgical incisions (6). Since the first report of POEM in 2010, thousands of patients have received this treatment for achalasia, and POEM has been rapidly accepted as a safe and effective therapy for achalasia and other esophageal motility disorders (7). With the growing number of patients undergoing POEM, safety and efficacy studies have been subsequently conducted to investigate the adverse events, learning curves, relapse, and risk factors for undesirable outcomes to improve the management of patients (8-14). Furthermore, inspired by the idea of submucosal tunneling, other new techniques, such as submucosal tunneling endoscopic resection (STER) (15), gastric POEM (G-POEM) (16), submucosal tunneling endoscopic septum division (STESD)/Zenker's diverticulum POEM (Z-POEM) (17), per-rectal endoscopic myotomy (PREM) (18), and other natural orifice transluminal endoscopic surgery (NOTES) techniques (19,20) have also been developed and received substantial attention.

Bibliometrics is an emerging subject that applies literature metrology to measure the contribution of an area of research by analyzing the publications quantitatively and qualitatively (21,22). In addition to comparing contributions among countries, regions, institutions, journals, and authors, it can also characterize and predict the development concerning a certain field over time to help predict research trends and hotspots in a research field. These advantages have made bibliometrics widely used in government policy making, clinical guidelines, and the prediction of research trends.

By adopting bibliometric methods, this work presents a comprehensive and integrated analysis of the current research literature on POEM based on Web of Science (WOS) data. We also predict the trends and potential hotspots in POEM research.

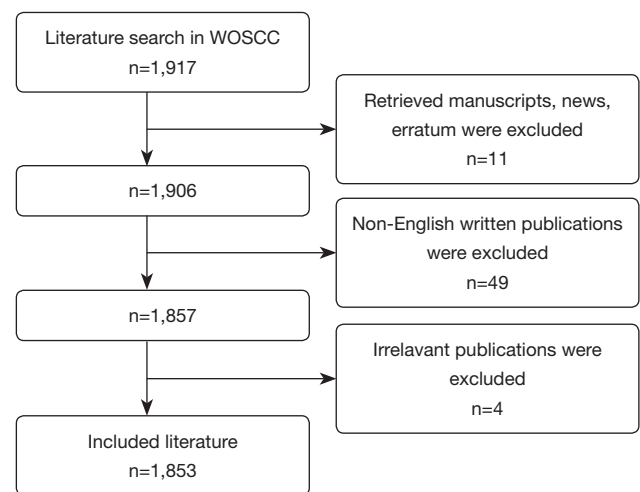


Figure 1 Flowchart of the literature filtering included in this study. A total of 1,917 publications were identified through a literature search, and 1,853 publications were included in the analyses after applying the inclusion and exclusion criteria. WOSCC, Web of Science Core Collection.

Methods

Data sources and search strategies

A literature search was conducted using the WOS Core Collection (WOSCC) database because the Science Citation Index-Expanded (SCI-E) of the WOS has been recognized as a suitable database for bibliometric analysis. All searches were completed on February 25, 2022. The search strategy was as follows: title (TI) = (peroral endoscopic myotomy) OR (per-oral endoscopic myotomy) OR (per oral endoscopic myotomy). Book chapters, retrieved manuscripts, news, erratum, non-English language publications, and irrelevant publications were excluded. A total of 1,853 eligible publications were subsequently analyzed. Detailed procedures for screening and enrollment are illustrated in *Figure 1*.

Data collection

Titles, keywords, publication dates, countries and regions, institutions, authors, publishing journals, and citations were extracted from all eligible publications. The country of origin was defined by each author of the article. For example, if one article was contributed to by authors from different institutions and countries/regions, one publication

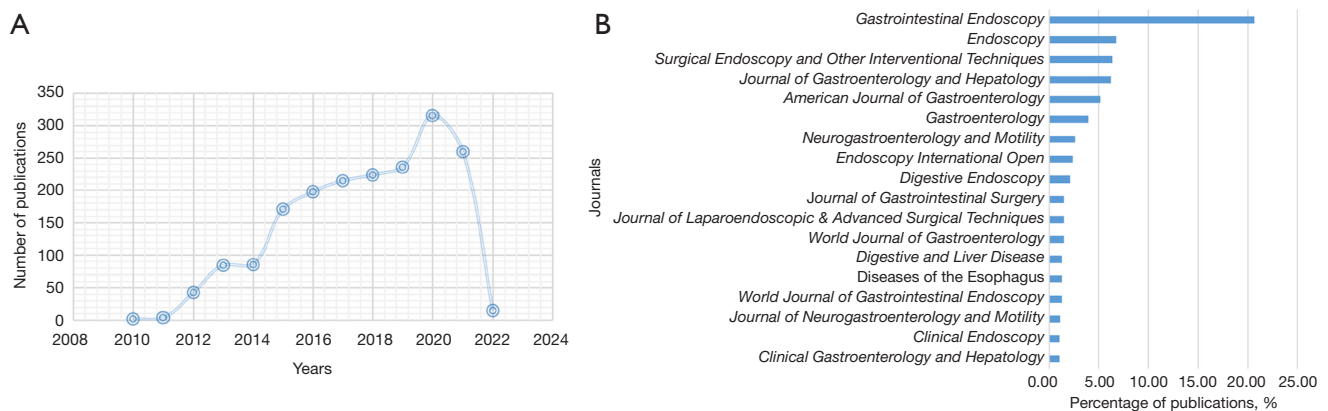


Figure 2 POEM publications from 2010 to 2022. (A) Trends of publications. The number of publications per year from January 1, 2020 to February 25, 2022. (B) The top 18 journals for POEM publications. List of journals with a publication volume of more than 20 articles on POEM. POEM, peroral endoscopic myotomy.

was added to all of the contributing institutions and countries/regions. Subsequently, the data were imported into Microsoft Excel 2010 (Redmond, WA, USA) and VOSviewer (Leiden University, Leiden, the Netherlands) for quantitative and qualitative analyses.

Bibliometric analysis

The contribution of countries/regions, institutions, and authors to global publications was assessed by ranking the number of publications, citations, and average citations per publication. The top journals and their number of publications were also retrieved from WOS. VOSviewer was used for mapping and visualization of the network of countries/regions, institutions, authors, and keywords by clustering based on co-occurrence analysis. In network visualization, the size of the dot represented the number of publications of the author/institution/country, while the lines between the dots indicated the strength of the co-occurrence of different authors, institutions, countries, or regions. Clusters were color-coded by time course in the overlay analyses, with the average appearing year (AAY; the average year in which the articles, including the particular keyword, was published) used to evaluate the novelty of a research topic.

Results

Publications on POEM from 2010 to 2022

A total of 1,853 publications met our inclusion criteria from

2010 to 2022 (Figure 1). Figure 2 shows a transformative trend in the annual literature numbers related to POEM. As shown in Figure 2A, there were only a limited number of publications on POEM before 2014 since the topic was first introduced in 2010. The volume of publications gradually increased and experienced a sharp increase in 2020, with an annual publication number of 316.

Nearly 70% of the publications were published in the 18 journals listed in Figure 2B, all of which had a publication volume of more than 20 articles on POEM. *Gastrointestinal Endoscopy* published the largest amount of works—383 publications, which accounted for 20.67% of all the publications. *Endoscopy*, *Surgical Endoscopy*, and *Other Interventional Techniques*, and the *Journal of Gastroenterology and Hepatology* also had more than 100 publications each on this topic, ranking second to fourth in this field with 126 (6.80%), 119 (6.42%), and 116 (6.26%) pieces, respectively. Other high impact journals, such as the *American Journal of Gastroenterology* and *Gastroenterology*, also published 96 and 73 pieces of work, respectively.

Contribution of countries/regions to global publications

All the incorporated literature on POEM was published by at least 60 countries or regions. The United States (n=743) was the largest contributor to POEM research, followed by China (n=346), Japan (n=223), India (n=150), and Italy (n=138), as shown in Table S1 and Figure 3A. The average number of citations was highest for publications from Germany (26.55), followed by Canada (24.04) and Japan

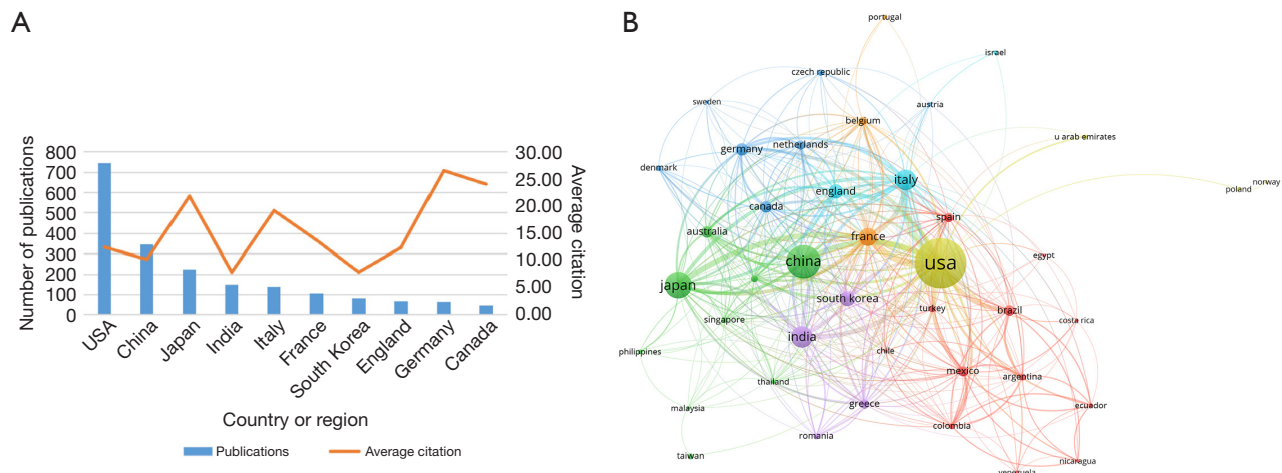


Figure 3 Contribution of countries/regions to global publications. (A) The top 10 countries/regions in POEM publications. List of the top 10 countries/regions with the most publications on POEM, the number of publications, and average citations. (B) Network visualization of countries/regions in POEM publications. The analysis of co-occurrence relations of 41 countries and regions with more than 5 publications resulted in 7 clusters indicated by different colors. The size of the dot represents the number of publications of the country, while the lines between the dots indicate the strength of the co-occurrence of different countries/regions. POEM, peroral endoscopic myotomy.

(21.83). After the exclusion of countries and regions not connected to other countries/regions and those with fewer than 5 publications, 41 countries/regions were analyzed using VOSviewer (Figure 3B). The network analysis of countries/regions resulted in 7 clusters: (I) Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Egypt, Mexico, Nicaragua, Spain, Turkey, and Venezuela; (II) Australia, Japan, Malaysia, China, Philippines, Singapore, Switzerland, and Thailand; (III) Austria, Canada, Czech Republic, Denmark, Germany, Netherlands, and Sweden; (IV) Norway, Poland, United Arab Emirates, and USA; (V) Greece, India, Romania, and South Korea; (VI) England, Israel, and Italy; and (VII) Belgium, France, and Portugal.

Institutions publishing research on POEM

With respect to institutions, Showa University published the most manuscripts ($n=121$), followed by Johns Hopkins University ($n=116$). Fudan University ($n=64$), Northwestern University ($n=59$), and the Asian Institution of Gastroenterology ($n=54$) also contributed more than 50 publications each. The top 10 institutions identified for their POEM research are summarized in Figure 4A and Table S2. Institutions with highest average number of citations in publications were Oregon Clinic (34.32), Northwestern University (33.54), and Showa University (33.11).

A total of 31 institutions with more than 20 publications were analyzed by clustering using VOSviewer (Figure 4B). The institutions network produced a relatively low-density map, with low connections among research institutions, especially in different geographical regions. The most frequent cooperation occurred in Japan and USA.

Authors publishing research on POEM

The 10 authors that published the most papers, among all 4,954 authors, on this subject were Inoue H, Khashab MA, Kumbhari V, Zhou PH, Onimaru M, Tang XW, Nabi Z, Raja S, Reddy DN, and Sanaka MR (Figure 5A and Table S3). Inoue H, Zhou PH, Onimaru M, Raja S, and Sanaka MR are from a surgical background, while Khashab MA, Kumbhari V, Tang XW, Nabi Z, and Reddy DN are from a gastroenterology background. Among them, Dr. Inoue H, who first reported the POEM technique (6), ranked first both in volume and number of citations, with 130 articles published and 4,250 citations. The average citation number was as high as 32.69. Other highly cited authors included Onimaru M, Khashab MA, Kumbhari V, and Zhou PH. The top 10 authors identified for their POEM research are summarized in Figure 5A and Table S3. Connections were tight between authors in the same institution but loose between authors from different institutions (Figure 5B).

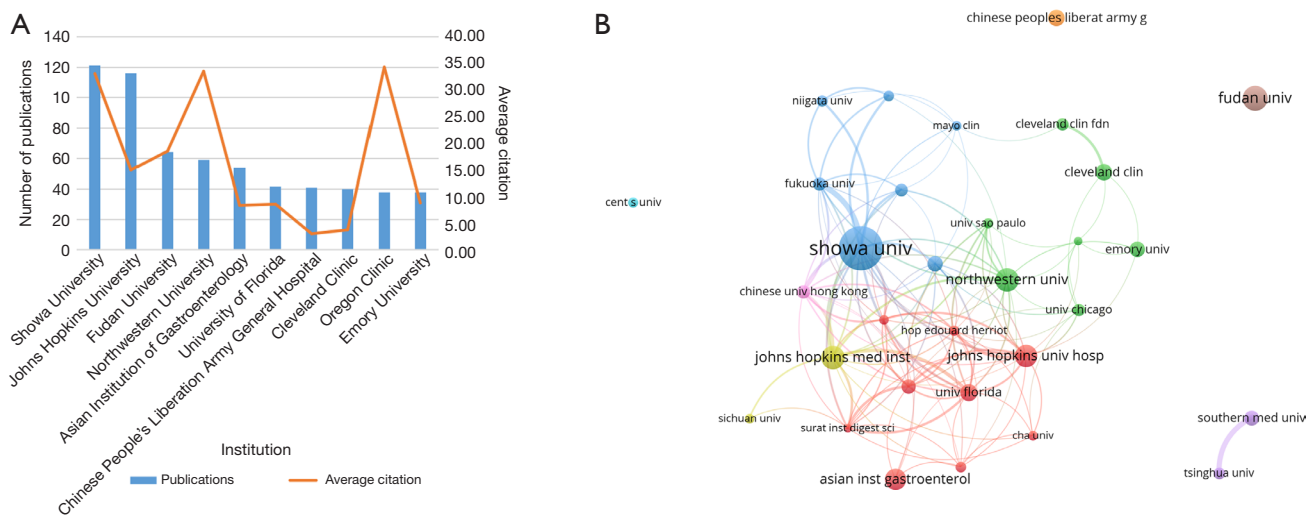


Figure 4 Contribution of institutions to global publication. (A) The top 10 institutions in POEM publications. List of the top 10 institutions with the most publications on POEM, the number of publications, and average citations. (B) Network visualization of institutions in POEM publications. The analysis of the co-occurrence relations of 31 institutions with more than 20 publications resulted in 8 clusters indicated by different colors. The size of the dot represents the number of publications of the institution, while the lines between the dots indicate the strength of the co-occurrence of different institutions. POEM, peroral endoscopic myotomy.

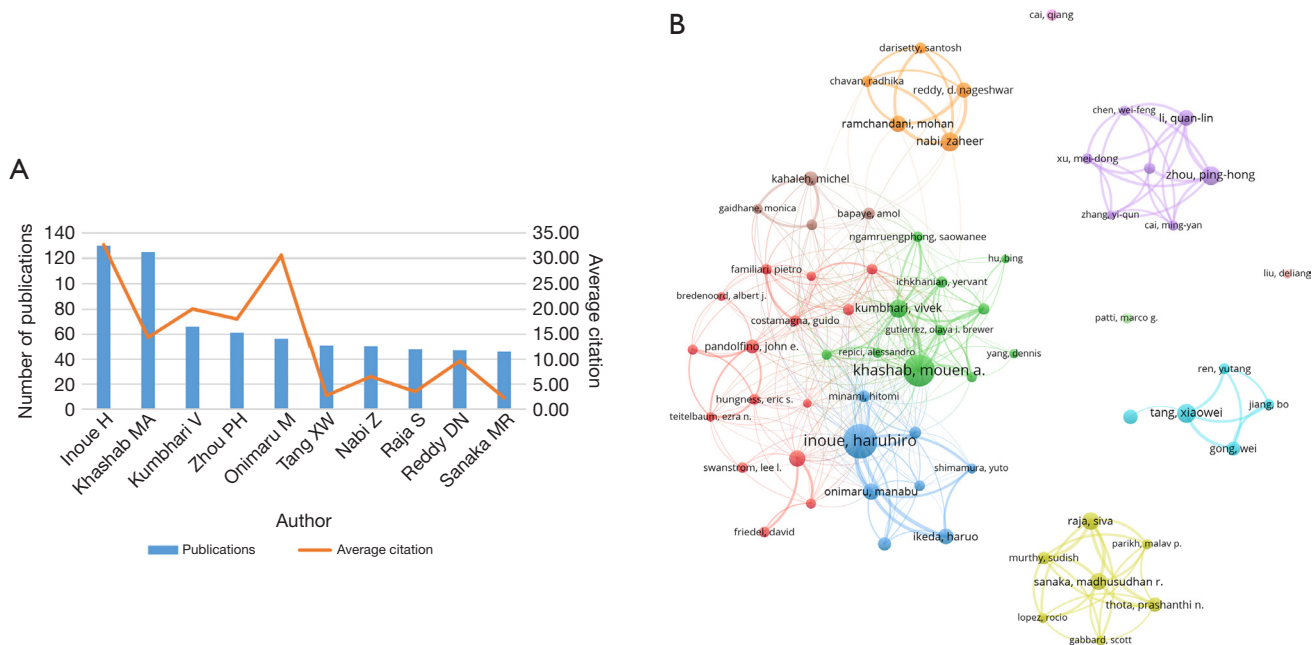


Figure 5 Contribution of authors to global publication. (A) The top 10 authors in POEM publications. List of the top 10 authors with the most publications on POEM, the number of publications, and average citations. (B) Network visualization of authors in POEM publications. The analysis of co-occurrence relations of authors resulted in 11 clusters indicated by different colors. The size of the dot represents the number of publications of the author, while the lines between the dots indicate the strength of the co-occurrence of different authors. POEM, peroral endoscopic myotomy.

Analysis of POEM research hotspots

Of all 1,838 keywords, those found over 20 times across all 1,853 publications were analyzed using VOSviewer. Keywords contain valuable information on the study subject with a relatively standard format and thus were considered a valid way to define the subject of an article compared to the article title. After merging words of the same meaning and excluding meaningless words as well as “achalasia” and “POEM,” 47 terms were identified and classified into 5 clusters in the map: cluster 1 (management and outcomes, in red), cluster 2 (new POEM-derived techniques, in green), cluster 3 (diagnosis and classification, in blue), cluster 4 (comparison with other treatment approaches, in yellow), and cluster 5 (fundoplication and POEM in children, in purple; *Figure 6A*). A larger circle size represents higher frequency. Within cluster 1, the following keywords frequently occurred: outcomes, management, efficacy, and Heller myotomy. In cluster 2, the relevant keywords included gastroparesis, G-POEM, botulinum toxin, and follow-up. In cluster 3, the primary keywords were motility disorders, high-resolution manometry, classification, and gastro-esophageal reflux disease (GERD). In cluster 4, only 4 keywords were included: dilation, laparoscopic Heller myotomy, lower esophageal sphincter, and randomized controlled trial. Similarly, in cluster 5, the 4 keywords were children, diagnosis, fundoplication, and surgery. In *Figure 6B*, the temporal trends of research hotspot shifts were analyzed by coloring the keywords according to the average time of word appearance, from blue to yellow, representing early to recent appearances, respectively.

We then color-coded all keywords based on the AAY of each word in the overlay analyses (*Figure 6B*). Keywords shown in yellow, such as adverse events (cluster 1; AAY of 2019.6), gastroparesis (cluster 2; AAY of 2019.0), G-POEM (cluster 2; AAY of 2019.2), and pyloromyotomy (cluster 2; AAY of 2018.9), appeared most recently, while keywords shown in blue were relatively old topics and were mostly in cluster 3. Hence, the G-POEM and related study cluster may constitute a new research trend.

Discussion

Our quantitative analysis showed that the research output on POEM has fluctuated over the past 13 years. As illustrated in the time curve, steady growth in the cumulative number of publications concerning global POEM research was observed over time, with an explosion

of research in this area after 2014. Notably, journals focusing on endoscopy, such as *Gastrointestinal Endoscopy*, *Endoscopy*, *Surgical Endoscopy*, and *Other Interventional Techniques*, were the primary journals publishing research on POEM. Thus, future developments are more likely to be published in these journals.

Regarding the contributions of countries/regions, the United States, China, and Japan have played an important role in POEM research. Their total numbers of studies rank first, second, and third, respectively. The total number of citations was also the highest in the United States. However, there was a disparity between the quantity and quality of publications. Although the total numbers of studies were larger in the United States and China than in Japan, the average citation per article was far lower than that of Japan. In addition, although Germany and Canada only ranked ninth and fifth in the total number of publications, the average citation per article for both countries exceeded 24 and ranked first and second, respectively.

In terms of institutions and scholars, Showa University, Johns Hopkins University, and Fudan University played a leading role among scientific agencies. Clearly, Inoue *et al.* (6) from Showa University, who first reported POEM in 2010, published the largest volume of POEM articles with the highest number of citations and average citations. Additionally, authors such as Onimaru M, Khashab MA, Kumbhari V, and Zhou PH not only published the largest numbers of papers in this field but also had high quality research. This publication record demonstrated that they had become an influential core group in the POEM field, having carried out substantial research to lay a solid foundation for future development. However, in clustering analyses, the connections between institutions and authors from different geographical areas were relatively loose, suggesting insufficient cooperation. Specifically, cooperation between Chinese institutions with other institutions was rare. Increased mutual cooperation is needed for future multicenter studies.

We identified 5 keyword clusters to analyze POEM research hotspots. We found that the study of POEM is relatively comprehensive, including diagnosis and classification, management and outcomes, comparison with other treatment approaches, GERD and fundoplication, POEM in specific populations such as children, and POEM-derived new techniques such as G-POEM for gastroparesis.

Recent years have seen the research focus switching from diagnosis and classification to management, outcomes,

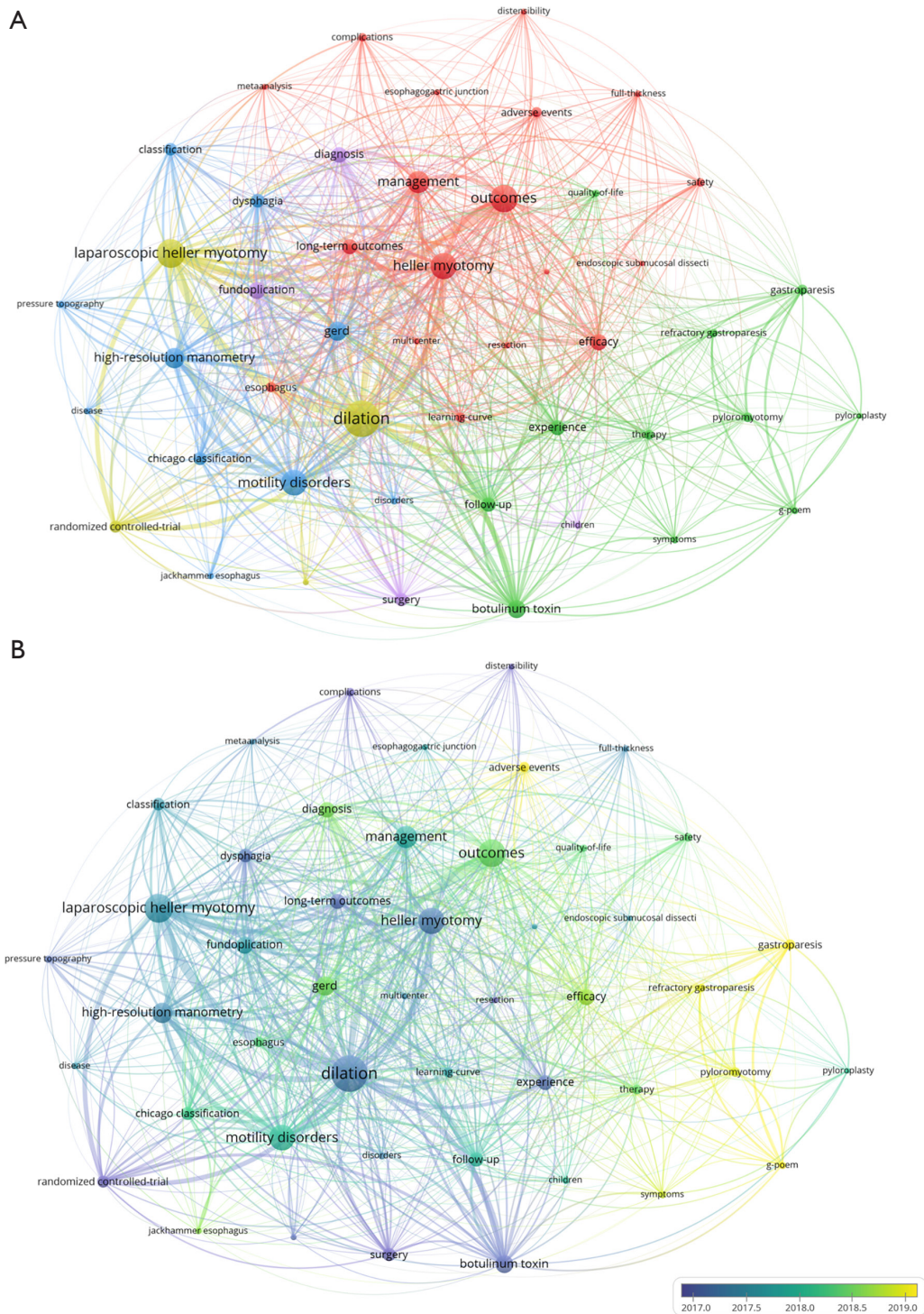


Figure 6 Network visualization and overlay visualization of keywords in POEM publications. (A) Network visualization of keywords in POEM publications. The co-occurrence relations of keywords were summarized into 5 clusters indicated by different colors. The size of the dot represents the number of the appearance of the keyword, while the lines between the dots indicate the strength of the co-occurrence of different keywords. (B) Overlay visualization of keywords in POEM publications. Keywords were color-coded based on the average appearing year of each word. Keywords shown in yellow appeared most recently, while keywords shown in blue appeared earlier. POEM, peroral endoscopic myotomy.

and new techniques. The topics of adverse events from the management and outcomes cluster as well as gastroparesis and G-POEM from the new techniques cluster have emerged most recently. For management and outcomes, prediction models for recurrence after POEM and adverse events were recently published based on large clinical datasets (23,24). Moreover, different choices in procedural details were also compared, such as a study comparing long tunnel versus short tunnel or a meta-analysis comparing the anterior approach versus the posterior approach (25,26). As GERD is a common complication after POEM, fundoplication after or with POEM also received increased attention (27).

For new techniques, G-POEM for gastroparesis and other disorders related to the stricture of the pylorus (16), STESD or Z-POEM for Zenker's Diverticulum (17), PREM for Hirschsprung disease (18), and NOTES techniques including STER and EISD were also recently invented techniques inspired by POEM. Although these novel POEM-derived techniques did not present in a high enough frequency to be included in the clustering analyses, based on the latest hotspot of G-POEM, we believe they could also become the focus of future research.

Our study accessed publications on POEM extracted from the WOS database. Nonetheless, some limitations should be addressed. We only considered publications written in English; therefore, we might have underestimated important research published in other languages. Moreover, the more recent papers could not accumulate a large number of citations at the time of this study, which might have affected our estimation of their research quality.

In conclusion, we illustrated global trends in POEM research using bibliometric analyses. The United States, China, and Japan made the most contributions in the field of POEM research, while there was a disparity between the quantity and quality of publications. Management-related research and novel POEM-derived techniques were considered potential foci for future research.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://atm.amegroups.com/article/view/10.21037/atm-22-2469/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Table S1 Top 10 countries with the largest publication volume in the field of POEM

Country	Publications	Citations	Average citation
USA	743	9276	12.48
China	346	3545	10.25
Japan	223	4868	21.83
India	150	1183	7.89
Italy	138	2648	19.19
France	108	1488	13.78
South Korea	81	641	7.91
England	69	856	12.41
Germany	66	1752	26.55
Canada	48	1154	24.04

POEM, peroral endoscopic myotomy.

Table S2 Top 10 institutions with the largest publication volume in the field of POEM

Institution	Publications	Citations	Average citation
Showa University	121	4006	33.11
Johns Hopkins University	116	1736	14.97
Fudan University	64	1184	18.50
Northwestern University	59	1979	33.54
Asian Institution of Gastroenterology	54	454	8.41
University of Florida	42	362	8.62
Chinese People's Liberation Army General Hospital	41	125	3.05
Cleveland Clinic	40	152	3.80
Oregon Clinic	38	1304	34.32
Emory University	38	336	8.84

POEM, peroral endoscopic myotomy.

Table S3 Top 10 authors with the largest publication volume in the field of POEM

Author	Publications	Citations	Average citation
Inoue H	130	4250	32.69
Khashab MA	125	1792	14.34
Kumbhari V	66	1321	20.02
Zhou PH	61	1098	18.00
Onimaru M	56	1714	30.61
Tang XW	51	139	2.73
Nabi Z	50	326	6.52
Raja S	48	168	3.50
Reddy DN	47	452	9.62
Sanaka MR	46	105	2.28

POEM, peroral endoscopic myotomy.