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REVIEW

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# Risk factors for endometrial polyps to transform into endometrial cancer: insights from a bibliometric analysis

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## Abstract

**Background** Endometrial polyps (EPs) are at risk of transforming into endometrial cancer (EC). Terminal EC seriously affects women's quality of life and places a heavy financial burden on families. Investigating the risk factors that influence the conversion of EPs to EC and preventing them from progressing further is crucial. This study attempts to map the features of published literature on risk factors and understand the frontiers and hotspots of that research by using bibliometric analysis.

**Methods** We obtained relevant publications from 1996 to 2024 from the Web of Science Core Collection (WoSCC) on July 11, 2024. Next, CiteSpace software, the R (Version 4.3.2) package Bibliometrix, the Online Analysis Platform of Document Metrology (http://biblimetric.com), and a web interface for Bibliometrix were used to analyse the data.

**Results** The analysis included 90 qualifying data points concerning the risk factors for the conversion of EPs to EC. The American Journal of Obstetrics and Gynecology was the most productive publication. The authors referenced the most were Cohen I and Ferrazzi E. After removing similar keywords, the keywords that did not have a specific meaning, the remaining keywords mainly included hysteroscopy, postmenopausal women, premenopausal, therapy, diagnosis, patients receiving tamoxifen, ultrasound, and management. The long-term management of EPs has emerged as a new research hotspot, per the trend topic.

**Conclusions** In the published literature, age, perimenopause and postmenopausal bleeding are the most frequently studied factors for the conversion of EPs to EC, also including PCOS and polyp size. Endometrial polypectomy and long-term management may be recommended for these patients.

**Keywords** Endometrial polyps, Endometrial cancer, Risk factors, CiteSpace, Bibliometric analysis

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## Background

Endometrial polyps (EPs) are benign conditions with an incidence of 7.8–34.9% [1], yet there is a 3–5% likelihood of them transforming into endometrial cancer (EC) [2], particularly when exposed to certain risk factors. EC is a group of malignant epithelial tumour that occur in the endometrium and is the sixth most common malignancy in the female population worldwide [3]. The aetiology of EC remains unclear, and it cannot be fully cured at present. Terminal cancer can significantly compromise women's quality of life and impose a substantial economic burden on families. Thus, it is critical to investigate the risk factors that impact EPs conversion to EC and prevent the formation of EC.

Previously, numerous studies have explored the risk factors for the conversion of EPs into EC, such as postmenopause, abnormal uterine bleeding, and obesity [4]. However, the descriptions of risk factors in the previous literature are relatively scattered, which is not conducive for beginners to quickly and comprehensively master and understand the relevant hot spots in this field. Bibliometrics is a science that employs mathematical and statistical methods to conduct quantitative analysis of literature, enabling us to gain a comprehensive understanding of the published literature [5]. The medical field has made extensive use of bibliometric analysis as a technique for analysing vast volumes of varied literature [6, 7]. Bibliometric analysis cannot directly identify disease risk factors, but it provides a comprehensive overview of the literature, which can identify which risk factors are research hotspots by analysing keywords, topic clustering, most commonly cited literature, etc., and provides direction for future in-depth research [8].

To our knowledge, the literature on the variables influencing the conversion of EPs into EC has not yet been subjected to bibliometric analysis. The Web of Science Core Collection (WoSCC) is one of the most commonly used databases for bibliometric analysis because of its high-quality bibliographic index and extensive subject coverage [9, 10, 11]. To perform this study, we used CiteSpace [12] to locate and display data from the WoSCC from different angles, such as different institutions, countries, cocited references, and cocited authors. Additionally, the R packages "bibliometrix" and "biblioshiny" were utilized to generate popular subjects and pinpoint areas of study interest [13]. Through these analyses, we attempted to understand the popular research risk factors for the transition from EPs to EC and discussed possible future research options in the field.

## Methods

### Data sources and methods of searching

Relevant papers were searched for in the Social Sciences Citation Index (SSCI) and WoSCC Science Citation Index Expanded (SCI-Expanded) to minimize prejudice related to database upgrades. The following search approach was used: TI= ("endometrial polyps" or "endometrial polyp") AND TS= ("carcinoma" or "cancer" or "malignant" or "malignancy") AND ALL= ("risk" or "factor" or "effect" or "influence"). The above search terms were from the Medical Subject Heading (MeSH) database and published literature. Specifically, the terms "carcinoma" and "risk" come from the MeSH database, while other terms were determined by reading relevant literature. Two researchers (Ying Liu and Wei Cheng) independently searched the WoSCC for articles based on terms (last search date 11 July 2024) and included all document types and language types. After the literature was searched, the abstracts of each article were read independently, and only studies that were not relevant to the present study were excluded.

### Data analysis and data visualization

All document types were unclassified and were imported into each analysis software for direct analysis. The WoSCC data were downloaded and then integrated into the Bibliometrics Online Analysis Platform as a tab-delimited file of text. To analyse the publication pattern throughout various years, the "Total volume" section was utilized, and the publication amount of each country was examined via the "National total" section.

The WoSCC database was used to obtain the entire dataset and referenced citations for these papers. Next, the files in TXT format were loaded into the CiteSpace program V6.1R6 (64-bit) Basic (Drexel University, Philadelphia, PA, USA) with the following parameters. The parameters that determined the selection criteria (g-index: k = 25, Top $N$ = 50, Top N% = 10%, maximum number of selected items per slice = 100), pruning (Pathfinder, Pruning sliced networks), time span (January 1996–December 2024), years per slice (1), links (strength: cosine, scope: within slices), and all other settings were maintained at their initial configurations. The parameters supplied for the node type parameter area were "Country" for intercountry investigation, "Institution" for interinstitutional investigation, "Cited-author" for coauthorship network investigation, and "References" for document cocitation investigation.

Using the TXT format data that were previously stored, Version 4.3.2 of the bibliometrix package in R and the bibliometrix online interface, called "biblioshiny," were utilized to retrieve the most frequently referenced literature as well as the most frequently term and popular subjects.

## Results

A total of 147 original articles were identified from the SSCI and SCI-Expanded, and 90 original articles were ultimately included for bibliometric analysis after being screened by two researchers.

### Analysis of the quantity and trends of published papers

The annual number of articles published was calculated using the Bibliometrics Online Analysis Platform (Fig. 1A). From the time of launch until the present (1996–2024), fewer than 10 articles were published annually. The number of articles related to the risk factors for converting EPs into EC was similar every year but reached its peak in 2014. Notably, no relevant articles were published in 2006 or 2015.

Furthermore, additional examination of publications from other nations was carried out to determine which nations were engaged in this type of study. As shown in

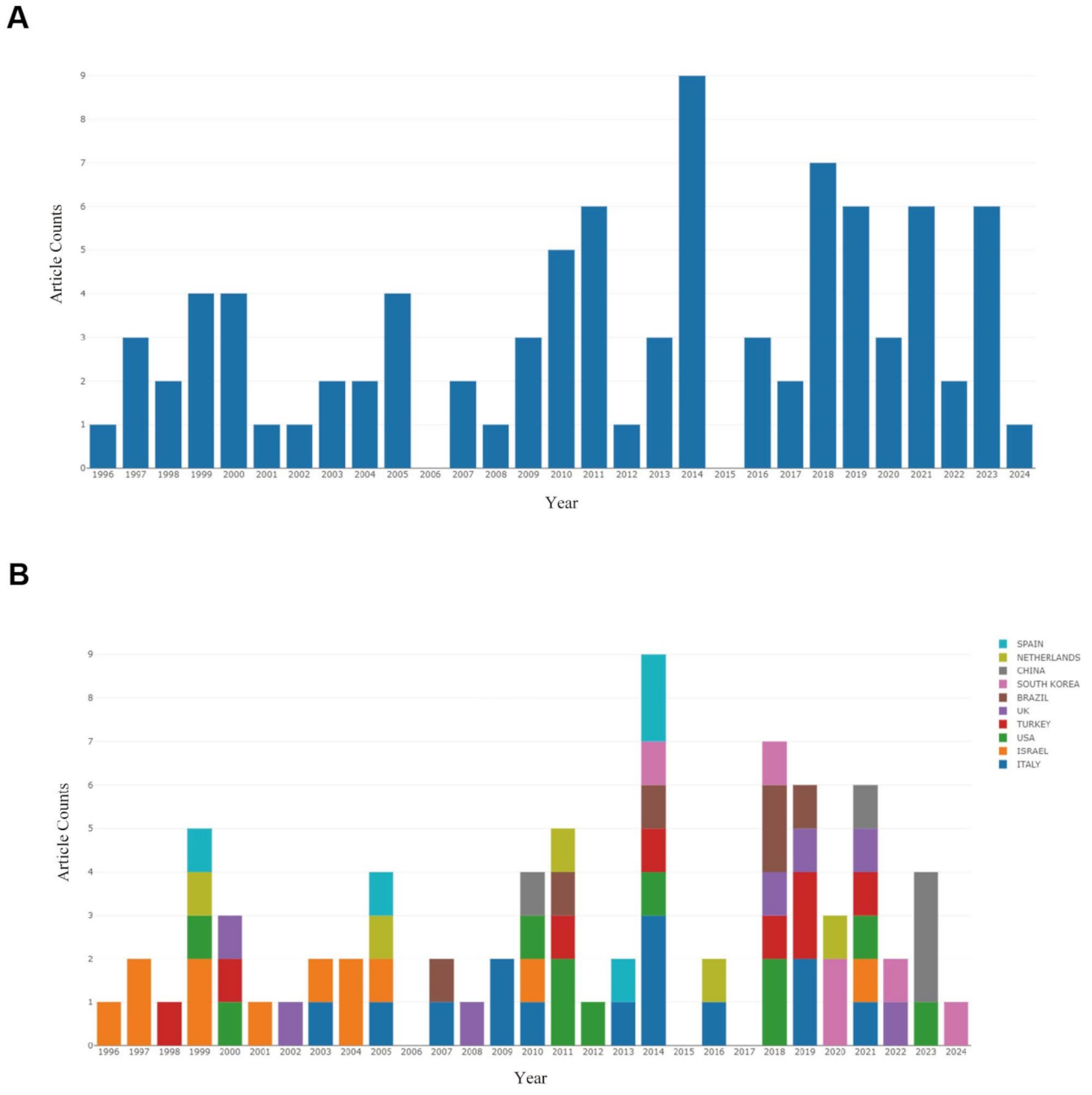


**Fig. 1** The quantity of articles on the growth pattern from beginning to July 2024 and the risk factors for EPs to EC. (**A**) The quantity and development patterns of yearly research publications; (**B**) The quantity and development patterns of yearly publications within the top 10 nations. One year total of online articles represented as a bar chart

Fig. 1B, the top 10 nations in terms of total number of papers published between 1996 and 2024 are displayed using a bar chart. Publications indicated that Spain was a leader in the subject, and it published the most articles in 2014. Since 1998, China has published articles in this field, which peaked in 2019.

### Journal analysis

For nearly 30 years starting from 1996, 90 articles in this study were published in 43 different journals, according to the results of the WoSCC search. An online bibliometric analysis was performed to look at the impact of journals. Supplementary Table 1 presents the top 10 journals by citation count. Among them, five publishers are based in the United States, and the remaining four are in the Netherlands, Denmark, Switzerland, and England. With an IF of 9.8, the American Journal of Obstetrics and Gynecology had the greatest number of citations overall (74) and the highest average quantity of references (18.50). With an IF of 4.7, Gynecologic Oncology was the journal with the greatest number of published articles (8).

### Evaluation of international and institutional collaboration

CiteSpace was used to conduct intercountry and interinstitutional analyses on research institutes and collaboration between institutions for the factors affecting the transformation of EPs into EC research, and after eliminating duplicate documents, we retained 90 published papers for the final analysis.

According to the outcomes of cooperation among regions, there are 23 connections between the 8 countries that have formed partnerships. The countries with the most publications in this area are the United States, Italy, Israel and Turkey, with Italy ranking first. Compared with the above countries, China's level of international cooperation is lower (Fig. 2 A).

Figure 2B shows the top 3 most productive institutions (threshold = 4). The quantity of publications is based on the diameter of concentric circles, and larger concentric circles are typically seen in universities that produce more articles. If two institutions are connected, it indicates that they collaborated on publications. The degree of cooperation is indicated by how boldly the lines are drawn. A total of 136 nodes and 179 linkages were discovered following an examination of the collaborations between the many universities. Organizations located in Israel, Turkey and Italy account for a large portion of the total. Tel Aviv University in Israel is the most productive institution with 7 articles and collaborates closely with other institutions. The second most productive establishments were Baskent University and the University of Roma - La Sapienza, which are based in Turkey and Italy, respectively, and the number of their articles is 4.

### Co-citation analysis of authors and documents

Cocitation analysis can provide research trends concerning the elements that influence the conversion of EPs into EC. To determine the top 8 most referenced authors and the top 10 most frequently cited sources, we conducted cited author and cited-reference studies. These results provide important hints (Fig. 3A and B). We may fully comprehend the primary authors and their contributions to a certain issue by looking at the authors' cocited networks, the strength of which indicates the authors' level of participation. The 90 original articles and 467 genuine and different references that were derived from them were analysed using CiteSpace to present the top 8 most cited authors and the top 10 most cited references on the variables influencing the conversion of EPs into EC. The author cocitation analysis yielded 1709 linkages and 418 nodes. Figure 3A displays the top 8 most-cited writers in this field of study. With 16 citations in 1996, Cohen I was the most-cited author. One of the most referenced authors in 2009 was Ferrazzi E of the University of Milan, who received 11 citations overall. The other six major research teams are also presented in Fig. 3A (Antunes A from the Hospital de Braga, Lee SC from the State University System of Florida, Dreisler E from the University of Copenhagen, Fisher B from the University of Pittsburgh, Goldstein SR from the University of California, and Costa-Paval from State University of Campinas Faculty of Medical Sciences).

Figure 3B shows the year and first author of the top 10 most-cited papers for the literature cocitation analysis. Supplementary Table 2 lists the specifics of these 10 articles. These studies span the time period from 2000 to 2012. The study published by Ferrazzi E in 2009 ranked first in citation ranking, with a citation frequency of 11. These studies have been published in several well-known obstetrics and gynecology journals, such as the American Journal of Obstetrics and Gynecology and Ultrasound in Obstetrics and Gynecology.

We also used bibliometrix codes and the R program to find additional compelling papers to support the research trend. Figure 3C and Supplementary Table 3 present the documents that have been quoted the most at the local level. The study "Histopathologic features and risk factors for benignity, hyperplasia, and cancer in endometrial polyps", published by Savelli L in 2003, achieved the highest local citation count (34 times) and global citation count (178 times), with a local to global citation ratio of 19.10%. In addition, some studies have a high ratio of local citations to global citations, such as Machtiger R's literature (35.90%) and Kassab A's literature (45.45%).

### Network clustering in coanalysis

We conducted a cluster network analysis to examine the cocited articles in further detail. Using the homogeneity

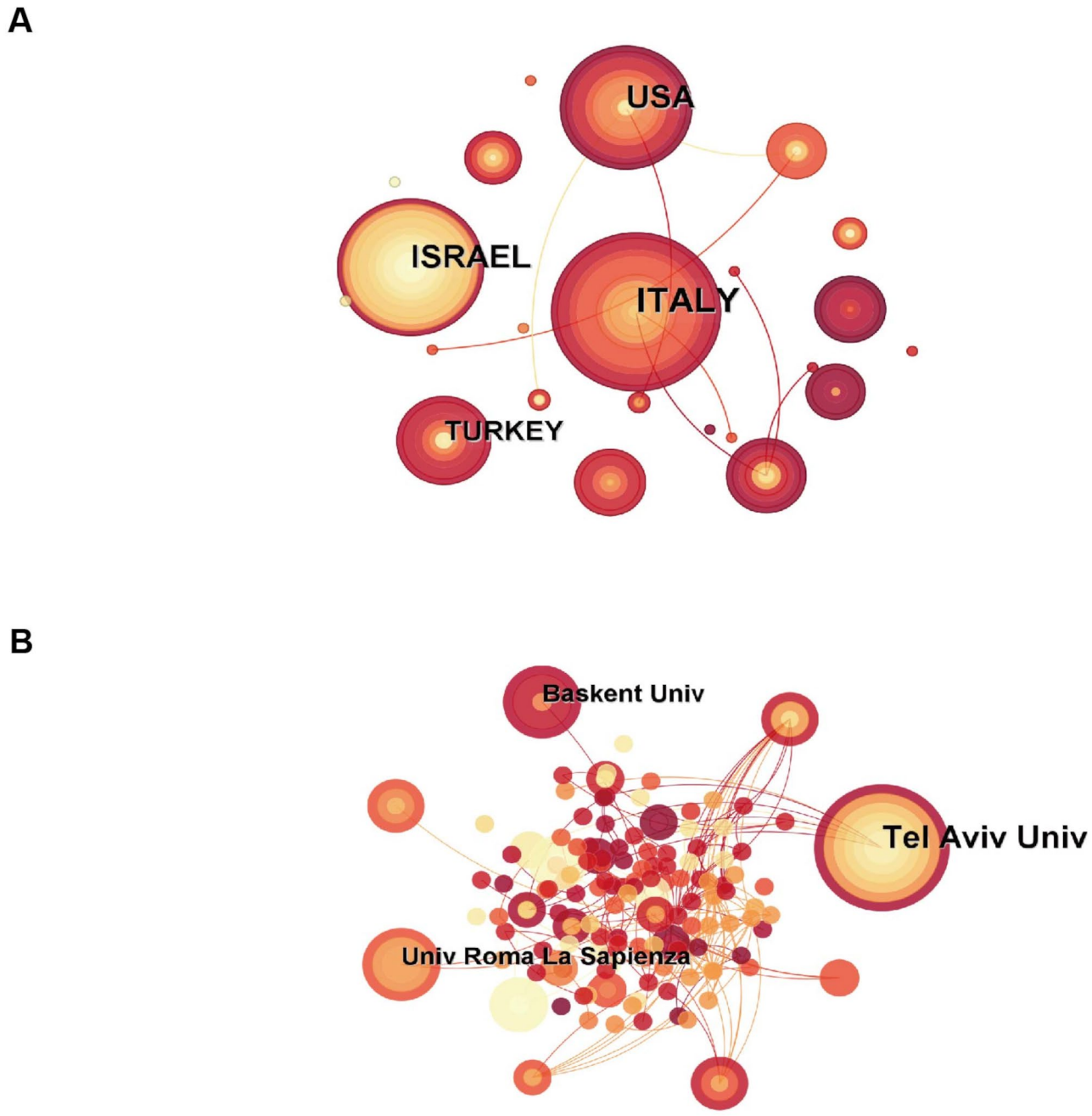


**Fig. 2** CiteSpace was used to depict a cooperation to investigate the risk factors for EPs to EC. (**A**) Intercountry cooperation; (**B**) interinstitutional cooperation. Every circle signifies a country/institution. The number of articles published by the nation or institution is positively connected with the size of the circle, and the collaboration between the two circles on a single article is shown by the link between them. There is a positive correlation between line thickness and collaboration frequency

analysis rationale, which states that publications with a large number of references are considered homogeneous, we separated the 90 articles into multiple groups. Eleven significant clusters were found after filtering using the "Show the Largest K Clusters" node (K = 25). The cocitation networks of 467 references, which were mentioned in 90 papers, were used to create these clusters. Cluster labels are important noun phrases that are retrieved from keywords using the least square filtering (LSR) technique, including #0 endometrial polyp, #1 uterine polyp, #2 asymptomatic postmenopausal breast cancer patient, #3 postmenopausal breast cancer patient, #4 distinct gene expression profile, #5 gynecologic oncology group study, #6 risk, #7 developing endometrial cancer, #8 retrospective study, #9 role, and #10 postmenopausal women (Fig. 4A). There is a negative correlation between

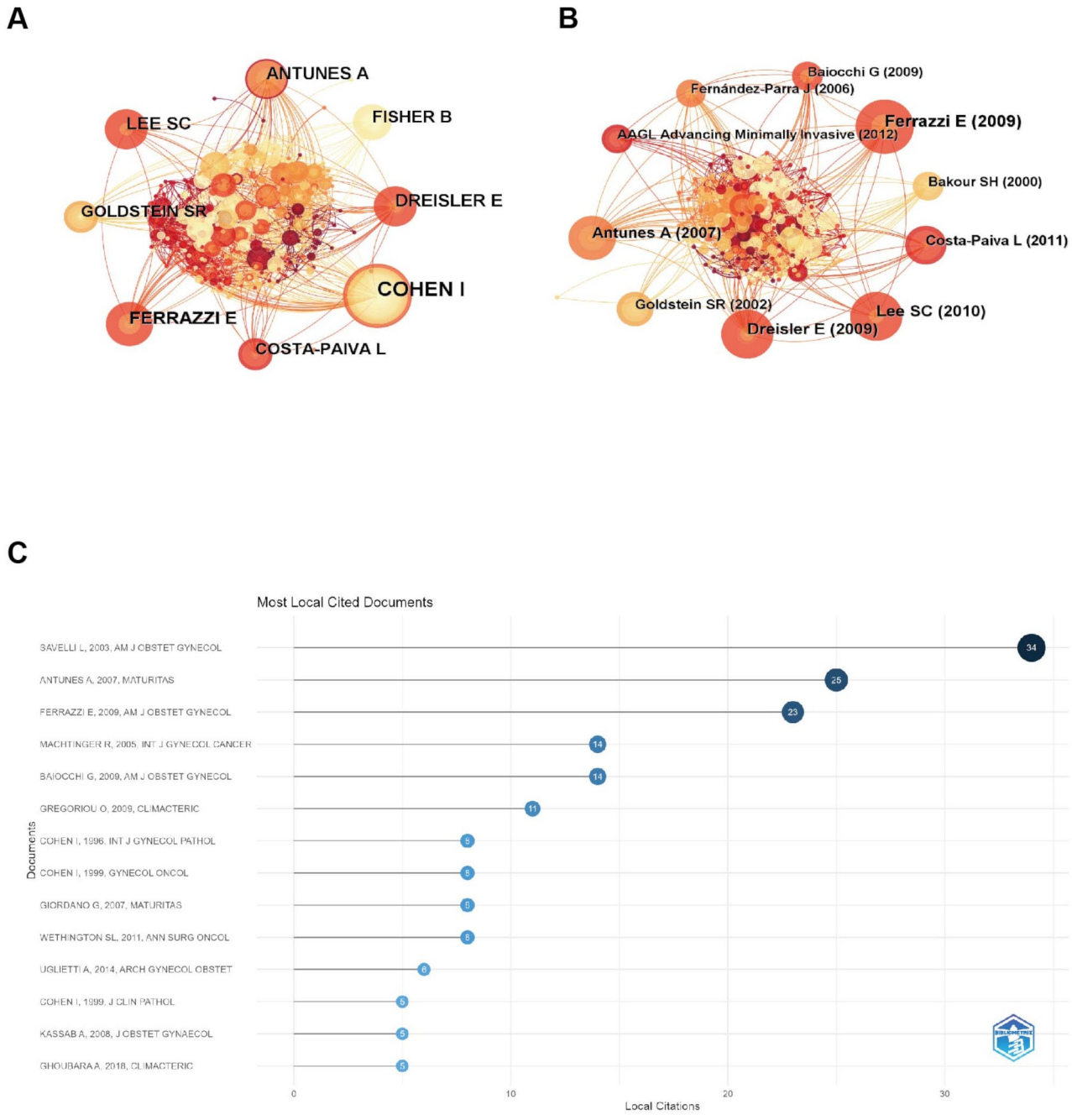


**Fig. 3** Cocited authors and cocited papers were analyzed. (**A**) Cocited author in the field of research on the risk factors for EPs to EC. Each circle represents an author. The link connecting the two circles signifies the cooperation of two authors on the same article, and the size of the circle is positively connected with the author's citation count. The frequency of collaboration is positively connected with line thickness; (**B**) Cocitation of literature on the risk factors for EPs to EC. Every circle has a reference point on it. The link connecting the two circles signifies two references referenced in the same article, and the size of the circle is positively connected with the frequency of citations. The top 10 most referenced articles' year and first author are displayed in the figure; (**C**) Most local cited documents on the the risk factors for EPs to EC

the number of cluster markers and the quantity of articles in each cluster.

Different timeline representations of the cocited material are displayed in Fig. 4B to more effectively show all of the cited research. The timeline in bold suggests that the cluster issue was very popular at present. The different-sized citation tree rings on the timeline represent some of the significant publications that received many citations. We found that in research on the factors affecting the transformation of EPs into EC, EPs were a popular subject after 2000 and peaked in approximately 2010. In 2010, many researchers explored the risk factors

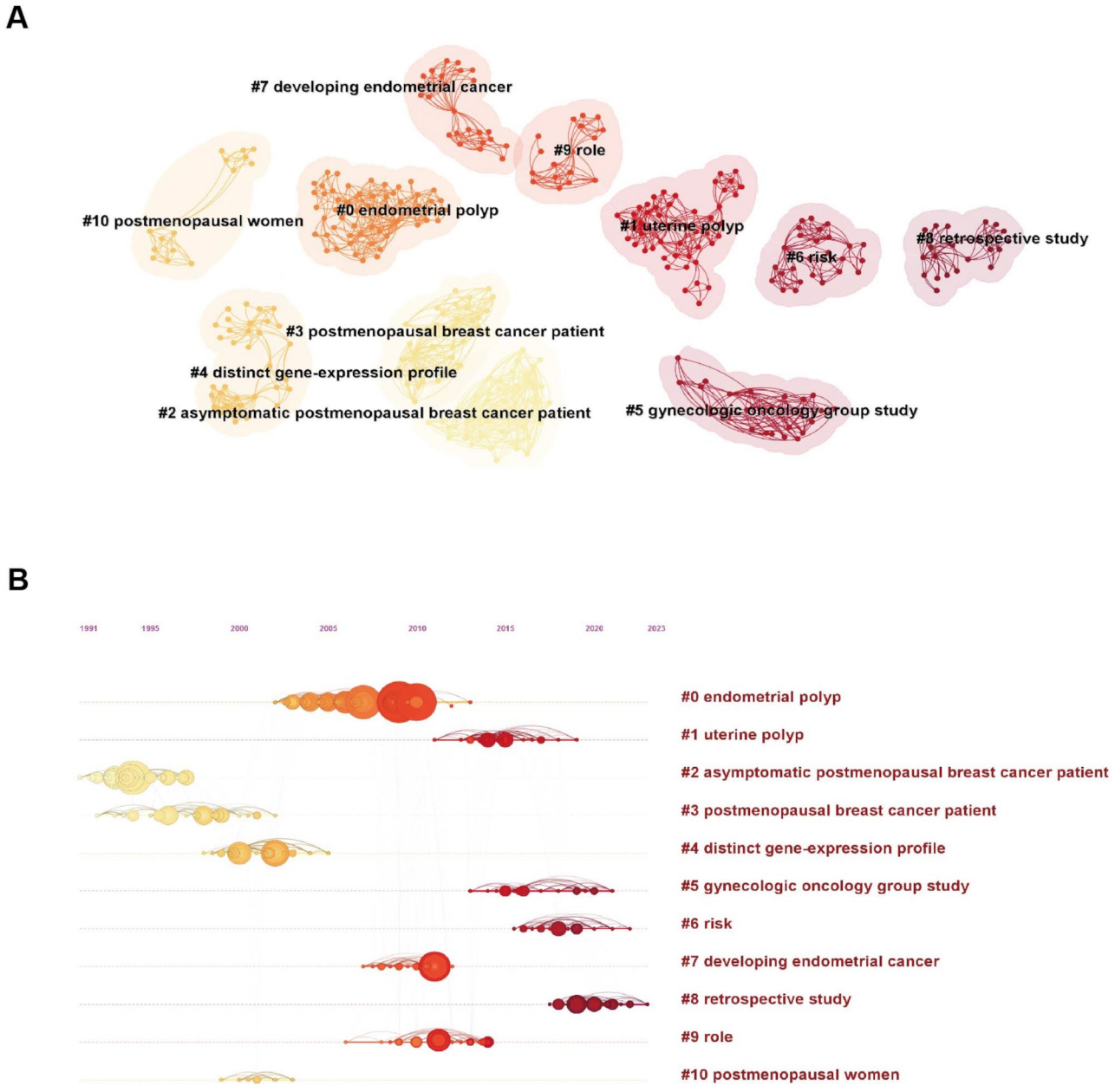


**Fig. 4** Network clustering in co-analysis. (**A**) CiteSpace cluster network of cocitation status for references and cited papers. presents the 11 largest clusters from the cited article in order; (**B**) A timeline view showcasing the article's top 11 clusters is referenced

for the transformation of EPs into EC, and subsequent studies have used mainly retrospective research methods. In addition, since 1991, researchers have focused on perimenopausal breast cancer patients while studying endometrial polyps. However, after 2000, the attention given to such patients began to decrease.

### Examination of research trends in keywords

To obtain a brief overview of the most pertinent terms and trending subjects, author keywords were utilized (the minimum word frequency was 3; the number of words per year was 2) (Fig. 5A and B).

The 20 most frequent words are obtained from biblioshiny, and after removing similar keywords and keywords that do not have a specific meaning, the remaining keywords mainly include "hysteroscopy", "postmenopausal women", "premenopausal", "therapy", "diagnosis", "patients receiving tamoxifen", "ultrasound", and "management", as Fig. 5A illustrates. The long-term management and risk prediction of EPs have emerged as new research hotspots per trend topic analysis.

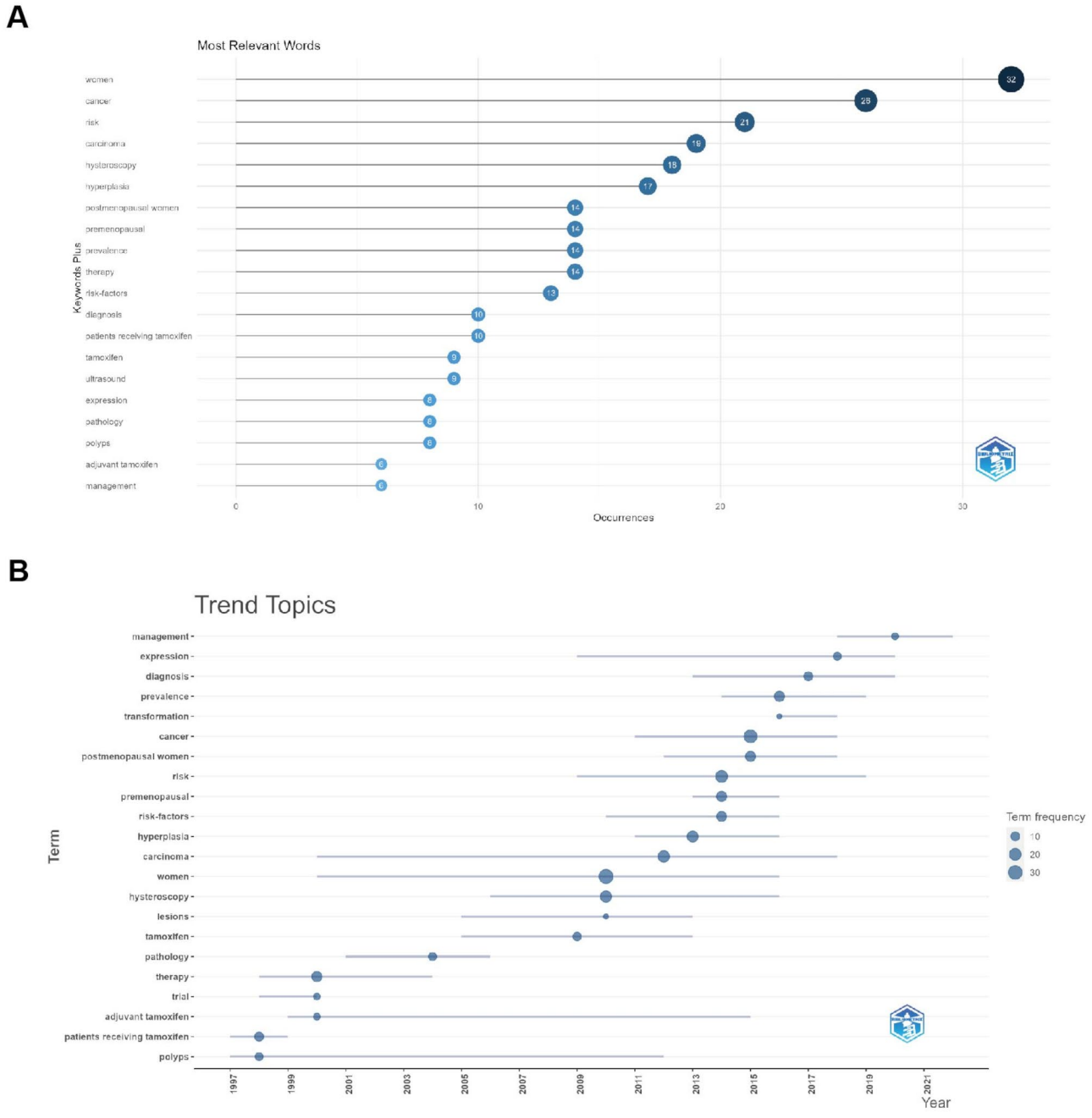


**Fig. 5** Analysis of author keywords. (**A**) The most relevant words in the top 20; (**B**) Trend topics are shown

## Discussion

Our bibliometric analysis provides a comprehensive overview of the research landscape on the risk factors for EPs progressing to EC, highlighting key trends and frequently studied factors. Three analytical tools were used to obtain a complete picture from various angles. There was no significant change in the number of articles on the topic from year to year. However, the annual total was close to nine by 2014. To improve the understanding of the most often cited works, a conversation focused on the details of the top 14 locally cited papers, which have made substantial contributions to the field's growth. Age and menopausal and postmenopausal bleeding were the two main factors used to categorize the research content. These 14 articles also presented other research findings, such as the relationships among some endocrine-related diseases, tamoxifen, hypertension, polyp size and the conversion of EPs to EC.

### Age

A review of 14 papers revealed that 5 addressed the relationship between age and the variables influencing the transformation of EPs into EC. Savelli et al. suggested that older age (average 64.4 years) might increase the risk of EC in women with EPs [14]. Machtinger et al. further supported this finding, particularly in postmenopausal women, and highlighted the utility of transvaginal ultrasound and diagnostic hysteroscopy for predicting malignancy with 79.9% accuracy [15]. Antunes et al. reported that women over 60 years old were 5.31 times more likely to have malignant polyps than were those aged 40–59 years [16]. Similarly, Gregoriou et al. reported that EP patients over 60 years of age were more likely to develop EC, with endometrioid carcinoma being the most common pathological type [17]. Uglietti et al. also reported that premenopausal patients over 50 years old were at increased risk [18]. Historically, it has been reported that women aged 60 years and older, particularly postmenopausal women, are at high risk of malignant conversion of EPs to EC, and premenopausal women over 50 years of age should also be closely monitored. However, these studies did not explore the specific mechanisms by which age affects the conversion of EPs to EC.

### Menopausal and postmenopausal bleeding

Six of the fourteen publications reported that the conversion of EPs into EC was closely associated with both menopausal and postmenopausal bleeding. Antunes et al. suggested that postmenopausal bleeding significantly correlates with malignant transformation, potentially due to impaired apoptotic function resulting from the loss of Bcl-2 expression [16]. Machtinger et al. and Baiocchi et al. further supported this link, reporting EC cases predominantly in patients with postmenopausal bleeding and a 6.5% malignant transformation rate, respectively [15, 19]. Kassab et al. reported a 10.9% prevalence of malignant polyps in such patients and recommended polyp removal [20]. Wethington et al. noted a threefold increased risk [21], and Uglietti et al. confirmed a fourfold increased risk (OR 4.0, 95% CI 1.9–8.5) in postmenopausal women with abnormal bleeding [18]. Generally, these studies revealed that among patients with EPs who experienced menopause and postmenopausal bleeding, there was a 6.5-10.9% chance of malignancy, which needs attention.

### Endocrine-related diseases and drug

Giordano et al. and Gregoriou et al. reported that diabetes was associated with the worsening of EPs [17, 22]. In 2018, Ghoubara et al. confirmed that body mass index and endometrial thickness were strongly associated with the malignant transformation of EPs. They reported that an endometrial thickness ≥ 10.8 mm and a BMI ≥ 32.5 kg/m2 increased the degree of malignancy risk by 3.5-fold and 5.5-fold, respectively, with a combined risk of 7-fold [23]. In recent studies, Iqbal et al. reported that polycystic ovary syndrome (PCOS) is also associated with EC [24]. Tamoxifen, a nonsteroidal antiestrogen used in breast cancer treatment [25], has been linked to worsening EPs. Cohen et al. reported that long-term tamoxifen use (> 48 months) increased the incidence of endometrial lesions to 30.8%, whereas it was 20.8% and 12.5% for shorter durations. They also reported a 3.0% malignancy rate in endometrial polyps among tamoxifen-treated patients, with two cases of adenocarcinoma reported [26, 27]. Postmenopausal bleeding or blood-stained discharge was more indicative of endometrial carcinogenesis in these patients [28]. The above literature discussed in detail the relationship between the deterioration of EPs and certain endocrine disorders and tamoxifen ingestion, which also needs attention. However, these studies also had little in-depth mechanistic studies, and almost all of them were clinical studies.

### Hypertension and polyp size

Hypertension has been linked to EPs progressing to EC. Savelli et al. suggested that it may affect cell growth and apoptosis [14]. Baiocchi et al. reported that 32 out of 45 cancer patients had high blood pressure in their trial [19]. Giordano et al. reported that COX-2 expression might play a role in the deterioration of EPs, but it was not linked to tumour aggressiveness or the expression of markers such as P53 and Ki67 [22]. Ferrazzi et a.i. The polyp diameter may be related to the deterioration of the EPs. They noted that polyps with a diameter of 18 mm or greater were at greater risk of histological abnormalities [29].

Notably, in these 14 studies, there is little controversy about the risk factors for age, perimenopause and postmenopausal bleeding, but there are different opinions on the risk factors for obesity, diabetes, hypertension, and tamoxifen ingestion. This may be due to different sample sizes and different patients. In other study, obesity, diabetes, oestrogen use, tamoxifen treatment, and PCOS were also the main risk factors for EC [30]. At present, many studies have been conducted on the risk factors that lead EPs to become EC, and as medicine has advanced, new research avenues have emerged that focus on managing EPs better over the long term and preventing them from recurring and becoming EC. Examples include the efficacy of drugs such as the levonorgestrel-releasing intrauterine system, drospirenone and ethinylestradiol tablets (II), and dydrogesterone in the long-term management of EPs [31]. Moreover, research has explored the pathogenesis of EC and provided new solutions for its targeted treatment [32, 33].

### Limitations

It is important to consider the limits of the current analysis. First, the data come from a single database and have not been analysed in conjunction with other databases (e.g., PubMed, Scopus), which may not be able to capture all relevant publications. Second, bibliometric analysis has citation bias and relies on publication trends, which may not fully reflect research quality and exaggerate the perceived impact of certain studies. Future research should consider the use of multiple databases and address potential biases to conduct more comprehensive studies.

## Conclusions

In patients with EPs, age, perimenopause and postmenopausal bleeding are among the most frequently studied factors in the literature. Other factors, such as PCOS and polyp size, have also received significant attention. Endometrial polypectomy and long-term management may be recommended for patients with these risk factors, and long-term management of EPs has become a new research hotspot. Other risk factors studied, including some endocrine-related diseases, such as diabetes, obesity, tamoxifen ingestion, and hypertension, are controversial in the published literature and need further research.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41043-025-00842-1.

**Supplementary table 1**: Top 10 journals in the the factors affecting the transformation of EPs into EC (sorted by total citation). Notes: EPs: endometrial polyps, EC: endometrial cancer. **Supplementary table 2**: Top 10 high-cited papers in the factors affecting the transformation of EPs into EC. Notes: EPs: endometrial polyps, EC: endometrial cancer. **Supplementary table 3**: Top 14 most local cited documents in factors affecting the transformation of EPs into EC. Notes: EPs: endometrial polyps, EC: endometrial cancer

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#### Author contributions

XG, XY and YL designed the study and management data analysis, YL, WC searched the related articles, AX, XW and YS analyzed the data and wrote the manuscript, YJ and LY revised the manuscript. All authors read and approved the final manuscript.

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#### Data availability

No datasets were generated or analysed during the current study.

## Declarations

#### Ethics approval and consent to participate

Not applicable.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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