Original Research

Global Publication Trends and Research Hotspots of the Gastric Neuroendocrine Neoplasms: A Bibliometric Analysis of the Current Situation

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ABSTRACT

Objective: Gastric neuroendocrine neoplasms (gNENs) are uncommon tumors, with growing understandings about the disease. Bibliometric analyzes have the advantage of visually depicting the dynamic evaluation of scientific knowledge of a specific topic. The aim of this study was to perform and report bibliometric analysis of gNENs, which was not formerly studied in the literature.

Methods: Articles published between 1980 and 2022 within the database of Web of Science Core Collection were included in this bibliometric analysis. Vosviewer package program and Datawrapper were used for bibliometric data interpretation.

Results: A total of 2270 articles about gNENs was detected with 63240 citations and an H index of 103. A remarkable increase was detected among the articles for years. Research have focused on gastroenterology and hepatology, endocrinology and metabolism, oncology, general medicine, pathology and surgery areas. Norwegian University of Science Technology was the leading institution about gNENs literature. Modlin IM, had the highest number of articles and citations among the authors. United States, Japan and Italy were the top three countries with the most published articles.

Conclusion: This bibliometric study provides an engrossing, insightful conclusion to the research and development trajectory in gNENs with a future perspective.

Keywords: neuroendocrine neoplasms, bibliometric, publication trends, research hotspots

INTRODUCTION

Gastric neuroendocrine neoplasms (gNENs) are uncommon tumors of the stomach, which are derived from enterochromaffin-like cells of the gastric mucosa [1]. While gNENs were called as carcinoids in the historical process, it was later classified according to different features and finally gNENs were classified as gastric neuroendorine tumors (gNETs) and gastric neuroendocrine carcinoma (gNEC) according to the tumor grade [2,3]. gNENs are seen uncommonly and represent 5%-23% of all digestive NENs, but the overall incidence of g-NENs increases with time [3,4]. A study showed that the incidence of g-NENs

increased from 0.309 to 6.149 per 1000000 persons in 40 years [5]. Changes in disease frequency and classification over years, made gNEN a target subject for studies. Formerly g-NENs were classified as three distinct subtypes, but a newly defined fourth type is also present [6,7]. It is essential to discriminate between types of g-NENs, because the prognosis, managing and treatment differ between these types. Treatment options for g-NENs are follow-up without excision, endoscopic resection, surgical resection or medical treatment depending on the tumor subtype, lesion size and number, disease extent and the differentiation of the tumor [1,3,8]. Recently, new data on new subgroups are

emerging, as well as changes in treatment and follow-up are present. Therefore, more studies about gNENs are expected in the literature.

Bibliometric was defined by Pritchard, as 'the application of mathematical and statistical methods to books and other media of communication' in 1969 and it was further defined as 'the quantitative analysis of the bibliographic features of a body of literature' by Hawkins [9,10]. Bibliometric analysis may also be defined as the measurement of all aspects related to the publication and reading of books and documents and bibliometric research are very popular in various areas in recent years [11,12]. It has the advantage of keeping abreast with the latest advances of interest within a particular scientific topic or area. Although the history of bibliometrics are quite old, it has become increasingly popular in recent years, especially in the field of medical sciences [13] To date bibliometric analyzes were performed for various gastrointestinal diseases, but a bibliometric analysis of gNENs is lacking. The aim of this study was to perform and report bibliometric analysis of gNENs, for the first time in the literature to the best of our knowledge. The objective of our study was to perform a bibliometric analysis about gNENs and we aimed to fill the gap on this subject. We believe that this study will serve as a guide for future researches about gNENs, save time to concentrate on more critical points, and make a notable contribution by directing gNENs research.

Main Points:

- The study aims to fill a gap in the literature by providing insights into publication trends, research hotspots, influential authors, institutions, and countries contributing to the field of gNENs.

- The analysis revealed a steady increase in both the number of publications and citations over the years, highlighting the growing interest and research activity in the field of gNENs. It also identified leading journals, authors, and institutions contributing to gNENs research globally.

- Additionally, correlations between publicaetion numbers and economic indicators like GDP and HDI are explored. The study concludes that bibliometric analysis serves as a valuable tool for understanding the evolving landscape of research on gNENs and guiding future studies in the field

MATERIALS AND METHODS

The search in the Web of Science Core Collection database was performed on 19.02.2023. The words "gastric neuroendocrine" or "gastric carcinoid" were used for analyze without using any exclusion criteria in all fields. No filtering was used while the search, and publications which were published between 1980 and 2022 were included in the search. Because including 2023 would cause misinterpretation, it was not included in the analysis. The numerical statistics of the publications were examined with the performance analyzes using Web of Science. The Web of Science website allows searching with certain keywords through the articles and journals indexed in the database, and the results obtained can be evaluated by analyzing characteristics such as authors, years, countries, journals in which they are published, subject headings and citations.

After the numerical statistics were extracted, visual network maps of the articles about gNENs were obtained using the Vosviewer package program (Version 1.6.17, Leiden University's Center for Science and Technology Studies). The obtained citation analyzes, co-citation and co-authorship analyzes, visual network maps of keyword analysis and the features and links of the researches were presented. The VOSviewer package program is one of the prominent analysis programs with its user-friendly interface in terms of visual mapping of bibliometric networks. With this program, downloaded data from the Web of Science website can be used to create visual maps. The networks which were detected through this program included countries, journals, institutions, authors or individual publications. Countries of origin were identified according to the first authors' affiliation. Citation numbers, keywords bibliographic matching, co-citation and co-authorship relationships can be used for the creation of these Networks [14]. Additionally, "https://app.datawrapper. de" website was used for the world map image. This website offers a free-to-use application that allows obtaining regional and worldwide maps in a wide variety of fields, from health to meteorology, and presenting visual data on these maps.

Correlation analysis between the number of articles produced by the countries and their economic and development indicators of GDP (gross domestic product), GDP PPP (purchasing power parity) and GDP per capita (data was obtained from the World Bank Group website - 2021 data) [15], and HDI (Human Development Index) (data was obtained from the United Nations Development Programme Human Development Report 2021-2022) [16] were analyzed using the Spearman correlation

coefficient. GDP is the sum of the value of all goods and services produced in a country in a given year. GDP PPP is the adjusted version of this value in order to evaluate the real purchasing power by taking into account the price differences of goods and services between countries [15]. GDP per capita is the production value of goods and services per capita obtained by dividing GDP data by the country's population [15]. HDI, on the other hand, is used as a more advanced welfare level calculation tool by including citizens' statistics such as life expectancy at birth, literacy rate, and education period in addition to the economic data of the countries [16].

A citation can be defined as a reference to an article identifying the document in which it may be found. Citation per publication was calculated by dividing the total citation to the total publications in a particular journal. The articles are divided into four groups according to their impact factor. Q1 (first quartile) represents the top 25% journals according to the impact factor for a specific subject category, Q2 the top 25% between 50%, Q3 the top 50% between 75% and Q4 lists the last 25% part according to the impact factor. The H index is defined as the number of articles (*h*) that have received at least *h* citations.

RESULTS

Publications between 1980 and 2022 were analyzed and 3269 manuscripts were found. After exclusion of reviews, 2270 articles were included for analysis. Annual productivity and citation counts increased by year gradually especially after 2010, with a slight decrease in 2022 (Figure 1).

The most popular journals by the number of articles published are given in Table 1. World Journal of Gastroenterology, Scandinavian Journal of Gastroenterology, American Journal of Surgical Pathology, Journal of Clinical Endocrinology Metabolism and Digestion published 49, 39, 30, 30 and 28 articles, respectively. The highest total citation count among journals was detected in Cancer Journal with a total citation count of 4229 (citation per document:162.65). Among the 2270 articles, 2027 items were published in journals which are indexed in Science Citation Index Expanded.

The top three authors were Modlin IM (55 articles), Waldum HL (52 articles) and Bordi C (36 articles), whereas other productive authors and citation numbers are presented in Table 2. Norwegian University of Science Technology (70 article), Yale University (62 article), National Institutes of Health USA (50 article), Uppsala University (49 article) and University of California (47 article) were the most prolific institutions.
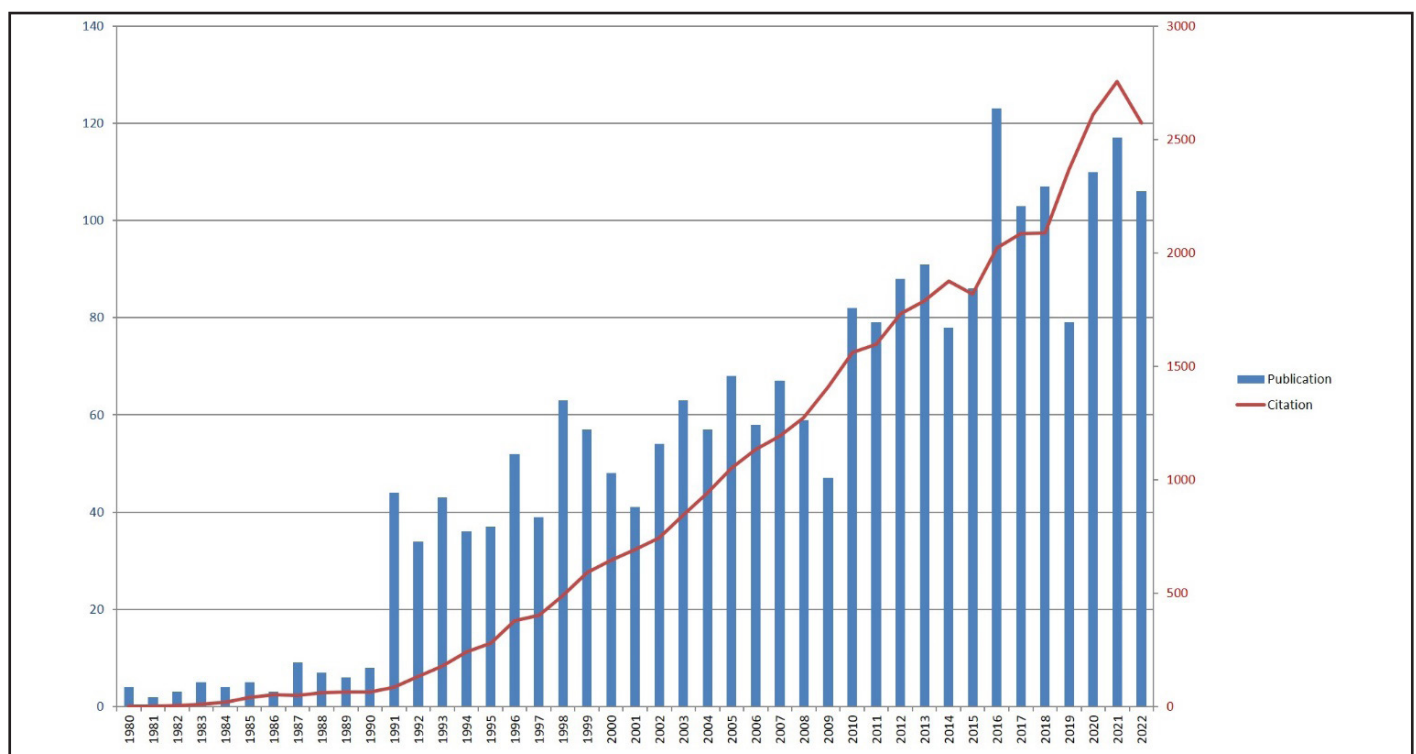

Figure 1. Annual article number and citation counts according to years from 1980 to 2022.

Table 1. Most popular journals according to the number of articles published and citation data.

Journals	Q	Publication	Citation	Citation per publication
World Journal of Gastroenterology	Q2	49	1048	21.39
Scandinavian Journal of Gastroenterology	Q4	39	1180	30.26
American Journal of Surgical Pathology	Q1	30	1792	59.73
Journal of Clinical Endocrinology Metabolism	Q1	30	2454	81.80
Digestion	Q3	28	945	33.75
Cancer	Q1	26	4229	162.65
Hepato Gastroenterology*		25	472	18.88
Medicine	Q3	23	259	11.26
Alimentary Pharmacology Therapeutics	Q1	21	787	37.48
Neuroendocrinology	Q2	21	1096	52.19
Regulatory Peptides**		21	541	25.76
Digestive Diseases and Sciences	Q3	20	559	27.95
Gastrointestinal Endoscopy	Q1	20	1864	93.20

* Hepato-Gastroenterology has been discontinued. ** Regulatory Peptides was incorporated into peptides.

Table 2. Most productive authors and their citation numbers.

Authors	Publication	Citation	Citation per publication
Modlin IM	55	4166	75.75
Waldum HL	52	1914	36.81
Bordi C	36	1978	54.94
Kidd M	36	3790	105.28
Sandvik AK	29	811	27.97
Fossmark R	27	657	24.33
Rindi G	25	2170	86.80
Solcia E	25	2237	89.48
Ahlman H	23	921	40.04
Jensen RT	23	1719	74.74
Qvigstad G	22	759	34.50
Capella C	21	1640	78.09
Delle Fave G	20	1149	57.45
Nilsson O	20	740	37.00
Huang CM	18	187	10.39
Wangberg B	18	629	34.94
Annibale B	17	532	31.29
Azzoni C	17	978	57.53
Li P	17	178	10.47
Varro A	17	508	29.88

Most of the articles were produced from the United States (586 articles), Japan (349 articles), Italy (230 articles), PR China (225 articles), Germany (178 articles), Sweden (118 articles), England (104 articles), South Korea (84 articles), Norway (78 articles) and France (70 articles) (Figure 2). Among the top 25 countries with the highest publication counts, highest citation per article numbers were achieved in Australia, Canada, France and Netherlands, respectively. Of the most prolific countries, only 3 countries had a GDP per capita level below 10000 dollars, whereas others had high GDP per capita values. The mean GDP per capita value was 43788 dollars among the top 25 countries. The correlation analysis between publication numbers and GDP, GDP PPP, GDP per capita and HDI showed that publication numbers increase with increased GDP, GDP PPP, GDP per capita and HDI (r: 0.811, 0.674, 0.521 and 0.516, respectively. p<0.001 for all parameters).

The total citation number of articles about gNENs was 63240, with an H index of 103. The average citation per item was calculated as 27.86. The most cited manuscript about gNENs was "A 5-decade analysis of 13,715 carcinoid tumors" which was written by Modlin IM in 2003 [17].

The top five indexed keywords except the term "neuroendocrine tumor" were: stomach, gastric cancer, carcinoid, immunohistochemistry and gastrin. Scientometric network analysis of the keywords is presented in Figure 3.

The citation network analysis included 30 countries with over 10 articles and 10 citations, which had the highest connection rates, and the network analysis is given in Figure 4. Similarly, the citation network analysis of institutions and authors with more than 5 articles and 5 citations are shown in Figure 5.
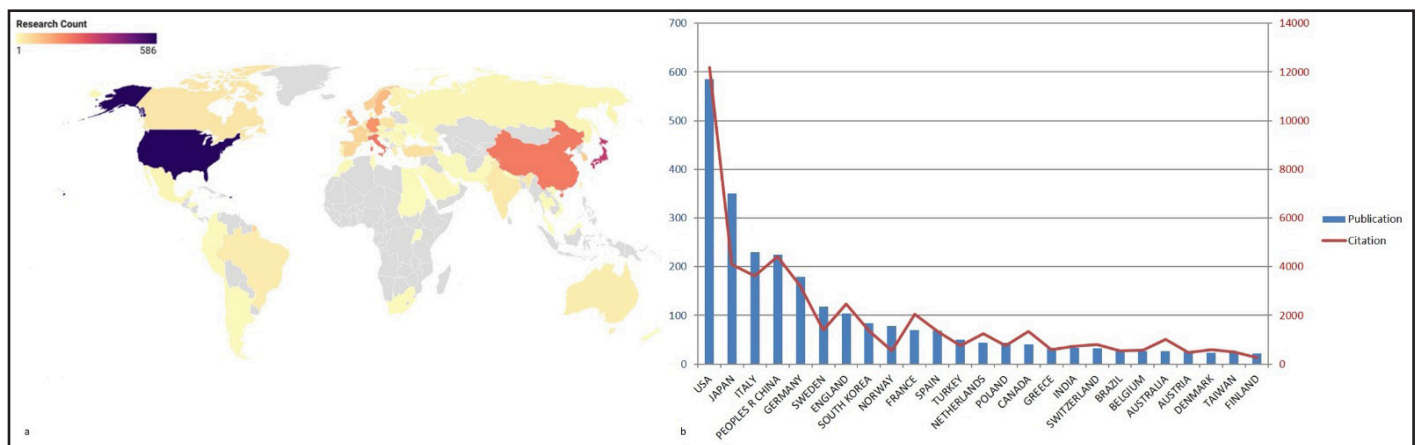

Figure 2. The most prolific countries in the field of gastric neuroendocrine tumors. a) The countries are shown in the world map, b) Top 25 countries according their publication number and citation counts of these countries.
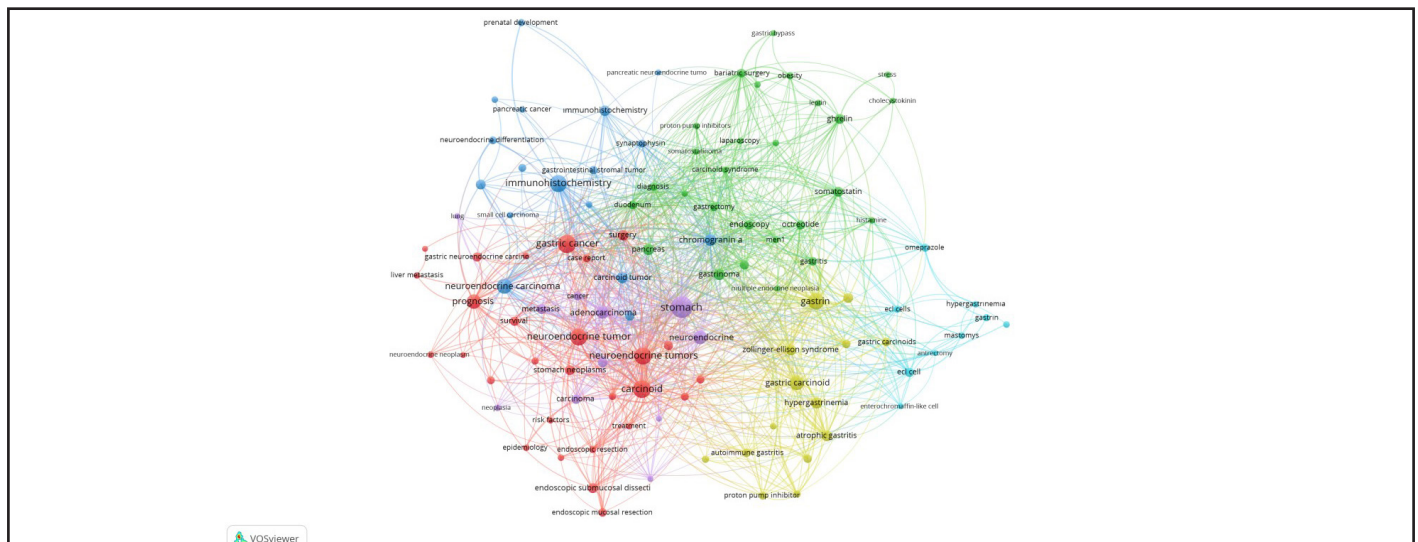

Figure 3. Scientometric network analysis of the mentioned keywords in articles about gastric neuroendocrine neoplasia.
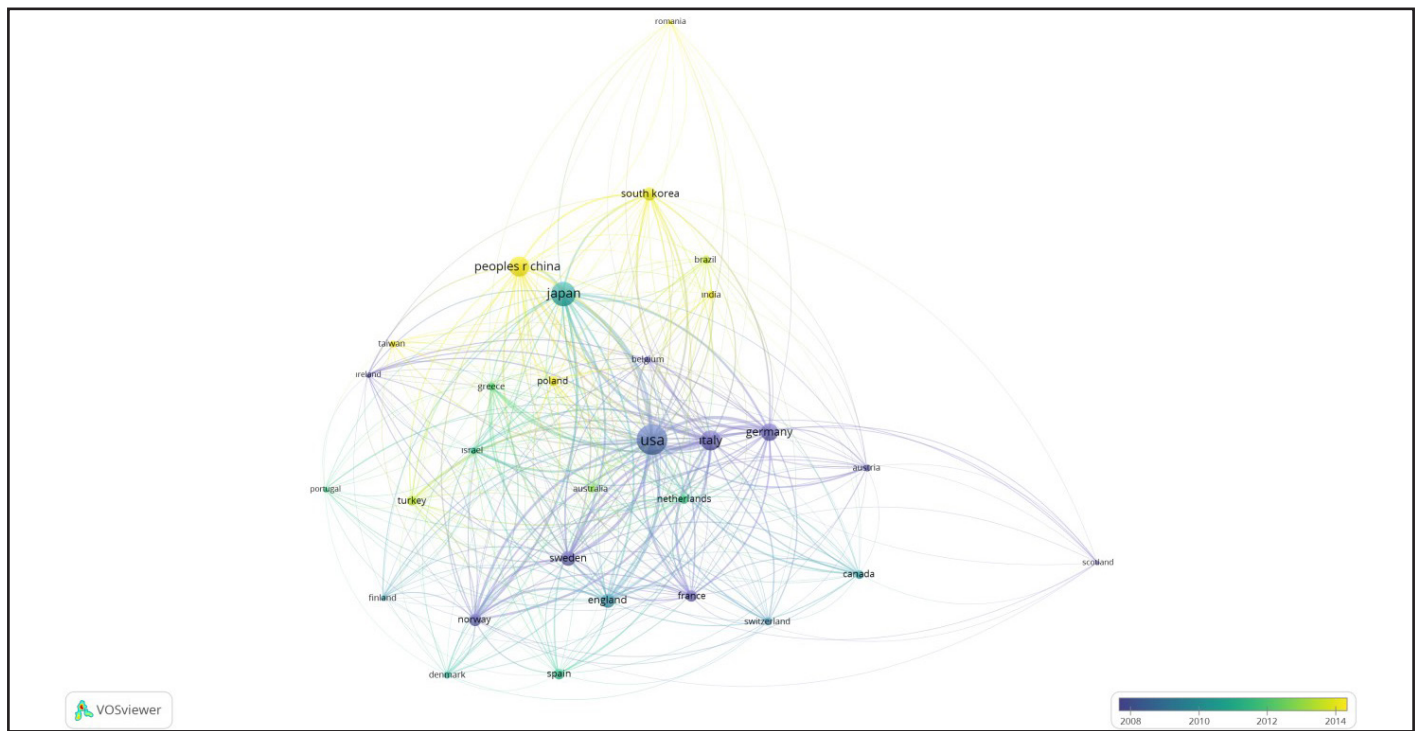
Figure 4. The citation network analysis including 30 countries with over 10 articles and 10 citations, which had the highest connection rates. Lighter colors indicate more recent studies.
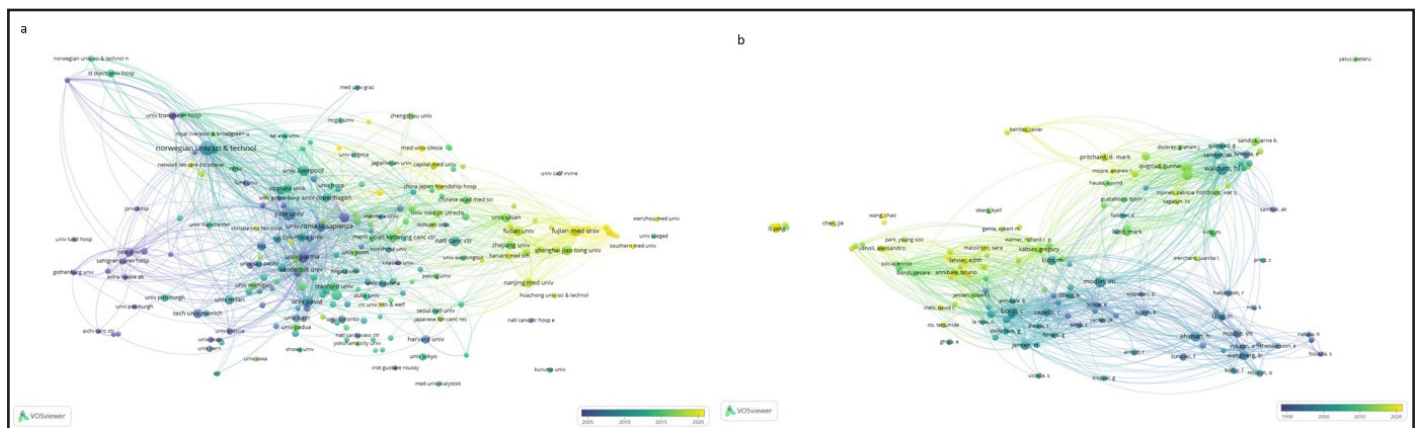

Figure 5. The citation network analysis of institutions and authors with more than 5 articles and 5 citations. Lighter colors indicate more recent studies.

DISCUSSION

Bibliometric analysis, which is a computer-based procedure in which all available publications on a subject are analyzed, benefits future studies by providing guidance based on previous data [18]. Bibliometric analysis, which is a computer-based procedure in which all available publications on a subject are analyzed, benefits future studies by providing guidance based on previous data [17]. Bibliometric analyses can be used by current researchers to save time. In this study, leading countries, organizations, authors, journals, hotspots, and trends in gNENs research were identified through a search of the Web of Science Core Collection database and VOSviewer to produce a thorough summary of the progress of gNENs research over the last 40 years. To the best of our knowledge, this study is the first bibliometric analysis of the existing gNENs literature.

Although the existence of gNENs was established more than a century ago, many new studies on the subject are being published, and ongoing scientific development in this area continues. In particular, the nomenclature, classification, treatment, and follow-up options for patients with gNENs are of great interest [3]. This data is supported by our analysis, which showed an increase in the number of articles and citations over the years. The number of citations is the basis of bibliometric analysis, and a relatively high number of citations per item was seen in our analysis [19]. The article most often cited was a large epidemiology series that included NENs written by Modlin IM [17]. Modlin IM was also found to be the most productive author, having published the most articles (55 articles) gNENs.

Most of the journals publishing articles on gNENs were indexed in Science Citation İndex Expanded. The top ten most popular journals were found to have high impact factors of Q1 (first quartile), representing the top 25% of journals, or Q2, representing the top 25% to 50%. The high number of Q1 and Q2 journals shows that there is considerable interest in the study of gNENs. Among the 11 most popular currently publishing journals, six belong to the category of gastroenterology and hepatology, two to endocrinology and metabolism, and one each to general medicine, oncology and pathology, and surgery. The fact that studies on gNENs have been published in journals from diverse categories shows the breadth of interest in the topic. The World Journal of Gastroenterology published the most articles on gNENs, which may be the result of its weekly publishing schedule. The journal most often cited was Cancer, which is a Q1 journal in the field of oncology.

The countries found to be leading in the publication of studies on gNENs were the United States, Japan, Italy, China, and Germany. The highest citation-per-article values were achieved in Australia, Canada, and France. Among the top 25 countries with the highest number of articles published, 16 are located in Europe, 5 in Asia, 2 in North America, 1 in South America, and 1 in Australia. No country in Africa placed in the top 25 countries. Publication counts were found to positively correlate with GDP and HDI. It is a fact that high income level creates more opportunity for further research. Another issue is that upper gastrointestinal endoscopy, which is the diagnostic method of gNENs, is an invasive method with relatively higher cost. Easy access to endoscopic facilities in higher income countries may be another reason for higher numbers of articles.

This study also determined the institutions with the greatest levels of production and their network analyses. The Norwegian University of Science Technology was the leading institution in the field of gNENs articles. Among the five highest-producing institutions, three are located in the United States and one each in Norway and Sweden.

Limitations

We have to mention some limitations of the study. Probably some articles may be missed during the search of the articles, because their titles or keywords did not comprise the selected keywords. Our study contained articles which are indexed in Web of Science Core Collection and other indexes were not searched. But Web of Science was used because it is the most reliable database indexing high quality journals with high impact factors. Although not containing other indexes we think that Web of Science would be sufficient for this analysis because we performed this bibliometric analysis with a satisfactory number of articles (2270 articles). Another limitation is that the countries were determined according to the first author, but some articles may have international cooperation. These limitations do not hinder our bibliometric results on the topic of gNENs, which is not formerly published in the literature.

CONCLUSION

This study examines global research trends on gastric neuroendocrine neoplasms (gNENs) from 1980 to 2022, revealing a rise in publications. The United States, Japan, and Italy are leading contributors, with the Norwegian University of Science Technology as a prominent institution. Prolific authors include Modlin IM, and high-impact journals in gastroenterology feature prominently. The analysis suggests a positive link between research output and economic indicators. Despite limitations, this study offers valuable insights for guiding future research on gNENs.

Ethical Approval: Ethical Approval was not taken because the study did not involve human participants.

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