

## R E V I E W

# Research productivity in the genetics of papillary thyroid carcinoma (1991-2020): a bibliometric analysis

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**Abstract.** *Background and aim:* Papillary thyroid carcinoma accounts for 85% of thyroid follicular epithelial-derived cancers. The identification of pathogenetic mechanisms improved the understating of papillary thyroid carcinoma pathogenesis. The current study aims to examine the research productivity and trends in the genetics of papillary thyroid carcinoma from 1991 to 2020. *Methods:* The Web of Science Core Collection database was searched to retrieve the relevant literature. A search string was applied and 1,741 relevant records were selected for the analysis. Bibliometric techniques were used in the statistical analysis with the help of Biblioshiny (RStudio). *Results:* The growth in the number of publications was observed to be over a hundred publications per year since 2015. 'Thyroid' published the highest number of publications, followed by 'Journal of Clinical Endocrinology & Metabolism'. 'Nikiforov YE' was identified as the most productive researcher with a total of 49 publications. Out of the top 20 most contributing researchers, seven belonged to Italy, and four were from the USA. 'University of Pittsburgh' contributed the highest number of publications. The top contributing countries in this field were the USA, China, and Italy. BRAF and RAS were among the frequently used keywords. *Conclusions:* This bibliometric review demonstrates that investigating the genetics underlying papillary thyroid carcinoma is a rapidly growing area of research. During the last two decades, China has been a significant contributor to the field. Besides, institutions in the USA and Italy have significantly contributed to research in the genetics of papillary thyroid carcinoma. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** papillary thyroid carcinoma, genetics, oncology; bibliometrics, scientometrics

## Introduction

Papillary thyroid carcinoma is a differentiated thyroid cancer, which accounts for 85% of thyroid follicular epithelial-derived cancers. According to the Surveillance, Epidemiology, and End Results (SEER) database (1975 to 2012), the incidence of papillary

thyroid carcinoma had tripled from 4.8 to 14.9 per 100,000. Based on 2014-2018 data, the incidence of thyroid cancer was 15.5 per 100,000 persons (1). Although the 5-year relative survival reaches up to 98.3% (1), distant metastases, and gross invasion of surrounding neck structures are possible consequences, which may occur in about 5% of patients (2). Critical

pathogenetic mechanisms in the development and progression of differentiated thyroid cancer are the mutations in the genes encoding for the proteins involved in the mitogen-activated protein kinase (MAPK) pathway (3, 4). The understanding of pathogenetic mechanisms underlying the initiation of thyroid cancers, including papillary carcinoma, could be utilized to invent ancillary therapeutic targets.

Evaluation of thyroid cancer scientific productivity, collaboration, and trends could delineate the current state and serve as guidance for future directions. In recent bibliometric analysis, the global progress from 1991-2020 in the field of thyroid cancer was evaluated. The study demonstrated that the research productivity about thyroid cancers is steadily expanding, with the majority of research dedicated to papillary thyroid carcinoma (5). Furthermore, the trends of papillary thyroid carcinoma research were evaluated by Huang *et al.*, where it has been demonstrated that productivity is rapidly growing with biological mechanisms being an area of great interest (6). Bibliometric analysis regarding the genetics of papillary thyroid carcinoma has, to the best of our knowledge, not been conducted. Therefore, the current study aims to examine the productivity and trends of the genetics of papillary thyroid carcinoma research from 1991 to 2020.

## Objectives

The primary objective was to examine the following components related to evaluating the research productivity and citation trends in the genetics of papillary thyroid carcinoma from 1991 to 2020:

1. Annual scientific research output in the genetics of papillary thyroid carcinoma
2. Most influential sources, organizations, and countries in the genetics of papillary thyroid carcinoma research
3. Most prominent authors in the field of the genetics of papillary thyroid carcinoma research
4. Researchers' authorship and collaboration trends in the field of the genetics of papillary thyroid carcinoma
5. Most used keywords in the genetics of papillary thyroid carcinoma research

## Methodology

For this study, a total number of bibliographic records, 2,338, were extracted from the Web of Science Core Collection (WOSCC) database, with the date range from January 1<sup>st</sup>, 1991, to December 31<sup>st</sup>, 2020. Data were downloaded on April 6<sup>th</sup>, 2021. Researchers checked 2,338 records one by one and excluded 597 irrelevant records. Finally, 1,741 relevant records were selected for the analysis. Bibliometric techniques were used in the statistical analysis with the help of Biblioshiny (RStudio) open-source software as well as MS Excel, MS Access, and VOS Viewer. The study investigated the annual scientific research output, most influential countries and organizations, most prominent authors and their contributions, most relevant sources, and commonly used papillary thyroid cancer genetics research keywords.

Web of Science (WOS) is one of the most reliable and consistent indexing and abstracting databases utilized by researchers around the globe, with wall-to-wall coverage; with a slogan, "The Discovery Starts Here" (7-9).

Boolean operators OR and AND were used to combine keywords to obtain the most relevant and maximum results. Furthermore, data were collected by searching through a list of keywords - "TS=((“papillary carcinoma”) OR (“papillary thyroid carcinoma”) OR (“papillary thyroid cancer” )) AND TS=( molecular OR genetics OR epigenetics OR miRNA OR “genetic alteration\*” OR “molecular biomarkers” OR “genetic signature\*” OR “genetic marker\*” OR “genetic diagnostics” OR “gene therapy\*” ); refined by: [excluding] PUBLICATION YEARS: (2021) AND [excluding] DOCUMENT TYPES: (EARLY ACCESS OR CORRECTION OR BOOK CHAPTER OR MEETING ABSTRACTS OR NOTE ). The research keywords were designed to cover a wide range of publications on the genetics of papillary carcinoma OR papillary thyroid carcinoma OR papillary thyroid cancer.

## Results

### 4.1 Yearly growth and citations in the genetics of papillary thyroid cancer research

The yearly growth and citations wise distribution of the genetics of papillary thyroid cancer research is shown in **Figure 1**. The data depicts that the topic did not get the attention of the researchers at the beginning, with only single-digit publications from 1991 to 1995 with a gap of publication in the year 1993. From 1996 to 2014, the growth in publications remained in a two-digit number. The growth in the number of publications was observed to be approximately over hundred publications from 2015 to 2020. The year 2020 contributed the highest number of publications. The citation wise analysis ranked the year 2006 as the top year with the highest number of citations followed by 2014, 2005, and 2010.

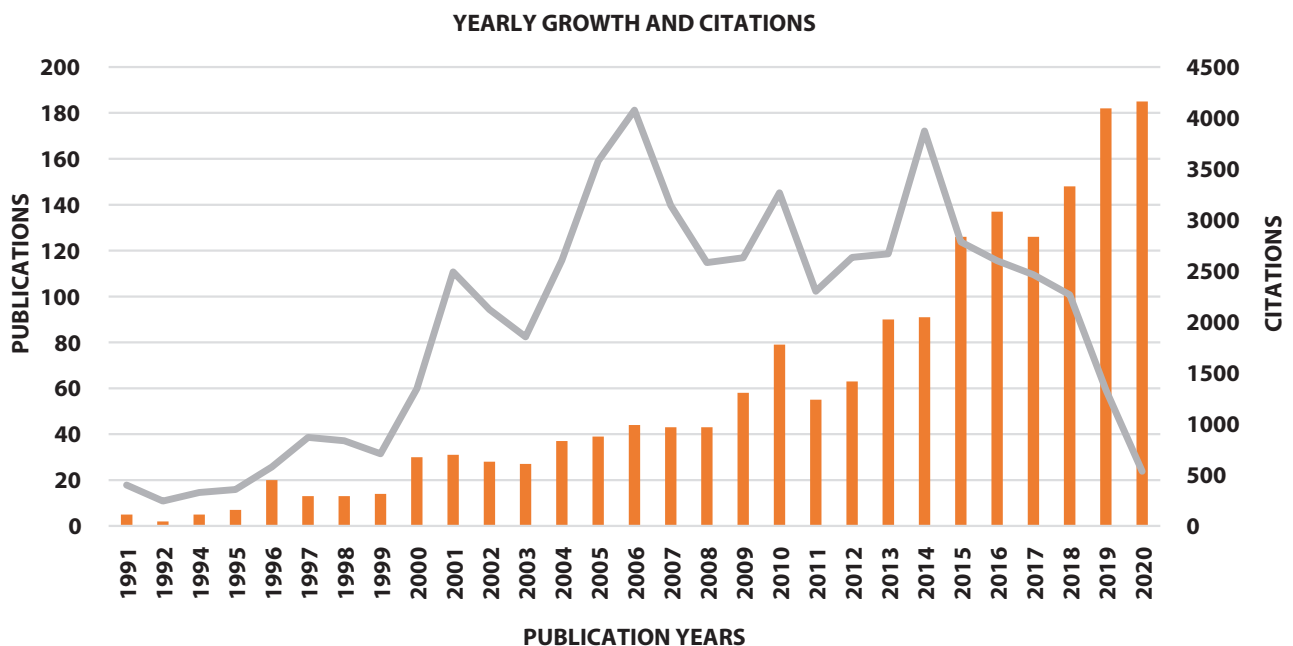
### 4.2 Most preferred document types

The most preferred document types by the researchers on the topic are shown in Table 1. The analysis disclosed the document type 'Article' as the most

preferred type chosen by the researchers for publishing their research, followed by document types 'Review' and 'Article; Proceedings Paper'. Likewise, the citation-wise analysis also presented the same trend. The document type 'Article' secured the highest number of citations distantly followed by 'Review' and 'Article; Proceedings Paper'. Although the least number of researchers preferred the document type 'Letter', it obtained more citations than 'Proceedings Papers'.

**Table 1.** Document types

Document type	Number of publications	Percent	Citations
Article	1,454	83.51	46,371
Article; Proceedings Paper	46	2.64	1,998
Editorial Material	15	0.86	234
Letter	3	0.17	17
Proceedings Paper	12	0.69	7
Review	211	12.12	8,851
<b>Total</b>	<b>1,741</b>	<b>100.00</b>	<b>57,478</b>



**Figure 1:** Yearly growth and citations of the genetics of papillary thyroid cancer research

#### 4.3 Authorship pattern in the genetics of papillary thyroid cancer research

The data in Figure 2 presents the authorship pattern of the researchers on the topic, and it ranges from single author to two hundred forty-three author patterns. The seven-author pattern emerged as the most favorite pattern in the collaborative research on the topic with 205 publications, followed by six and five author patterns with 200 and 192 publications, respectively. Further analysis revealed that eight to ten authored patterns each contributed over a hundred publications. Interestingly, one publication was collaborative research of two hundred forty-three authors.

#### 4.4 Most productive sources for the genetics of papillary thyroid cancer research

Table 2 ranks the most favorite sources (journals) preferred by the researchers on the topic for publishing their research. The journal ‘Thyroid’ ranked at the top of the list by publishing the highest number of documents, followed by ‘Journal of Clinical Endocrinology & Metabolism’ and ‘Endocrine Pathology’.

The analysis ranked simultaneously three sources at the eighth, two sources at the ninth, three sources at the eleventh, and two sources at the thirteenth positions, due to an equal number of publications. The data also highlighted publication sources that did not receive any citation. In this regard, ‘Cancer Cytopathology’ and ‘Surgery’ had one publication each without any citation. The citation-wise analysis also ranked the source ‘Journal of Clinical Endocrinology & Metabolism’ at the top position, followed by ‘Thyroid’ and ‘Endocrine Pathology’.

#### 4.5 Most prolific authors and their impact

The most prolific researchers on the topic are listed in Table 3. It is evident from the data that out of the top 20 most contributing researchers, seven belonged to Italy, and four were from the USA. Researcher ‘Nikiforov YE’ from the University of Pittsburgh, Pennsylvania, USA, secured the top position with 49 publications, followed by three Italian researchers, ‘Santoro M’ and ‘Fusco A’ from the University of Naples Federico II, and ‘Basolo F’ from the University of Pisa. Researchers ‘Asa SL’, ‘Zhang L’, and ‘Carty SE’

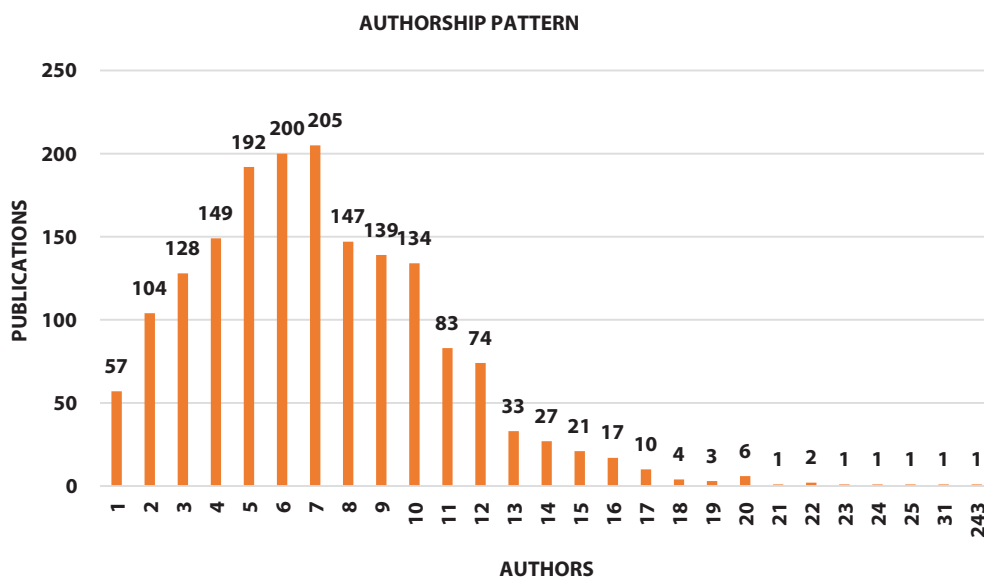


Figure 2. Authorship pattern of the genetics of papillary thyroid cancer research

**Table 2.** Top 20 sources of publication for the genetics of papillary thyroid cancer research

Rank	Source (N=452)	TP	TCP	TC	TC/TP	TC/TCP	PY start
1	Thyroid	81	81	2,961	36.56	36.56	1997
2	Journal of Clinical Endocrinology & Metabolism	74	74	5,923	80.04	80.04	1996
3	Endocrine Pathology	47	47	1,348	28.68	28.68	1997
4	Endocrine-Related Cancer	32	32	1,542	48.19	48.19	2005
5	Oncotarget	26	26	626	24.08	24.08	2010
6	Cancer Cytopathology	24	23	654	27.25	28.43	1999
7	PLoS One	20	20	541	27.05	27.05	2009
8	Oncogene	19	19	1,981	104.26	104.26	1991
8	Modern Pathology	19	19	1,514	79.68	79.68	1991
8	Surgery	19	18	437	23.00	24.28	1995
9	European Journal of Endocrinology	18	18	689	38.28	38.28	1996
9	International Journal of Oncology	18	18	290	16.11	16.11	1994
10	American Journal of Surgical Pathology	17	17	954	56.12	56.12	1996
11	Cancer Research	16	16	2,273	142.06	142.06	1995
11	Clinical Cancer Research	16	16	1,457	91.06	91.06	1998
11	Human Pathology	16	16	397	24.81	24.81	2000
12	Histopathology	14	14	414	29.57	29.57	1997
13	Journal of Pathology	13	13	906	69.69	69.69	1996
13	Molecular and Cellular Endocrinology	13	13	629	48.38	48.38	2010
14	Cancer	11	11	853	77.55	77.55	1999

TP = Total publications; TCP = Total cited publications; TC = Total citations; PY = Publication year

each had one publication that could not get any citation. The citation-wise analysis also ranked 'Nikiforov YE' at the top position with 5,809 total citations, followed by 'Fusco A', 'Santoro M', and 'Xing MZ', each securing over 3000 total citations. The analysis regarding citation impact (TC/TP) ranked 'Xing MZ' at the top position, followed by 'Asa SL', and 'Carty SE'.

#### 4.6 Top highly-cited documents in the genetics of papillary thyroid cancer research

Table 4 presents the highly-cited documents on the topic. The data reported only one document with over 1000 citations. The analysis ranked 'Agrawal N, 2014, Cell' at the top position securing the highest

total citations (1336) followed by 'Cibas ES, 2009, Am J Clin Pathol' and 'He HL, 2005 Natl Acad Sci USA'. The data equally ranked 'Xia T, 2014, Sci Rep-UK' and 'Takahashi M, 2001, Cytokine Growth F R' in the fifteenth position due to the same number of citations secured. Similarly, documents 'Zhu ZW, 2003, Am J Clin Pathol' and 'Nikiforov YE, 2002, Endocr Pathol' were ranked in the sixteenth position due to the same number of citations.

#### 4.7 Top contributing countries

Table 5 shows the top countries contributing research on the topic. The analysis reported Europe and Asia as the most contributing continents. The

**Table 3.** Top 20 contributing authors and their impact

Author (n=7,874)	Affiliation	Country	TP	TCP	TC	Citation impact (TC/TP)	h index	PY start
Nikiforov YE	University of Pittsburgh, Pennsylvania	USA	49	49	5,809	118.55	32	1998
Santoro M	University of Naples Federico II	Italy	32	32	3,109	97.16	25	1992
Fusco A	University of Naples Federico II	Italy	30	30	3,336	111.20	26	1992
Basolo F	University of Pisa	Italy	25	25	1,503	60.12	16	2000
Sobrinho-Simoes M	University of Porto	Portugal	25	25	1,188	47.52	18	2000
Miccoli P	University of Pisa	Italy	23	23	1,284	55.83	15	1999
Nikiforova MN	University of Pittsburgh, Pennsylvania	USA	22	22	1,791	81.41	16	2001
Soares P	Universidade do Porto	Portugal	22	22	1,077	48.95	16	2002
Yamashita S	Nagasaki University	Japan	20	20	476	23.80	13	1994
Tallini G	University of Bologna	Italy	18	18	2,201	122.28	15	1998
Asa SL	University Health Network	Canada	17	16	2,804	164.94	13	2000
Fugazzola L	Università degli Studi di Milano	Italy	17	17	1,019	59.94	12	1995
Jung CK	The Catholic University of Korea	South Korea	17	17	634	37.29	12	2012
Elisei R	University Hospital of Pisa	Italy	16	16	1,212	75.75	12	1997
Jarżab B	Maria Skłodowska-Curie Institute–Oncology Centre	Poland	16	16	669	41.81	13	2001
Xing MZ	Johns Hopkins University	USA	16	16	3,086	192.88	16	2003
Yip L	University of Pittsburgh, Pennsylvania	USA	16	16	1,112	69.50	13	2009
Zhang L	Huazhong University of Science and Technology Wuhan	China	16	15	251	15.69	10	2008
Bae JS	The Catholic University of Korea	Korea	15	15	394	26.27	12	2010
Carty SE	Concordia University	Canada	15	14	2,353	156.87	13	2009

TP = Total publications; TCP = Total cited publications; TC = Total citations; PY = Publication year

country-wise analysis reported USA as the top contributing country with 432 publications, closely followed by China with 404 publications, and distantly by Italy with 256 publications in the third position. India, Israel, and Russia ranked at the bottom of the list with 24, 23, and 20 publications, respectively. USA outclassed all countries in securing citations and maintained the top position in terms of citations. Italy secured the second position with 11,273 citations, followed by China with 6,225 citations. Iran held the last position with only 277 citations.

#### 4.8 Most productive organizations

The most productive organizations are presented in Table 6. The data revealed an outstanding contribution by organizations from USA as eight organizations were from USA, whereas three organizations were from China, two from Italy and South Korea each. The data ranked ‘University of Pittsburgh’ from USA at the top position in producing the highest number of publications, followed by ‘University of Pisa’ and ‘University of Naples Federico II’, both from Italy. ‘Catholic

**Table 4.** Most cited documents in the genetics of papillary thyroid cancer research

Documents (n=1,741)	TC	CY	TCPY
Agrawal N, 2014, Cell	1336	7	190.86
Cibas ES, 2009, Am J Clin Pathol	968	12	80.67
He HL, 2005, P Natl Acad Sci USA	943	16	58.94
Xing MZ, 2005, J Clin Endocr Metab	678	16	42.38
Xing MZ, 2007, Endocr Rev	673	14	48.07
Brzezianska E, 2006, Mutat Res-Fund Mol M	643	15	42.87
Kondo T, 2006, Nat Rev Cancer	629	15	41.93
Carlomagno F, 2002, Cancer Res	490	19	25.79
Elisei R, 2008, J Clin Endocr Metab	359	13	27.62
Xu XL, 2003, Cancer Res	355	18	19.72
Adeniran AJ, 2006, Am J Surg Pathol	351	15	23.40
Capper D, 2011, Acta Neuropathol	347	10	34.70
Huang Y, 2001, P Natl Acad Sci USA	343	20	17.15
Kebebew E, 2007, Ann Surg	317	14	22.64
Xia T, 2014, Sci Rep-UK	307	7	43.86
Takahashi M, 2001, Cytokine Growth F R	307	20	15.35
Zhu ZW, 2003, Am J Clin Pathol	304	18	16.89
Nikiforov YE, 2002, Endocr Pathol	304	19	16.00
Hou P, 2007, Clin Cancer Res	284	14	20.29
Santoro M, 1994, Oncogene	283	27	10.48

TC = Total citations; CY = Citation years; TCPY = Total citations per year

University of Korea', 'Sungkyunkwan University', and 'University of Texas MD Anderson Cancer Center' remained at the bottom of the list with 21 publications from each organization. The highest number of citations were received by 'Johns Hopkins University', followed by 'University of Pisa', 'University of Pittsburgh', and 'University of Naples Federico II'.

#### 4.9 Country collaboration map for the genetics in papillary thyroid cancer research

Figure 3 depicts the country collaboration map related to the genetics in papillary thyroid cancer research. USA had the maximum collaboration with other countries in publishing research on the topic. USA also maintained three top positions in

collaborating with other countries among the top four positions. The research collaboration from USA and Italy ranked at the top position with a contribution of 49 publications, followed by China and USA, USA and Germany, and USA and UK.

#### 4.10 Most frequently used keywords in the genetics of papillary thyroid cancer research

Figure 4 presents the analysis of author-supplied keywords with a minimum number of keyword occurrences of 12. Out of 2,582 keywords, 63 met the threshold. The map divided the keywords into seven clusters. The same color of the circles describes the similarity of the topic in the keywords. Similarly, the circle size indicates the frequency of the occurrence

**Table 5.** Top 20 contributing countries to the genetics of papillary thyroid cancer research

Country (n=68)	Continent	TP	TCP	TC	PY start	PY end
USA	North America	432	425	24,554	1991	2020
China	Asia	404	368	6,225	2001	2020
Italy	Europe	256	251	11,273	1992	2020
Japan	Asia	120	117	3,959	1991	2020
South Korea	Asia	118	116	3,380	1998	2020
Germany	Europe	74	70	2,841	1996	2020
Brazil	South America	66	62	1,844	2001	2020
Canada	North America	57	56	2,712	1999	2020
Poland	Europe	55	52	1,686	2000	2020
France	Europe	51	47	1,495	1998	2020
Portugal	Europe	41	40	1,513	1995	2020
Turkey	Asia	35	28	403	2004	2020
England	Europe	34	33	1,690	1996	2020
Spain	Europe	33	33	1,258	1995	2020
Switzerland	Europe	31	31	960	1995	2020
Australia	Australia	26	26	757	2000	2020
Iran	Asia	26	23	277	2009	2020
India	Asia	24	18	658	2006	2020
Israel	Asia	23	23	649	1999	2020
Russia	Europe	20	18	563	1995	2020

TP = Total publications; TCP = Total cited publications; TC = Total citations; PY = Publication year

of the author-supplied keywords. The larger size of the circle reflects the more co-selection of the keywords by the researchers on the topic. The keyword 'papillary thyroid carcinoma' appeared to be the most frequently used keyword by the researchers. Other prominent keywords were BRAF, thyroid, thyroid cancer, papillary thyroid cancer, papillary carcinoma, and RAS.

## Discussion

Over the past three decades, a total of 1,741 publications on the genetics of papillary thyroid carcinoma were identified. This constitutes almost one-fifth of all publications related to thyroid cancer, indicating that the genetics of papillary thyroid cancer is a hotspot

of research (6). The number of publications per year did not exceed 100 publications till the year of 2015. This reflects a recent growing interest in genetics, and the great potential that genetic research holds in advancing therapeutic alternatives for papillary thyroid carcinoma. The study conducted by Agrawal *et al.*, which was identified as the most cited article in the field, extended the set of known genetic alterations that derive papillary thyroid cancer to incorporate *EIF1AX*, *PPM1D*, and *CHEK2* (10). Based on this discovery, the percentage of papillary thyroid cancer of unknown oncogenic drive was reduced from 25% to 3%; therefore, a reclassification of papillary thyroid cancer was suggested for better reflection of the underlying pathogenetic mechanisms and therapeutic strategies (10).



**Table 6.** Top 20 productive organizations in the genetics of papillary thyroid cancer research

Organizations (n=1,871)	Country	TP	TCP	TC	PY start	PY end
University of Pittsburgh	United States	47	47	2,858	2003	2019
University of Pisa	Italy	47	46	3,098	1995	2020
University of Naples Federico II	Italy	35	35	2,673	1998	2020
University of Porto	Portugal	34	33	1,360	1995	2020
Nagasaki University	Japan	32	29	785	1991	2020
China Medical University	Taiwan	31	27	593	2010	2020
Mem Sloan Kettering Cancer Center	United States	30	30	1,282	1997	2020
Shanghai Jiao Tong University	China	29	27	502	2009	2020
Wenzhou Medical University	China	29	27	333	2015	2020
Harvard University	United States	28	28	2,394	2001	2017
Fudan University	China	28	24	413	2008	2020
Johns Hopkins University	United States	27	23	3,504	2001	2017
Mayo Clinic	United States	27	20	1,461	1991	2020
Brigham & Women's Hospital	United States	26	11	2,085	2001	2020
University of Toronto	Canada	24	24	1,778	2000	2020
University Sao Paulo	Brazil	24	21	1,243	2002	2020
National Cancer Institute	United States	22	22	2,363	1997	2017
Catholic University of Korea	South Korea	21	21	776	2010	2020
Sungkyunkwan University	South Korea	21	21	530	1998	2018
University of Texas MD Anderson Cancer Center	United States	21	21	574	2009	2020

TP = Total publications; TCP = Total cited publications; TC = Total citations; PY = Publication year

'Thyroid' published the largest number of publications (N = 81), followed by 'Journal of Clinical Endocrinology & Metabolism' (N = 74). Nonetheless, 'Journal of Clinical Endocrinology & Metabolism' received double the citations (5,923) received by 'Thyroid' (2,961), indicating that the impact of a source is not necessarily a function of the number of publications. These findings are in line with the previous reports (5, 6). The fourth most cited publication was published in the 'Journal of Clinical Endocrinology & Metabolism', where Xing *et al.* demonstrated that the BRAF mutation is associated with poorer prognosis and independently predicts tumor recurrence (11).

'Nikiforov YE' from the University of Pittsburgh was identified as the most productive researcher with

a total of 49 publications, whereas 'Xing MZ' from Johns Hopkins University secured the highest citation impact. Interestingly, in disagreement with our results, 'Nikiforov YE' was not identified as one of the top 5 contributing authors in thyroid cancer research and papillary thyroid cancer research (5, 6). One of Nikiforov's papers features in the list of top 20 cited publications in the present analysis. In that paper, the rearrangement of the RET gene in papillary thyroid cancer was reviewed thoroughly (12). Different types of RET/PTC are clearly correlated with distinct morphologic variants of papillary thyroid carcinoma. RET/PTC1 is commonly associated with typical papillary microcarcinomas with the usually benign course, while RET/PTC3 is associated with a solid variant of

### Country Collaboration Map

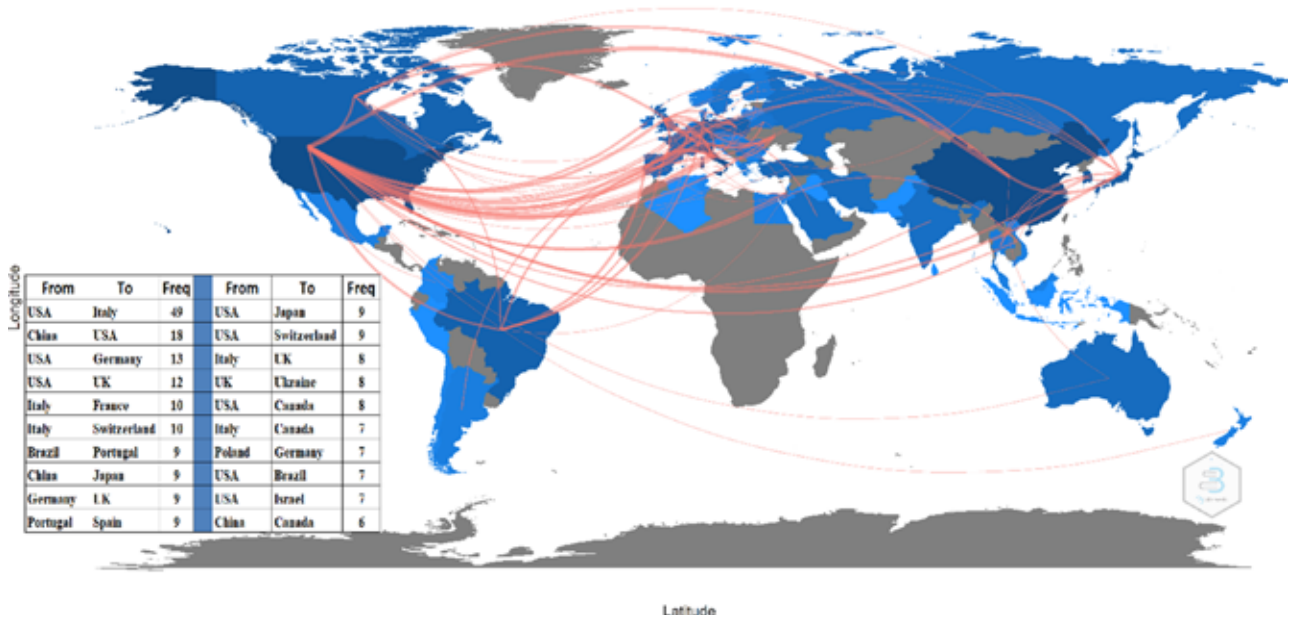


Figure 3. Top 20 country collaborations in the genetics of papillary thyroid cancer research

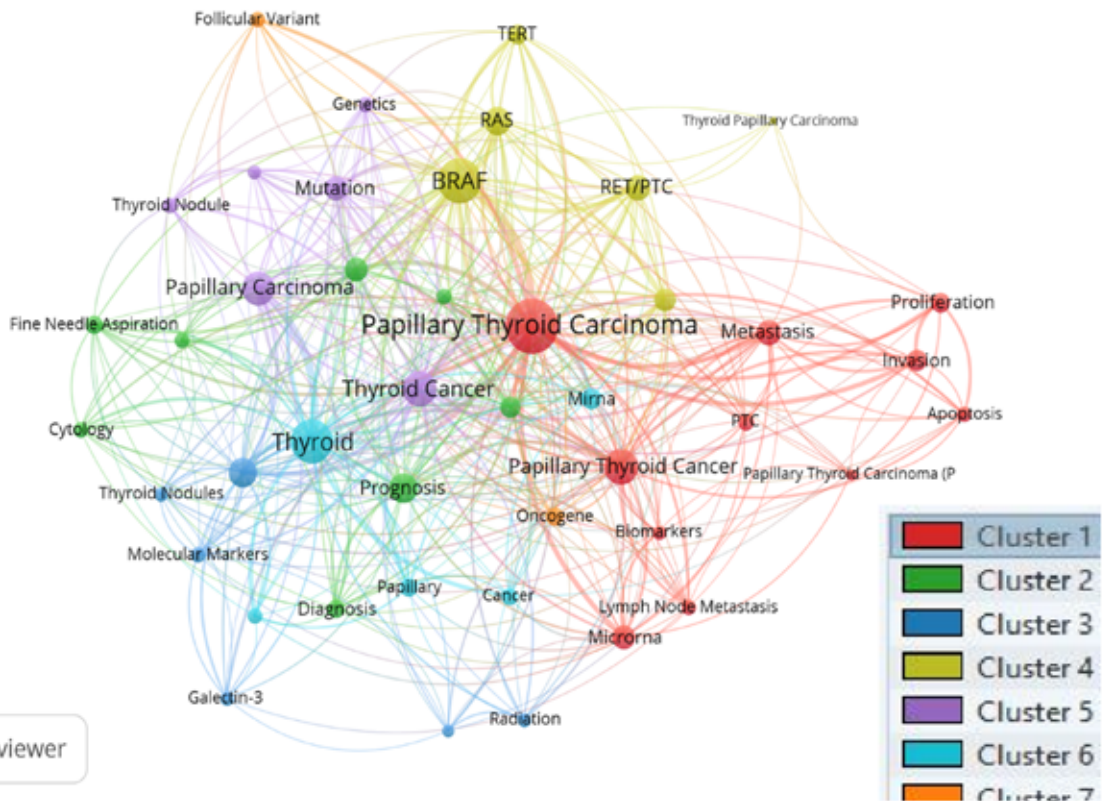


Figure 4. Most frequently used keywords in the genetics of papillary thyroid cancer research

papillary carcinoma, which manifests a more aggressive tumor behavior (13, 14). In concordance with the institutional affiliation of the top contributing authors, University of Pittsburgh, USA, was ranked the first in terms of the number of publications, while Johns Hopkins University, USA, secured the highest total citations despite being ranked much lower in terms of the number of publications. Therefore, the impact of an organization is not necessarily reflected by the number of publications.

Regarding contributing countries, about half of the publications were contributed by USA (N = 432/1,741) and China (N = 404/1,741). Interestingly, China's publication year start was in 2001, while that for USA was ten year earlier (1991). This reflects the rapidly expanding research contribution from China in this field. In agreement with our report, Huang *et al.* found that China had the highest sustained research output in relation to papillary thyroid carcinoma since 2012 (6). In the near future, it is likely that China will surpass USA and be the leading country in contributing to research on the genetics of papillary thyroid cancer. The collaboration between USA and Italy was the most predominant pattern of collaboration with a total of 49 publications. Although the presence of some developing countries, including Brazil, Iran, and India, were noted in the top 20 contributing countries, the collaboration between developed and developing countries is rather scarce. Bridging the gaps between the developed and developing countries is crucial to enhance the global health.

Unsurprisingly, papillary thyroid carcinoma was the most frequently used keyword. Additionally, other frequently used keywords included BRAF and RAS, indicating the central role played by these biological mechanisms in understanding the pathogenetic mechanism of papillary thyroid carcinoma. The identification of the RET-Ras-BRAF signaling cascade improved the understating of papillary thyroid carcinoma pathogenesis (4). Furthermore, BRAF mutation has been associated with clinical progression, recurrence, and failure of treatment (15).

A number of limitations of the present analysis should be considered. First, only a single database (WOSCC) was searched, with the possibility of missing relevant data. Second, our analysis was largely

based on citation metrics, which are subjected to several biases, such as citation bias and self-citation, leading to inaccurate measurement of research impact. Additionally, the true impact of a publication should not be solely evaluated by scientometric measurements; what matters is the content therein.

## Conclusion

Papillary thyroid carcinoma is the most common thyroid cancer. Since 1975, the incidence of papillary thyroid carcinoma has increased three times. In the present bibliometric review, we mapped the research productivity and trends in the genetics of papillary thyroid carcinoma. The review demonstrates that studying the genetics underlying papillary thyroid carcinoma is a newly evolving and rapidly growing area of research. Additionally, almost half of the publications were contributed by USA and China. China has been a big contributor to the field during the last two decades and may become the leading contributor in this specific area in the near future. Research collaborations were mainly observed between developed countries. It is worth repeating that collaborations between developed and developing countries should be encouraged and supported. Indeed, the future direction of thyroid cancer research will be the further investigation of the genetics of papillary thyroid carcinoma.

**Conflict of Interest:** Each author declares that he/she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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