



The 100 most cited papers on thymic epithelial tumours: a bibliometric analysis

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Abstract: Bibliometric analysis can help us analyse the most influential papers, authors, research institutions in a discipline or topic and analyse the impact of these papers on a specific field. Our purpose is to identify the 100 most cited papers about thymic epithelial tumours (TETs) and analyse their key characteristics. We use certain search terms in the Web of Science database to identify the 100 most cited papers, and analysed the first author, country of the first author, institution, journal, type of paper, number of citations, and citation rate. The search returned 26,497 results. The top 100 papers received 17,674 citations. The most cited paper was by Masaoka *et al.* (n=1,190 citations), in which, clinical staging criteria are proposed for thymoma with special emphasis on the therapy and prognosis. The paper with the highest citation rate was also by Masaoka *et al.* (citations rate =30.51). Osaka University published the most papers (n=6) and accrued the highest number of citations (n=2,122 citations). The United States was the country with the most published papers (n=45) and the highest number of citations (n=7,991 citations). *Cancer* is the journal with the most published papers (n=19) and the highest number of citations (n=5,017 citations). Through the analysis of the most influential papers, this study provides a reference for researchers trying to understand TETs, thus providing guidance for future research.

Keywords: Thymic epithelial tumours (TETs); thymoma; thymic tumour; bibliometric analysis; citations

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Introduction

Thymic epithelial tumours (TETs), are a group of epithelial tumours originated from thymic epithelium, including thymoma, thymic carcinoma, and thymic neuroendocrine tumours, most of which mainly located in the anterior mediastinum of adults. TETs are a relatively rare type of malignant mediastinal tumours with an incidence of <1% of all adult cancers (1,2). Also, TETs are typically indolent-growing tumours because the survival of the patients with TETs is longer even after disease progression. Therefore, some scholars suggested a longer follow-up (10 years) for TETs, focusing on the patient's overall survival (OS) and recurrence (3).

Bibliometric citation analysis is a direct and standardized method used to assess the strengths, trends and gaps in a certain field. It uses the number of citations received in scientific papers to develop citation rankings to assess the impact and quality of these papers (4).

TETs are the most common type of anterior mediastinal tumours. So far, however, there has been no bibliometric analysis of the literature on TETs. The purpose of this citation analysis is to understand the most important research into TETs by studying the year of publication, first author, country of the first author, institution, journals, type of paper, number of citations, and citation rate.

Methods

Search methodology

We used the Web of Science citation indexing database for research. The search strategy was to identify papers that contained specific search terms/keywords in their title, abstract or topic. After an independent trial search by two authors (GQ, FW), the following keywords were used in the final search: “thymic epithelial tumours” OR thymoma OR “thymic carcinoma” OR “thymic tumours” OR “thymic neoplasms” OR “thymic cancer” OR thymectomy OR thymomas. The search results were set to come from all databases within the Web of Science. Only papers written in English were selected. The final search date was 10 July 2020.

Paper selection

The search results were sorted in descending order of “times cited”, and then the two authors (GQ, FW) reviewed the included papers in order of total number of citations. Inclusion criteria are: (I) papers related to TETs; (II) papers written in English. The exclusion criteria are: (I) papers not related to the subject; (II) papers written in languages other than English; (III) papers focused on non-TETs topics, such as papers related to thymic diseases. The two researchers independently analysed the included papers and reviewed the full text of the included papers if necessary. When there were conflicts between the two researchers, the author (YW) would reconcile the difference. After the final 100 papers were determined, all included full texts were reviewed and the required data extracted.

Data extraction

We analysed the 100 most cited papers by the year of publication, first author, country of the first author, institution, journals, type of paper, number of citations, and citation rate; because older papers tend to accumulate more citations over time, thus we controlled for historical publication bias by calculating citation rate. Powell *et al.* proposed that the method of calculation of citation rate should be such that we divide the total number of citations of a paper by the number of years since the paper was published (citation). For papers with the same number of citations, we ranked them according to citation rate. Papers with higher citation rate were ranked higher.

Results

We retrieved 26,497 papers from Web of Science. *Table 1* lists the 100 most cited papers. These 100 papers received a total of 17,674 citations, the number of citations ranged from 101 for Evoli *et al.* (*Thymoma in patients with MG: characteristics and long-term outcome*) to 1,190 for Masaoka *et al.* (*Follow-up study of thymomas with special reference to their clinical stages*). The earliest published paper of the 100 most cited papers was that by Gafni *et al.* (*Idiopathic acquired agammaglobulinemia associated with thymoma. Report of two cases and review of the literature*) which was published in 1960.

This type of bibliometric analysis has certain limitations: papers published earlier may accumulate more citations, thereby reducing the number of newly published papers among the 100 most cited papers. To control this, we divided the number of citations by the number of years since publication to get the citation rate. *Table 2* lists the top 10 papers with the highest citation rate. The citation rate for the top 100 papers ranged from 1.87 for Gafni *et al.* (*Idiopathic acquired agammaglobulinemia associated with thymoma. Report of two cases and review of the literature*) to 30.51 for Masaoka *et al.* (*Follow-up study of thymomas with special reference to their clinical stages*).

The 100 most cited papers were published in 33 journals, with the number of papers per journal ranging from one to 19 (*Table 3*). *Cancer* published the most papers and had the highest number of citations (n=19, n=5,017 citations). As shown in *Table 4*, the United States accounted for the most papers (n=45) with a total of 7,991 citations, followed by Japan (n=19, n=4,200 citations). Staff at Osaka University authored the most papers (n=6) with a total of 2,111 citations (*Table 5*).

In *Table 6*, Dettnerbeck and Loehrer published the most papers (n=4) with a total of 657 and 590 citations, respectively. However, Masaoka published two papers with the highest number of citations (n=1,294 citations).

According to the University of Oxford Centre for Evidence-Based Medicine guides and National Health and Medical Research Council of Australia, we analysed the top 100 papers by level of evidence and study type (*Table 7*) (5,6). Five guidelines (level I/1, National Health and Medical Research Council of Australia/Centre for Evidence-Based Medicine), four RCTs (level II/2), and eight prospective papers (level III-2/3) reflected a high level of evidence. There were 50 retrospective papers (level III-3/4) in the list.

Fifteen authors contributed four or more papers to the

Table 1 The top 100 cited papers on TETs

Rank	Title	First author	Citations	Citations per year
1	Masaoka A, Monden Y, Nakahara K, Tanioka T. Follow-up study of thymomas with special reference to their clinical stages	Masaoka A	1,190	30.51
2	Kondo K, Monden Y. Therapy for thymic epithelial tumors: a clinical study of 1,320 patients from Japan	Kondo K	449	26.41
3	Okumura M, Ohta M, Tateyama H, Nakagawa K, Matsumura A, Maeda H, Tada H, Eimoto T, Matsuda H, Masaoka A. The World Health Organization histologic classification system reflects the oncologic behavior of thymoma—a clinical study of 273 patients	Okumura M	387	21.5
4	Lattes R. Thymoma and other tumors of thymus—an analysis of 107 cases*	Lattes R	386	6.66
5	Lewis JE, Wick MR, Scheithauer BW, Bernatz PE, Taylor WF. Thymoma—a clinicopathologic review	Lewis JE	374	11.33
6	Bernatz PE, Clagett OT, Harrison EG. Thymoma—a clinicopathologic study	Bernatz PE	351	5.95
7	Marino M, Mullerhermelink HK. Thymoma and thymic carcinoma*	Marino M	317	9.06
8	Suster S, Rosai J. Thymic carcinoma—a clinicopathological study of 60 cases	Suster S	308	10.62
9	Chen G, Marx A, Chen WH, Yong J, Puppe B, Strobel P, Muller-Hermelink HK. New WHO histologic classification predicts prognosis of thymic epithelial tumors—a clinicopathologic study of 200 thymoma cases from China	Chen G	289	16.06
10	Regnard JF, Magdeleinat P, Dromer C, Dulmet E, DeMontpreville V, Levi JF, Levasseur P. Prognostic factors and long-term results after thymoma resection: a series of 307 patients	Regnard JF	287	11.96
11	Engels EA, Pfeiffer RM. Malignant thymoma in the United States: Demographic patterns in incidence and associations with subsequent malignancies	Engels EA	284	16.71
12	Maggi G, Casadio C, Cavallo A, Cianci R, Molinatti M, Ruffini E. Thymoma—results of 241 operated cases	Maggi G	272	9.38
13	Blumberg D, Port JL, Weksler B, Delgado R, Rosai J, Bains MS, Ginsberg RJ, Martini N, McCormack PM, Rusch V, Burt ME. Thymoma—a multivariate-analysis of factors predicting survival	Blumberg D	268	10.72
14	Verley JM, Hollmann KH. Thymoma—a comparative-study of clinical stages, histologic features, and survival in 200 cases	Verley JM	267	7.63
15	Leyvraz S, Henle W, Chahinian AP, Perlmann C, Klein G, Gordon RE, Rosenblum M, Holland JF. Association of Epstein-Barr virus with thymic carcinoma	Leyvraz S	244	6.97
16	Detterbeck FC, Parsons AM. Thymic tumors	Detterbeck FC	238	14.88
17	Koga K, Matsuno Y, Noguchi M, Mukai K, Asamura H, Goya T, Shimosato Y. A review of 79 thymomas: Modification of staging system and reappraisal of conventional division into invasive and noninvasive thymoma	Koga K	238	9.15
18	Salyer WR, Eggleston JC. THYMOMA-clinical and pathological study of 65 cases	Salyer WR	238	5.41
19	Snover DC, Levine GD, Rosai J. Thymic carcinoma—5 distinctive histological variants*	Snover DC	222	5.84
20	Kondo K, Yoshizawa K, Tsuyuguchi M, Kimura S, Sumitomo M, Morita J, Miyoshi T, Sakiyama S, Mukai K, Monden Y. WHO histologic classification is a prognostic indicator in thymoma	Kondo K	212	13.25
21	Curran WJ, Kornstein MJ, Brooks JJ, Turrisi AT. Invasive thymoma: the role of mediastinal irradiation following complete or incomplete surgical resection	Curran WJ	211	6.59

Table 1 (continued)

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Rank	Title	First author	Citations	Citations per year
22	Strobel P, Bauer A, Puppe B, Kraushaar T, Krein A, Toyka K, Gold R, Semik M, Kiefer R, Nix W, Schalke B, Muller-Hermelink HK, Marx A. Tumor recurrence and survival in patients treated for thymomas and thymic squamous cell carcinomas: a retrospective analysis	Strobel P	210	13.13
23	Engels EA. Epidemiology of thymoma and associated malignancies	Engels EA	209	20.9
24	Batata MA, Martini N, Huvos AG, Aguilar RI, Beattie EJ. Thymomas—clinicopathologic features, therapy, and prognosis	Batata MA	204	4.43
25	Eng TY, Fuller CD, Jagirdar J, Bains Y, Thomas CR. Thymoma: state of the art	Thomas CR	192	9.14
26	Kim ES, Putnam JB, Komaki R, Walsh GL, Ro JY, Shin HJ, Truong M, Moon H, Swisher SG, Fossella FV, Khuri FR, Hong WK, Shin DM. Phase II study of a multidisciplinary approach with induction chemotherapy, followed by surgical resection, radiation therapy, and consolidation chemotherapy for unresectable malignant thymomas: final report	Kim ES	188	11.75
27	Loehrer PJ, Kim K, Aisner SC, Livingston R, Einhorn LH, Johnson D, Blum R. Cisplatin plus doxorubicin plus cyclophosphamide in metastatic or recurrent thymoma: final results of an intergroup trial	Loehrer PJ	187	7.19
28	Abraham KM, Levin SD, Marth JD, Forbush KA, Perlmutter RM. Thymic tumorigenesis induced by overexpression of p56lck	Abraham KM	181	6.24
29	Quintanillamartinez L, Wilkins EW, Choi N, Efid J, Hug E, Harris NL. Thymoma-histologic subclassification is an independent prognostic factor	Quintanilla-martinez L	175	6.73
30	Nakahara K, Ohno K, Hashimoto J, Maeda H, Miyoshi S, Sakurai M, Monden Y, Kawashima Y. Thymoma: results with complete resection and adjuvant postoperative irradiation in 141 consecutive patients	Nakahara K	175	5.47
31	Oberg K, Hellman P, Ferolla P, Papotti M, Grp EGW. Neuroendocrine bronchial and thymic tumors: ESMO clinical practice guidelines for diagnosis, treatment and follow-up	Oberg K	168	21
32	Nakagawa K, Asamura H, Matsuno Y, Suzuki K, Kondo H, Maeshima A, Miyaoka E, Tsuchiya R. Thymoma: a clinicopathologic study based on the new world health organization classification	Nakagawa K	165	9.71
33	Venuta F, Rendina EA, Longo F, De Giacomo T, Anile M, Mercadante E, Ventura L, Osti MF, Francioni F, Coloni GF. Long-term outcome after multimodality treatment for stage III thymic tumors	Venuta F	161	9.47
34	Fornasiero A, Daniele O, Ghiotto C, Piazza M, Fioredonati L, Calabro F, Rea F, Fiorentino MV. Chemotherapy for invasive thymoma	Fornasiero A	159	5.48
35	Bergh NP, Gatzinsky P, Larsson S, Lundin P, Ridell B. Tumors of the thymus and thymic region: I. clinicopathological studies on thymomas	Bergh NP	158	3.76
36	Wright CD, Wain JC, Wong DR, Donahue DM, Gaissert HA, Grillo HC, Mathisen DJ. Predictors of recurrence in thymic tumors: Importance of invasion, World Health Organization histology, and size	Wright CD	157	10.47
37	Kelleher P, Misbah SA. What is Good's syndrome? Immunological abnormalities in patients with thymoma	Kelleher P	157	9.24
38	Wilkins EW, Edmunds LH, Castleman B. Cases of thymoma at massachusetts general hospital	Wilkins EW	154	2.85
39	Detterbeck FC, Nicholson AG, Kondo K, Van Schil P, Moran C. The Masaoka-Koga stage classification for thymic malignancies: clarification and definition of terms	Detterbeck FC	152	16.89
40	Tarr PE, Sneller MC, Mechanic LJ, Economides A, Eger CM, Strober W, Cunningham-Rundles C, Lucey DR. Infections in patients with immunodeficiency with thymoma (Good syndrome)	Tarr PE	151	7.95

Table 1 (continued)

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Rank	Title	First author	Citations	Citations per year
41	Legg MA, Brady WJ. Pathology and clinical behavior of thymomas*	Legg MA	150	2.73
42	Loehrer PJ, Chen M, Kim KM, Aisner SC, Einhorn LH, Livingston R, Johnson D. Cisplatin, doxorubicin, and cyclophosphamide plus thoracic radiation therapy for limited-stage unresectable thymoma: an intergroup trial	Loehrer PJ	148	6.43
43	Ruffini E, Mancuso M, Oliaro A, Casadio C, Cavallo A, Cianci R, Filosso PL, Molinatti M, Porrello C, Cappello N, Maggi G. Recurrence of thymoma: analysis of clinicopathologic features, treatment, and outcome	Ruffini E	147	6.39
44	Wick MR, Scott RE, Li CY, Carney JA. Carcinoid tumor of the thymus—a clinicopathologic report of 7 cases with a review of the literature	Wick MR	145	3.63
45	Gibril F, Chen YJ, Schrupp DS, Vortmeyer A, Zhuang ZP, Lubensky IA, Reynolds JC, Louie A, Entsua LK, Huang K, Asgharian B, Jensen RT. Prospective study of thymic carcinoids in patients with multiple endocrine neoplasia type 1	Gibril F	144	8.47
46	Miyauchi A, Kuma K, Matsuzuka F, Matsubayashi S, Kobayashi A, Tamai H, Katayama S. Intrathyroidal epithelial thymoma: an entity distinct from squamous cell carcinoma of the thyroid*	Miyauchi A	144	4.11
47	Marx A, Chan JKC, Coindre JM, Detterbeck F, Girard N, Harris NL, Jaffe ES, Kurrer MO, Marom EM, Moreira AL, Mukai K, Orazi A, Stroebel P. The 2015 World Health Organization classification of tumors of the thymus continuity and changes	Marx A	143	28.6
48	Loehrer PJ, Jiroutek M, Aisner S, Aisner J, Green M, Thomas CR, Livingston R, Johnson DH. Combined etoposide, ifosfamide, and cisplatin in the treatment of patients with advanced thymoma and thymic carcinoma—an intergroup trial	Loehrer PJ	143	7.53
49	Detterbeck FC, Stratton K, Giroux D, Asamura H, Crowley J, Falkson C, Filosso PL, Frazier AA, Giaccone G, Huang J, Kim J, Kondo K, Lucchi M, Marino M, Marom EM, Nicholson AG, Okumura M, Ruffini E, Van Schil P, Prognostic FC, Advisory B, Participating ITD. The IASLC/ITMIG thymic epithelial tumors staging project: proposal for an evidence-based stage classification system for the forthcoming (8 th) edition of the TNM classification of malignant tumors	Detterbeck FC	140	23.33
50	Legolvan DP, Abell MR. Thymomas*	Legolvan DP	140	3.26
51	Kirchner T, Schalke B, Buchwald J, Ritter M, Marx A, Mullerhermelink HK. Well-differentiated thymic carcinoma - an organotypical low-grade carcinoma with relationship to cortical thymoma*	Kirchner T	139	4.96
52	Monden Y, Nakahara K, Iioka S, Nanjo S, Ohno K, Fujii Y, Hashimoto J, Kitagawa Y, Masaoka A, Kawashima Y. Recurrence of thymoma: clinicopathological features, therapy, and prognosis	Monden Y	138	3.94
53	Namba T, Brunner NG, Grob D. Myasthenia-gravis in patients with thymoma, with particular reference to onset after thymectomy	Namba T	138	3.29
54	Hirst E, Robertso.Ti. Syndrome of thymoma and erythroblastopenic anemia—a review of 56 cases including 3 case reports*	Hirst E	137	2.58
55	Maggi G, Giaccone G, Donadio M, Ciuffreda L, Dalesio O, Leria G, Trifiletti G, Casadio C, Palestro G, Mancuso M, Calciati A. Thymomas a review of 169 cases, with particular reference to results of surgical treatment	Maggi G	136	4
56	Giaccone G, Ardizzoni A, Kirkpatrick A, Clerico M, Sahnoud T, vanZandwijk N. Cisplatin and etoposide combination chemotherapy for locally advanced or metastatic thymoma: a phase II study of the European Organization for Research and Treatment of Cancer Lung Cancer Cooperative Group	Giaccone G	134	5.58

Table 1 (continued)

Table 1 (continued)

Rank	Title	First author	Citations	Citations per year
57	Pan CC, Chen PCH, Chiang H. KIT (CD117) is frequently overexpressed in thymic carcinomas but is absent in thymomas*	Pan CC	133	8.31
58	Macchiarini P, Chella A, Ducci F, Rossi B, Testi C, Bevilacqua G, Angeletti CA. Neoadjuvant chemotherapy, surgery, and postoperative radiation therapy for invasive thymoma	Macchiarini P	132	4.55
59	Singhal S, Shrager JB, Rosenthal DI, LiVolsi VA, Kaiser LR. Comparison of stages I-II thymoma treated by complete resection with or without adjuvant radiation	Singhal S	131	7.71
60	Falkson CB, Bezjak A, Darling G, Gregg R, Malthaner R, Maziak DE, Yu E, Smith CA, McNair S, Ung YC, Evans WK, Lung CDSGCCO. The management of thymoma: a systematic review and practice guideline	Falkson CB	130	11.82
61	Wilkins KB, Sheikh E, Green R, Patel M, George S, Takano M, Diener-West M, Welsh J, Howard S, Askin F, Bulkley GB. Clinical and pathologic predictors of survival in patients with thymoma	Wilkins KB	130	6.19
62	Okumura M, Miyoshi S, Fujii Y, Takeuchi Y, Shiono H, Inoue M, Fukuhara K, Kadota Y, Tateyama H, Eimoto T, Matsuda H. Clinical and functional significance of WHO classification on human thymic epithelial neoplasms—a study of 146 consecutive tumors	Okumura M	128	6.74
63	Detterbeck FC. Clinical value of the WHO classification system of thymoma	Detterbeck FC	127	9.07
64	Suster S, Moran CA. Thymoma, atypical thymoma, and thymic carcinoma—a novel conceptual approach to the classification of thymic epithelial neoplasms*	Suster S	126	6
65	Strobel P, Hartmann M, Jakob A, Mikesch K, Brink I, Dirnhofer S, Marx A. Thymic carcinoma with overexpression of mutated KIT and the response to imatinib	Strobel P	124	7.75
66	Zettl A, Strobel P, Wagner K, Katzenberger T, Ott G, Rosenwald A, Peters K, Krein A, Semik M, Muller-Hermelink HK, Marx A. Recurrent genetic aberrations in thymoma and thymic carcinoma	Zettl A	124	6.2
67	Blumberg D, Burt ME, Bains MS, Downey RJ, Martini N, Rusch V, Ginsberg RJ. Thymic carcinoma: current staging does not predict prognosis	Blumberg D	123	5.59
68	Vernino S, Lennon VA. Autoantibody profiles and neurological correlations of thymoma	Vernino S	122	7.63
69	Bernatz PE, Khonsari S, Harrison EG, Taylor WF. Thymoma—factors influencing prognosis	Bernatz PE	122	2.6
70	Rea F, Sartori F, Loy M, Calabro F, Fornasiero A, Daniele O, Altavilla G. Chemotherapy and operation for invasive thymoma	Rea F	121	4.48
71	Morgenthaler TI, Brown LR, Colby TV, Harper CM, Coles DT. Thymoma	Morgenthaler TI	121	4.48
72	Hoffacker V, Schultz A, Tiesinga JJ, Gold R, Schalke B, Nix W, Kiefer R, Muller-Hermelink HK, Marx A. Thymomas alter the T-cell subset composition in the blood: a potential mechanism for thymoma-associated autoimmune disease	Hoffacker V	121	6.05
73	Ogawa K, Toita T, Uno T, Fuwa N, Kakinohana Y, Kamata M, Koja K, Kinjo T, Adachi G, Murayama S. Treatment and prognosis of thymic carcinoma - A retrospective analysis of 40 cases	Ogawa K	119	6.61
74	Wilkins EW, Grillo HC, Scannell JG, Moncure AC, Mathisen DJ. Role of staging in prognosis and management of thymoma	Wilkins EW	119	4.1
75	Venuta F, Anile M, Diso D, Vitolo D, Rendina EA, De GT, Francioni F, Coloni GF. Thymoma and thymic carcinoma	Venuta F	116	11.6
76	Sung YM, Lee KS, Kim BT, Choi JY, Shim YM, Yi CA. F-18-FDG PET/CT of thymic epithelial tumors: Usefulness for distinguishing and staging tumor subgroups	Sung YM	116	8.29

Table 1 (continued)

Table 1 (continued)

Rank	Title	First author	Citations	Citations per year
77	Kim DJ, Yang WI, Choi SS, Kim KD, Chung KY. Prognostic and clinical relevance of the World Health Organization schema for the classification of thymic epithelial tumors—a clinicopathologic study of 108 patients and literature review	Kim DJ	116	7.73
78	Kubonishi I, Takehara N, Iwata J, Sonobe H, Ohtsuki Y, Abe T, Miyoshi I. Novel t(15;19)(q15;p13) chromosome abnormality in a thymic carcinoma	Kubonishi I	115	3.97
79	Suster S, Moran CA. Primary thymic epithelial neoplasms showing combined features of thymoma and thymic carcinoma—a clinicopathologic study of 22 cases*	Suster S	114	4.75
80	Hsu CP, Chen CY, Chen CL, Lin CT, Hsu NY, Wang JH, Wang PY. Thymic carcinoma ten years' experience in twenty patients	Hsu CP	113	4.35
81	Loehrer PJ, Wang W, Johnson DH, Ettinger DS. Octreotide alone or with prednisone in patients with advanced thymoma and thymic carcinoma: an Eastern Cooperative Oncology Group Phase II Trial	Loehrer PJ	112	7
82	Gafni J, Michaeli D, Heller H. Idiopathic acquired agammaglobulinemia associated with thymoma. Report of two cases and review of the literature	Gafni J	112	1.87
83	Yamakawa Y, Masaoka A, Hashimoto T, Niwa H, Mizuno T, Fujii Y, Nakahara KA. Tentative tumor-node-metastasis classification of thymoma	Yamakawa Y	111	3.83
84	Buckley C, Douek D, Newsom-Davis J, Vincent A, Willcox N. Mature, long-lived CD4+ and CD8+ T cells are generated by the thymoma in myasthenia gravis	Buckley C	110	5.79
85	Jeong YJ, Lee KS, Kim J, Shim YM, Han JH, Kwon OJ. Does CT of thymic epithelial tumors enable us to differentiate histologic subtypes and predict prognosis?	Jeong YJ	109	6.81
86	Ogawa K, Uno T, Toita T, Onishi H, Yoshida H, Kakinohana Y, Adachi G, Itami J, Ito H, Murayama S. Postoperative radiotherapy for patients with completely resected thymoma—a multi-institutional, retrospective review of 103 patients	Ogawa K	109	6.06
87	Rea F, Marulli G, Girardi R, Bortolotti L, Favaretto A, Galligioni A, Sartori F. Long-term survival and prognostic factors in thymic epithelial tumours	Rea F	108	6.75
88	Girard N, Shen R, Guo T, Zakowski MF, Heguy A, Riely GJ, Huang J, Lau C, Lash AE, Ladanyi M, Viale A, Antonescu CR, Travis WD, Rusch VW, Kris MG, Pao W. Comprehensive genomic analysis reveals clinically relevant molecular distinctions between thymic carcinomas and thymomas	Girard N	107	9.73
89	Eng TY, Fuller CD, Jagirdar J, Bains Y, Thomas CR. Thymic carcinoma: state of the art review	Eng TY	107	7.13
90	Pescarmona E, Rendina EA, Venuta F, Darcangelo E, Pagani M, Ricci C, Ruco LP, Baroni CD. Analysis of prognostic factors and clinicopathological staging of thymoma	Pescarmona E	106	3.53
91	Marx A, Stroebel P, Badve SS, Chalabreysse L, Chan JKC, Chen G, de Leval L, Detterbeck F, Girard N, Huang J, Kurrer MO, Lauriola L, Marino M, Matsuno Y, Molina TJ, Mukai K, Nicholson AG, Nonaka D, Rieker R, Rosai J, Ruffini E, Travis WD. ITMIG consensus statement on the use of the WHO histological classification of thymoma and thymic carcinoma: refined definitions, histological criteria, and reporting	Marx A	105	17.5
92	Ishibashi H, Suzuki T, Suzuki S, Moriya T, Kaneko C, Takizawa T, Sunamori M, Handa M, Kondo T, Sasano H. Sex steroid hormone receptors in human thymoma	Ishibashi H	105	6.18
93	Giaccone G, Rajan A, Berman A, Kelly RJ, Szabo E, Lopez-Chavez A, Trepel J, Lee MJ, Cao L, Espinoza-Delgado I, Spittler J, Loehrer PJS. Phase II study of belinostat in patients with recurrent or refractory advanced thymic epithelial tumors	Giaccone G	104	11.56

Table 1 (continued)

Table 1 (continued)

Rank	Title	First author	Citations	Citations per year
94	Masaoka A. Staging system of thymoma	Masaoka A	104	10.4
95	Kaira K, Endo M, Abe M, Nakagawa K, Ohde Y, Okumura T, Takahashi T, Murakami H, Tsuya A, Nakamura Y, Naito T, Hayashi I, Serizawa M, Koh Y, Hanaoka H, Tominaga H, Oriuchi N, Kondo H, Nakajima T, Yamamoto N. Biologic correlation of 2-[F-18]-fluoro-2-deoxy-d-glucose uptake on positron emission tomography in thymic epithelial tumors	Kaira K	104	10.4
96	Okumura M, Miyoshi S, Takeuchi Y, Yoon HE, Minami M, Takeda S, Fujii Y, Nakahara K, Matsuda H. Results of surgical treatment of thymomas with special reference to the involved organs	Okumura M	104	4.95
97	Gray GF. Thymoma—clinicopathologic study of 54 cases	Gray GF	104	2.54
98	Sadohara J, Fujimoto K, Mueller NL, Kato S, Takamori S, Ohkuma K, Terasaki H, Hayabuchi N. Thymic epithelial tumors: Comparison of CT and MR imaging findings of low-risk thymomas, high-risk thymomas, and thymic carcinomas	Sadohara J	103	7.36
99	Rieker RJ, Hoegel J, Morresi-Hauf A, Hofmann WJ, Blaeker H, Penzel R, Otto HF. Histologic classification of thymic epithelial tumors: comparison of established classification schemes	Rieker RJ	103	5.72
100	Chalabreysse L, Roy P, Cordier JF, Loire R, Gamondes JP, Thivolet-Bejui F. Correlation of the WHO schema for the classification of thymic epithelial neoplasms with prognosis—a retrospective study of 90 tumors	Chalabreysse L	103	5.72

*, article related to pathology. TET, thymic epithelial tumour.

Table 2 Top 10 papers with the highest citation rate

Title	First author	Year	Citations per year
Follow-up study of thymomas with special reference to their clinical stages	Masaoka A	1981	30.51
The 2015 World Health Organization classification of tumors of the thymus continuity and changes	Marx A	2015	28.6
Therapy for thymic epithelial tumors: a clinical study of 1,320 patients from Japan	Kondo K	2003	26.41
The IASLC/ITMIG thymic epithelial tumors staging project: proposal for an evidence-based stage classification system for the forthcoming (8 th) edition of the TNM classification of malignant tumors	Detterbeck FC	2014	23.33
The World Health Organization histologic classification system reflects the oncologic behavior of thymoma—a clinical study of 273 patients	Okumura M	2002	21.5
Neuroendocrine bronchial and thymic tumors: ESMO clinical practice guidelines for diagnosis, treatment and follow-up	Oberg K	2012	21
Epidemiology of thymoma and associated malignancies	Engels EA	2010	20.9
ITMIG consensus statement on the use of the WHO histological classification of thymoma and thymic carcinoma: refined definitions, histological criteria, and reporting	Marx A	2014	17.5
The Masaoka-Koga stage classification for thymic malignancies: clarification and definition of terms	Detterbeck FC	2011	16.89
Malignant thymoma in the United States: demographic patterns in incidence and associations with subsequent malignancies	Engels EA	2003	16.71

Table 3 Journals that published the top 100 papers

Journal	Number of articles	Total number of citations
<i>Cancer</i>	19	5,017
<i>Annals of Thoracic Surgery</i>	12	2,379
<i>Journal of Thoracic and Cardiovascular Surgery</i>	11	1,897
<i>Journal of Clinical Oncology</i>	9	1,402
<i>Journal of Thoracic Oncology</i>	7	983
<i>American Journal of Surgical Pathology</i>	6	810
<i>New England Journal of Medicine</i>	3	480
<i>Medicine</i>	3	426
<i>International Journal of Cancer</i>	2	387
<i>Mayo Clinic Proceedings</i>	2	266
<i>Journal of Clinical Endocrinology & Metabolism</i>	2	249
<i>Clinical Cancer Research</i>	2	229
<i>European Journal of Cardio-thoracic Surgery</i>	2	224
<i>Virchows Archiv</i>	1	317
<i>Pathology International</i>	1	238
<i>Lung Cancer</i>	1	188
<i>Proceedings of the National Academy of Sciences of the United States of America</i>	1	181
<i>Annals of Oncology</i>	1	168
<i>Journal of Clinical Pathology</i>	1	157
<i>World Journal of Surgery</i>	1	144
<i>Journal of Pathology</i>	1	133
<i>Annals of Surgery</i>	1	130
<i>American Journal of Clinical Pathology</i>	1	126
<i>American Journal of Pathology</i>	1	124
<i>Surgical Clinics of North America</i>	1	122
<i>Blood</i>	1	121
<i>Journal of Nuclear Medicine</i>	1	116
<i>Chest</i>	1	116
<i>Cancer Research</i>	1	115
<i>Annals of Neurology</i>	1	110
<i>American Journal of Roentgenology</i>	1	109
<i>International Journal of Radiation Oncology Biology Physics</i>	1	107
<i>European Journal of Radiology</i>	1	103

Table 4 Number of papers per country of origin in 100 most cited

Country	Number of articles	Total number of citations
United States	45	7,991
Japan	19	4,200
Italy	11	1,775
Germany	8	1,069
China	3	535
France	3	657
Sweden	2	326
Korea	3	341
United Kingdom	2	267
Australia	1	137
Europe	1	134
Canada	1	130
Israel	1	112

Table 5 Institutions with the highest number of papers in the top 100

Institutions	Number of articles	Total number of citations
Osaka University	6	2,122
Mayo Clinic	5	1,090
University of Wurzburg	5	718
Indiana University Medical Center	4	590
Mount Sinai Medical Center	3	666
National Cancer Institute	3	597
Memorial Sloan-Kettering Cancer Center	3	595
Massachusetts General Hospital	3	486
Yale University	3	419
University of Rome	3	383
Marie Lannelongue Hospital	2	554
University of Torino	2	419
Johns Hopkins University	2	368
Hospital of University of Pennsylvania	2	342
University of Texas	2	295
University of Heidelberg	2	246
University of Padua	2	229
University of the Ryukyus School of Medicine	2	228
Sungkyunkwan University	2	225
Nagoya City University	2	215

Table 6 Authors that contributed to more than one paper in the top 100 list

First author	Number of articles	Total number of citations
Detterbeck FC	657	4
Loehrer PJ	590	4
Okumura M	619	3
Suster S	548	3
Masaoka A	1,294	2
Kondo K	661	2
Engels EA	493	2
Bernatz PE	473	2
Maggi G	408	2
Blumberg D	391	2
Strobel P	334	2
Venuta F	277	2
Wilkins EW	273	2
Marx A	248	2
Giaccone G	238	2
Rea F	229	2

Table 7 Level of evidence of the papers in the top 100 list

Level of evidence		Article type	No. of articles
NHMRC	CEBM		
I	1	Guidelines	5
II	2	RCT	4
III-2	3	Original prospective	8
III-3	4	Original retrospective	50
		Case report	7
		Review	8

CEBM, University of Oxford Centre for Evidence-Based Medicine; NHMRC, National Health and Medical Research Council of Australia; RCT, randomized controlled trial.

list (Table 8), with five authors contributing six or more, and one author (Marx) reaching eight.

Discussion

The higher citation rate of papers published in recent years indicates that these papers will gain more citations in the

next few years and thus become more influential. Among the 10 papers with highest citation rate, nine of which were published after 2002 (citation rate: 16.71–30.51).

Among the 10 highest citation rate papers, there are four papers on the staging system of TETs, four papers on large-sample retrospective studies, one guideline, and one review. The most cited paper with the highest citation rate

Table 8 Authors who contributed four or more papers to the top 100 list

Author	No. of articles	Position on author list
Marx A	8	First and corresponding [2], corresponding [2], second [1], fifth [1], eleventh [1], thirteenth [1]
Detterbeck FC	6	First and corresponding [4], forth [1], eighth [1]
Loehrer PJ	6	First and corresponding [4], third [1], twelfth [1]
Muller-Hermelink HK	6	Corresponding [1], sixth [1], seventh [1], eighth [1], tenth [1], eleventh [1]
Strobel P	6	First and corresponding [1], first [1], second [2], sixth [1], thirteenth [1]
Nakahara K	5	First and corresponding [1], second [1], third [1], seventh [1], eighth [1]
Monden Y	5	First and corresponding [1], second [2], seventh [1], tenth [1]
Masaoka A	5	First and corresponding [2], second [1], ninth [1], tenth [1]
Fujii Y	4	Third [1], sixth [2], seventh [1]
Giaccone G	4	First and corresponding [2], corresponding [1], ninth [1]
Kondo K	4	First and corresponding [2], third [1], twelfth [1]
Mukai K	4	Forth [1], ninth [1], eleventh [1], sixteenth [1]
Okumura M	4	First and corresponding [2], first [1], seventeenth [1]
Rosai J	4	Corresponding [1], third [1], fifth [1], twentieth [1]
Ruffini E	4	First [1], sixth [1], eighteenth [1], twenty-first [1]

is the “*Follow-up study of thymomas with special reference to their clinical stages*” written by Masaoka (n=1,190 citations) from Osaka University, Japan. This paper was the only one to elicit more than 1,000 citations, which proposes the Masaoka staging system widely used in clinical practice. Four of the top 10 citation-rate papers studied the staging system, which was the basis for studying TETs.

The publication of these four papers is as follows: in 1981, Masaoka *et al.*, after analysing 93 patients, proposed a four-stage Masaoka staging system (*Follow-up study of thymomas with special reference to their clinical stages*, n=1,190 citations, citation rate =30.51); in 1994, Koga *et al.* revised the Masaoka staging system after analysing 79 patients, and the revised Masaoka-Koga staging system has since been widely used (*A review of 79 thymomas: modification of staging system and reappraisal of conventional division into invasive and noninvasive thymoma*, n=449 citations, citation rate =26.41); however, both the Masaoka staging system and the Masaoka-Koga staging system as revised by Koga incorporate certain vague terminological definitions, leading to possible confusion, therefore, in 2011, the International Thymic Malignancies Interest Group (ITMIG) published clearer definitions and explanations on many details of the Masaoka-Koga staging system (*The Masaoka-Koga stage classification for thymic malignancies: clarification and definition*

of terms, n=152 citations, citation rate =16.89); in 2014, both ITMIG and the International Association for the Study of Lung Cancer (IASLC) published a new staging system, for the 8th TNM on TETs [*The IASLC/ITMIG thymic epithelial tumors staging project: proposal for an evidence-based stage classification system for the forthcoming (8th) edition of the TNM classification of malignant tumors*, n=140 citations, citation rate =23.33].

Among the 10 highest citation-rate papers, four were large-sample retrospective studies, which were related to the characteristics of TETs. Although TETs are considered as malignant tumours, most of them are inert tumours with good prognosis, making prospective studies more difficult. Therefore, database-based retrospective studies have become the most common way in which to study TETs.

The large proportion of retrospective studies may be related to the better prognosis of TETs. In 2016, Fukui *et al.* conducted a retrospective analysis on the prognosis of surgical treatment of TETs. The results indicated that the 5- and 10-year survival rates of patients with TETs were 91% and 81% (7). In 2017, Tseng *et al.* conducted a long-term follow-up of 235 patients with TETs. The median follow-up time was 105 [12–198] months, and the OS rate of the patients was 94.4% (8). These studies have shown that patients with TETs have a good prognosis, and long-

term prospective clinical trials may consume considerable manpower and financial resources. Therefore, most of the studies related to TETs conducted as retrospective studies.

Most papers were published in the *Cancer* (n=19), followed by *Annals of Thoracic Surgery* (n=12) and *Journal of Thoracic and Cardiovascular Surgery* (n=11). Most papers were published in the cognate area of oncology (n=43), rather than in surgery journals (n=34) and general journals (n=10). As a result, oncology-related journals had published the most papers related to TETs.

Eleven papers were published relating to pathology. The most cited paper was “*Thymoma and other tumors of thymus—an analysis of 107 cases*” by Lattes (n=386 citations) from Columbia University, USA published in 1962, which proposed the histological classification system widely used in the practice of pathology. This traditional histological classification system of thymomas was based on the proportion of non-neoplastic lymphoid cells as compared to neoplastic epithelial cells, which classify thymoma as predominantly lymphoid, predominantly spindle cell, predominantly epithelial, and predominantly rosette-forming.

The second most cited paper with the highest citation rate is “*Thymoma and thymic carcinoma*” by Marino (n=317 citations, citation rate =9.06) from Ospedale San Giacomo, Italy, which proposed a histological classification to classify TETs into medullary, cortical, and mixed tumours, published in 1985. In 1999, Suster presented a proposal for a novel approach to the histologic classification of primary TETs that was based on morphological features of differentiation (*Thymoma, atypical thymoma, and thymic carcinoma—a novel conceptual approach to the classification of thymic epithelial neoplasms*, n=126 citations, citation rate =6).

Since 2000, biomarker investigation and immunological findings have been devoted to the progress of assessment of the pathology of TETs. In 2004, Pan found that KIT (CD117), a tyrosine kinase receptor, is involved in the pathogenesis of thymic carcinomas, which express infrequently in thymoma [*KIT (CD117) is frequently overexpressed in thymic carcinomas but is absent in thymomas*, n=133 citations, citation rate = 8.31]. In addition, mutations and expressions of EGFR and IGF-1R also appear in thymic tumours (9-13).

The limitations of this study are as follows: (I) most papers always tended to cite papers in more prestigious journals, thus some high-quality papers published in journals with lower impact factors would be ignored; (II) this study only included papers written in English; (III)

papers published earlier usually elicited more citations, so we used the citation rate to solve this problem, however, no paper has been included in the past 5 years. The most recently included paper is the 2015 World Health Organization “*The 2015 World Health Organization classification of tumors of the thymus continuity and changes*” (n=141 citations, citation rate =28.20) published by Marx in 2015. We can see that only newly published papers with a high citation rate have the chance to be included in the top 100 papers, which is likely to induce historical bias. As a result, new techniques, new ideas, and new directions cannot be captured timeously. We partially corrected this problem by introducing citation rate; (IV) we did not count co-authors other than the first author, which may ignore the contributions of some authors.

Conclusions

This is the first study of bibliometric analysis as related to TETs, which analysed the year of publication, first author, country of the first author, institution, journals, type of paper, number of citations, and citation rate of 100 most cited papers.

Researchers and clinicians can offer insight into the topic of TETs through this study, which can provide guidance for future TETs research.

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Footnote

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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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