

# Covid-19 and Thyroid: A Scopus-based Bibliometric Assessment of Research Output

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## ABSTRACT

**Introduction:** A bibliometric assessment of coronavirus disease 2019 (Covid-19)-related thyroid research is unavailable. **Materials and Methods:** We searched Elsevier's Scopus database for publications on Covid-19 and thyroid disease up to August 18, 2021, using a predefined search strategy. The data were analyzed by publication characteristics, the most active countries, institutions, authors, journals, citations, and research trends.

**Results:** The global publications totaled 599; 446 (74.4%) were original articles. Only 18.0% (108) were funded, but these received higher citations per paper (CPP) than the non-funded publications (average CPP 14.8 versus 9.8). Of the 97 countries that participated in the research, the USA, Italy, India, and China were the most productive, whereas China, Germany, UK, and the USA were the most impactful. The studied patient population groups were "Adults" (50.5%), "Middle-Aged" (33.7%), "Aged" (29.3%), "Children" (7.8%), and "Adolescents" (6.5%). The research organizations and authors numbered 272 and 404, respectively. The most productive organizations were Università Degli Studi Napoli, Italy, Harvard Medical School, USA, and Università Degli Studi Milano, Italy. The most productive authors were G. Troncone, L. Giovannella, and G. Anedda. The top productive journals were Endocrine, Journal of Endocrine Investigation,

and Frontiers in Endocrinology. Only 22 (3.6%) were highly-cited (average CPP 141.8). **Conclusion:** The Covid-19 research concerning thyroid disorders has been largely conducted in the USA and Europe with contributions from China and India. There is a need to foster collaboration between high- and low-income countries for formulating better strategies to tackle thyroid-related morbidities in Covid-19. Additionally, such research should involve younger age groups.

**Key words:** Coronavirus disease 2019, Thyroid diseases, Co-morbidities, Children, Adults.

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## INTRODUCTION

Coronavirus disease 2019 (Covid-19) pandemic is an enormous global health problem. It has resulted in significant morbidity and mortality and worldwide disruption in healthcare services.<sup>1,2</sup> The pandemic forced the medical fraternity to quickly formulate guidelines for patients with underlying medical conditions and adopt new methods of healthcare delivery.<sup>3-5</sup> The main reason for morbidity and mortality in Covid-19 is its severely damaging effects on the patients' respiratory system. However, the disease is now known to cause considerable damage to other vital organs and the endocrine system. While diabetes remains the most common association, other endocrine dysfunction such as adrenal insufficiency, low T3 and low TSH syndrome, hyperprolactinemia, and hypopituitarism also occur in a significant proportion of patients with moderate or severe Covid-19.<sup>6-8</sup> A recent hospital-based study found thyroid dysfunction in almost one-fourth of Covid-19 patients who underwent hormonal profiles.<sup>7</sup> Indeed, virtually all kinds of non-neoplastic thyroid diseases such as Hashimoto's thyroiditis, Graves' disease, subacute thyroiditis, Low T3 and low T4 syndrome, etc., have been reported to complicate Covid-19.<sup>9</sup> Although causality by the virus has been strongly implicated in all these thyroid disorders, several aspects of thyroid involvement in Covid-19 remain unexplained.<sup>10</sup> Extensive research is thus still needed in order to manage thyroid dysfunction in patients with Covid-19 better. The first step to further research is to assess previously conducted research and identify the gaps and hotspots, researchers, organizations, and funding agencies that share research interests. This is

usually achieved through scientometric or bibliometric studies.<sup>11</sup> There is thus a need for conducting a bibliometric assessment of research output on thyroid disorders in relation to Covid-19.

Previous bibliometric assessments of thyroid diseases were either conducted prior to the Covid-19 pandemic or did not separately assess the literature concerning Covid-19 and thyroid.<sup>12-14</sup> A bibliometric study published recently on global publication output on Covid-19 did not contain information on thyroid publications.<sup>15</sup> Of the various endocrine problems related to Covid-19, only diabetes research has been assessed bibliometrically.<sup>16</sup> We thus planned a similar study to address the lack of a comprehensive assessment of published literature on thyroid disorders concerning Covid-19.

## Objectives

The study aimed to provide a quantitative and qualitative assessment of global research on thyroid diseases in relation to the Covid-19 pandemic based on publications indexed in Elsevier's Scopus database during 2020-2021. The analysis included publications growth, research collaborations, funding support, citation impact, top organizations, authors, journals, and characteristics of highly-cited papers (HCPs).

## MATERIALS AND METHODS

The publications on the theme "Covid-19 & Thyroid" were identified from the Elsevier's Scopus database (<https://www.scopus.com>), using

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two sets of keywords “Covid-19” and “Thyroid” in field tags, “Keyword” or “Title” (Article Title) and limiting the search to 2020-2021. The search string is shown below:

TITLE ( “Covid 19” or “2019 novel coronavirus” or “coronavirus 2019” or “coronavirus disease 2019” or “2019-novel CoV” or “2019 ncov” or covid 2019 or covid19 or “corona virus 2019” or ncov-2019 or ncov2019 or “nCoV 2019” or 2019-ncov or covid-19 or “Severe acute respiratory syndrome coronavirus 2” or “SARS-CoV-2” ) or KEY ( “Covid 19” or “2019 novel coronavirus” or “coronavirus 2019” or “coronavirus disease 2019” or “2019-novel CoV” or “2019 ncov” or covid 2019 or covid19 or “corona virus 2019” or ncov-2019 or ncov2019 or “nCoV 2019” or 2019-ncov or covid-19 or “Severe acute respiratory syndrome coronavirus 2” or “SARS-CoV-2” ) and Key (thyroid\* or hyperthyroid\* or hypothyroid\*).

The search yielded 599 records, which were further analyzed using additional analytical provisions in the Scopus database. Publication characteristics were tabulated, including titles, authors, co-cited authors, journal sources, keywords, affiliations, countries, or regions. Co-cited authors mean that the authors have been cited together. To resolve the issue of synonyms or homonyms in authors’ names, we used other specific fields such as affiliations. To assess the quality of publications, various indicators such as citations per paper (CPP), relative citation index (RCI), and Hirsch index (HI) were used. Publications that had received more than 50 citations were considered HCPs. Citations to publications were counted from the date of their publication till August 18, 2021. We also utilized VOSviewer (version 1.6.14) software to analyze the collaborations and keywords clusters.

## RESULTS

### The general profile of publications

The total number of publications was 599; 293 and 306 during 2020 and 2021, respectively. These publications received 5878 citations, averaging 9.8 CPP. The funded publications (108, 18.0%) received 1604 citations, averaging 14.8 CPP. The leading global funding agencies were the National Institutes of Health (15 papers), the US Department of Health and Human Services (11 papers), the National Natural Science Foundation of China (10 papers), Conselho Nacional de Desenvolvimento Científico Tecnológico (7 papers) and National Cancer Institute (7 papers).

The broad subject-wise distribution showed the largest share of publications in Medicine (92.8%), followed by Biochemistry, Genetics and Molecular Biology (25.8%), Immunology and Microbiology (7.8%), Pharmacology, Toxicology and Pharmaceutics (3.3%), and Neurosciences (3.0%). An overlap was observed in subject areas. In terms of impact, publications on Biochemistry, Genetics and Molecular Biology registered the highest, and Immunology and Microbiology recorded the least CPP of 11.1 and 5.7, respectively. The majority of the studies (234, 39%) were on the treatment of thyroid disorders, followed by clinical aspects (157, 26.2%), complications (110, 18.3%), pathophysiology (103, 17.2%), epidemiology (88, 14.7%) and risk factors (71, 11.8%). Pathophysiology and epidemiology studies registered the highest and the least CPP of 15.9 and 7.1, respectively.

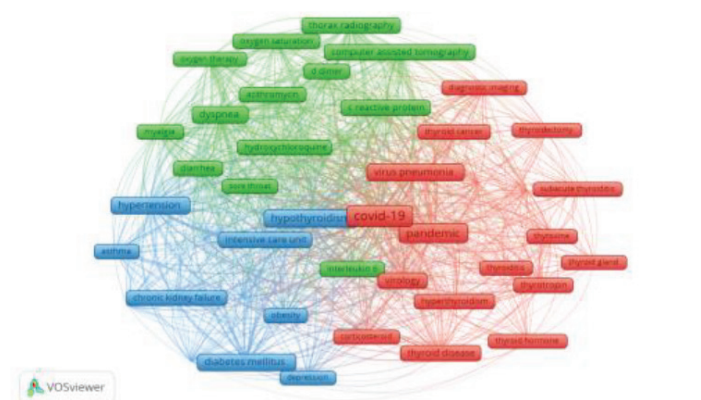
On classifying the publications by age group of the patient population, it was observed that studies related to “Adults” accounted for the largest share of publications (50.5%), followed by “Middle-Aged” (33.7%), “Aged” (29.3%), “Children” (7.8%) and “Adolescents” (6.5%). We also identified forty-four significant keywords with the frequency of appearance varying from 30 to 325, which broadly indicate the trends of research on our study’s theme (Figure 1).

### The top contributing countries

Eighty-seven countries unevenly participated in global research on thyroid disorders in Covid-19; 61 countries contributed 1-5 papers each, nine countries 6-10 papers each, 15 countries 11-50 papers each, and two countries 123-129 papers. The top 10 countries together contributed 86.6% of publications. USA and Italy made the largest contributions (21.5% and 20.5% share), followed by India, China, and UK (8.3%, 8.0%, and 7.01% respectively). Four of the top 10 countries registered CPP and RCI higher than their group average of 15.0 and 1.5, respectively, and were considered more impactful (Table 1). The collaborative linkages between the top 10 countries are shown in Figure 2.

### Top research organizations

The contribution of 272 organizations that participated in the thyroid-Covid-19 research was uneven; 247 contributed 1-5 papers each, 20 organizations 6-10 papers each, and six organizations 11-14 papers each. The top 25 organizations contributed 213 (35.5%) publications and 3557 (60.5%) citations. The contributions of 11 organizations were higher than the group average of 8.5, while six organizations registered CPP and RCI above the group average of 16.7 and 1.7, respectively. Table 2



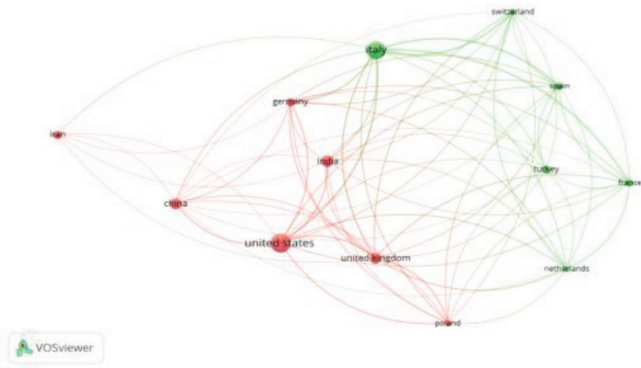
**Figure 1:** Cooccurrence network of 44 significant keywords arranged in three clusters (red, green & blue), having 909 links and total link strength of 13020. The thickness of nodes depicts their frequency of occurrence.

**Table 1: The most productive and influential countries in Covid-19-thyroid research.**

S. no.	Country	TP	TC	CPP	HI	ICP	%ICP	% TP	RCI
1	USA	129	2155	16.7	17	40	31.0	21.5	1.7*
2	Italy	123	1557	12.6	19	35	28.4	20.5	1.2
3	India	50	242	4.8	8	10	20.0	8.3	0.5
4	China	48	1453	30.2	11	10	20.8	8.0	3.0*
5	UK	42	852	20.3	11	20	47.6	7.0	2.0*
6	Iran	28	193	6.9	5	5	17.8	4.6	0.7
7	Germany	26	776	29.8	9	4	15.3	4.3	3.0*
8	Turkey	26	89	3.4	4	4	15.3	4.3	0.3
9	Spain	25	177	7.0	8	12	48.0	4.1	0.7
10	France	22	324	14.7	9	11	50.0	3.6	1.5
	Total	519	7818	15.0	10.1	151	29.0	86.6	1.5

\*more impactful than others

**Abbreviations:** TP, total papers; TC, total citations; CPP, citations per paper; ICP, international collaborative papers; HI, H-Index; RCI, relative citation index.



**Figure 2:** The collaborative network of the most productive countries. The thickness of the node represents productivity. The countries are arranged in 2 clusters (Red & Green), having 72 links and total link strength of 230.

**Table 2: The most productive and most influential organizations in thyroid-Covid-19 research.**

S.no.	Organization	TP	TC	CPP	HI	ICP (%)	RCI
<b>Top 10 most productive organizations</b>							
1	Universita degli Studi di Napoli II, Italy	14	504	36.0	5	6 (42.8)	3.6
2	Harvard Medical School, USA	13	182	14.0	6	5 (38.4)	1.4
3	Universita degli Studi di Milano, Italy	13	177	13.6	7	6 (46.1)	1.4
4	Universita degli Studi di Messina, Italy	12	57	4.7	3	5 (41.6)	0.4
5	Sapienza Universita di Roma, Italy	12	79	6.5	4	2 (16.6)	0.6
6	Massachusetts General Hospital, USA	11	40	3.6	4	6 (54.5)	0.3
7	Tehran University of Medical Sciences, Iran	10	128	12.8	4	0 (0.0)	1.3
8	PGIMER-Chandigarh, India	9	113	12.5	4	1 (11.1)	1.2
9	Huazhong University of Science & Technology, China	9	535	59.4	3	1 (11.1)	6.0
10	Universita degli Studi della Campania Luigi Vanvitelli, Italy	9	80	8.9	4	4 (44.4)	0.9
<b>Top 10 most impactful organizations</b>							
1	Universita Cattolica de Sacro Cuore, Campus di Roma, Italy	7	472	67.4	4	2 (28.5)	6.8
2	Memorial Sloan-Kettering Cancer Center, USA	6	397	66.17	4	3 (50.0)	6.7
3	Huazhong University of Science & Technology, China	9	535	59.4	3	1 (11.1)	6.0
4	Universita degli Studi di Napoli II, Italy	14	504	36.0	5	6 (42.8)	3.6
5	University of Pennsylvania, Italy	6	161	26.8	5	3 (50.0)	2.7
6	Universitats Spital Zurich, Switzerland	7	154	22.0	4	5 (71.4)	2.2
7	Tongji Medical College, China	7	112	16.0	2	0 (0.0)	1.6
8	Harvard Medical School, USA	13	182	14.0	6	5 (38.4)	1.4
9	Universita degli Studi di Milano, Italy	13	177	13.6	7	6 (46.1)	1.4
10	Tehran University of Medical Sciences, Iran	10	128	12.8	4	0 (0.0)	1.3

**Abbreviations:** TP, total papers; TC, total citations; CPP, citations per paper; ICP, international collaborative papers; HI, H-Index; RCI, relative citation index.

shows the relative contribution of the ten most productive and ten most impactful organizations.

### Most prolific and influential authors

Of the 404 authors who participated unevenly in research, 286 contributed one paper each, 68 contributed two papers each, 33 published three papers each, 15 contributed four papers each. One each published 5 and 7 papers. Table 3 lists the ten most productive and the ten most impactful authors.

### Most productive journals

Five hundred ninety-eight papers were published as journal articles and one as conference proceedings. Of the 181 journals that participated, 170 journals published 1-5 papers each, eight published 6-10 papers each, and three published 11-19 papers each. The top 10 journals contributed 27.6% of total publications in this research field. The profiles of the most active and the most influential journals are shown in Table 4.

### Highly cited publications

Only 22 (3.6%) publications were HCPs which cumulatively received 3121 citations, averaging 141.8 CPP. Fourteen papers received 51 to 92 citations, four received 101-140 citations, and four received 287-431 citations. The largest number of HCPs were contributed by the USA, followed by China (6 papers) and Italy (5 papers). The majority (19 out of 22) of the HCPs were collaborative endeavors; 12 were national, and seven were international collaborative.

## DISCUSSION

Our analysis reveals that the quantity of research on thyroid disorders in relation to Covid-19 was much lower than other endocrine problems such as diabetes, recently assessed bibliometrically. The number of publications was approximately 34 per month for thyroid compared to about 84 per month for diabetes.<sup>16</sup> This was probably related to the lower contribution to morbidity and mortality and ease of management of thyroid disorders as compared to diabetes in patients with Covid-19.<sup>6-9</sup> In addition, almost 40% of the research was conducted in two high-income countries, i.e., the USA and Italy. Although several low- and middle-income countries such as Brazil, Libya, and African countries have reported a high prevalence of thyroid disorders in the immediate pre-Covid era, only China and India could manage to contribute significantly to thyroid research concerning Covid-19.<sup>17</sup> But despite being ranked third in productivity, the quality of Indian research as indicated by CPP and RCI was much lower compared to other highly productive countries. A significant reason could be the disparity in the researchers' approach and the funding devoted to Covid-19 research in high- compared to low-income countries. While the high-income countries approached Covid-19 research that enabled them to develop priorities to inform future research studies and funding decisions, such an approach was lacking in the low-income countries.<sup>18</sup> The redistribution of resources during the Covid-19 pandemic meant little funding support available for research in low-income countries. Even before Covid-19, resource crunch for research is generally experienced in low- and middle-income countries and leads to lower quality of research.<sup>19</sup> It is well known that research funding is associated with improvement in the quality of research.<sup>20</sup> A recent bibliometric analysis showed that the CPP of funded publications was 4-times higher than non-funded publications (77.2 versus 18.6).<sup>21</sup>

A notable finding of our analysis was the low quantity of publications on the pediatric patient population compared to other age groups. This is understandable as the number of affected children and the severity of

**Table 3: The most prolific and the most influential authors in Thyroid-Covid-19 research.**

S.no.	Author	Affiliation	TP	TC	CPP	HI	ICP (%)	RCI
<b>Ten most productive authors</b>								
1	G.Troncone	University degli Studi di Napoli Federico 11, Italy	7	53	7.5	4	3 (42.8)	0.8
2	L.Glovannella	University of Zagreb, Switzerland	5	16	3.2	2	5 (100.0)	0.3
3	G.Anedda	Universita degli Studi di Cagliari, Italy	4	4	1.0	1	0 (0.0)	0.1
4	C.Bellevicine	University degli Studi di Napoli Federico 11, Italy	4	44	11.0	3	1 (25.0)	1.2
5	P.G.Calo	Universita degli Studi di Cagliari, Italy	4	4	1.0	1	0 (0.0)	0.1
6	G.L.Canu	Universita degli Studi di Cagliari, Italy	4	4	1.0	1	0 (0.0)	0.1
7	F.Cappellacci	Universita degli Studi di Cagliari, Italy	4	4	1.0	1	0 (0.0)	0.1
8	L.Chiovato	Instituti Clinici Scientifici Maugeri Italy	4	36	9.0	3	0 (0.0)	1.0
9	P.Del Rio	University of Parma, Parma, Italy	4	6	1.5	2	1 (25.0)	0.1
10	A.Glustina	Universita Vita-Salute Raffaele, Italy	4	62	15.5	4	2 (50.0)	1.7
<b>Ten most impactful authors</b>								
1	A.Glustina	Universita Vita-Salute Raffaele, Italy	4	62	15.5	4	2 (50.0)	1.7
2	A.B.Grossman	University of Oxford, UK	4	53	13.2	3	4 (100.0)	1.4
3	C.Bellevicine	University degli Studi di Napoli Federico 11, Italy	4	44	11.0	3	1 (25.0)	1.2
4	E.Vigliar	University degli Studi di Napoli Federico 11, Italy	4	44	11.0	3	1 (25.0)	1.2
5	R.M Ruggeri	Universita degli Studi di Messina, Italy	4	40	10.0	2	3 (75.0)	1.1
6	W.S.Chow	University of Hong Kong	3	30	10.0	2	0 (0.0)	1.1
7	L.Chiovato	Instituti Clinici Scientifici Maugeri Italy	4	36	9.0	3	0 (0.0)	1.0
8	K.Esposito	E.O. Ospedali Galliera, Genoa, Italy	3	27	9.0	2	2 (66.6)	1.0
9	L.Croce	Instituti Clinici Scientifici Maugeri Italy	3	27	9.0	2	0 (0.0)	1.0
10	G.Troncone	University degli Studi di Napoli Federico 11, Italy	7	53	7.5	4	3 (42.8)	0.8

**Abbreviations:** TP, total papers; TC, total citations; CPP, citations per paper; ICP, international collaborative papers; HI, H-Index; RCI, relative citation index.

**Table 4: The most active and the most influential journals in Covid-19-thyroid research.**

S.no.	Journal	TP	TC	CPP
<b>Ten most prolific journals</b>				
1	Endocrine	19	116	6.11
2	Journal of Endocrine Investigation	18	251	13.94
3	Frontiers in Endocrinology	11	39	3.55
4	BMJ Case Reports	10	46	4.60
5	Journal of Clinical Endocrinology & Metabolism	8	180	22.50
6	Journal of Medical Virology	8	51	6.38
7	Head & Neck	7	33	4.71
8	Annals of Medicine & Surgery	6	3	0.50
9	Diabetes & Metabolic Syndrome. Clinical Research & Reviews	6	45	7.50
10	European Journal of Endocrinology	6	95	15.83
<b>Ten most impactful journals</b>				
1	Travel Medicine & Infectious Diseases	6	191	31.83
2	Journal of Clinical Endocrinology & Metabolism	8	180	22.50
3	European Journal of Endocrinology	6	95	15.83
4	Journal of Endocrine Investigation	18	251	13.94
5	International Journal of Infectious Diseases	5	68	13.60
6	Reviews in Endocrine & Metabolic Disorders	4	51	12.75
7	International Journal of Gynecology & Obstetrics	4	39	9.75
8	Ear Nose & Throat Journal	4	31	7.75
9	Diabetes & Metabolic Syndrome: Clinical Research & Reviews	6	45	7.50
10	Journal of the Endocrine Society	4	28	7.00

Abbreviations: TP, total papers; TC, total citations; CPP, citations per paper.

Covid-19 was lower during the previous Covid-19 waves.<sup>22</sup> Nevertheless, in view of the subsequent Covid-19 waves likely to affect more children, there is a need to be prepared with research strategies aimed at mitigating the effects of co-morbidities such as thyroid disease in addition to general pandemic countermeasures such as public health messaging and guidance for primary care.<sup>23</sup> In this regard, high-volume pediatric centers and researchers already engaged in thyroid research will have to play an active role, specifically in low-income countries.<sup>24-28</sup>

We used a single database for the current analysis, similar to most previous scientometric studies.<sup>29,30</sup> Because of Scopus's broader content coverage, search analysis tools, citation accuracy, and funding information than other databases, most bibliometric analyses prefer to utilize Scopus.<sup>31</sup> But Scopus does not cover all the published content, so our study may have missed data and citations on the theme of our study. A simultaneous search in Scopus, PubMed, and Web of Science may have captured additional data but is very cumbersome to carry out.<sup>32</sup> Despite the limitation, our analysis could identify the research gaps and trends in thyroid research in relation to Covid-19 and suggest the potential use of our findings. The study thus provides a framework for authors, organizations, and countries to focus on critical areas of future research in this field.

## CONCLUSION

The Covid-19 research in relation to thyroid disorders has been largely conducted in the USA and Europe with substantial contributions from China and India. The studies mainly focused on the treatment and clinical

spectrum of thyroid disease in Covid-19. There is a need to foster collaboration between high-income and low-income countries for formulating better research strategies to combat thyroid-related morbidities in Covid-19. There is a need to prioritize research involving children and adolescents because of a possible future Covid-19 wave speculated to affect children disproportionately.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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