Supplementary Material

Materials and Methods

To identify COVID-19 related publications and comments, PubMed was queried in two steps: 1) keyword "(Covid-19[MeSH] OR Covid-19[Title/Abstract]) and hascommentin", identifying publications that have COVID-19 in titles or abstracts and include at least one comment; 2) keyword "(Covid-19[MeSH] OR Covid-19[Title/Abstract]) and hascommenton", identifying comments that have COVID-19 in titles or abstracts and comment on at least one publication. For each query, we then parse the metadata of retrieved papers to acquire article comment pairs. Specially, we obtained the "comment list" of each study by "comment in" tag to map study-comment pairs and the "study list" of each comment by "comment on" tag to map comment-study pairs. Through "hascommentin", 13,465 commented papers were retrieved; through "hascommenton", 15,727 commentary materials were retrieved. Finally, we fully joined the mapping results of two steps to include the final complete 19,601 commented-commenting pairs dataset, with 14,222 commented papers and 17,354 commentary materials.

Network structure analysis. To have an overview of respective comment network in two sources, we firstly constructed study-comment networks of each database to compare the network structural features. Specifically, we visualized the comment network of each source respectively and compared their subgraph distributions and network depth.

Commented papers: Citation sentiment analysis. We then analyzed and compared the citation sentiment distribution of commented papers in two sources and the baseline. Using Dimensions [1] (the largest citation-related bibliographic databases) for citation times and Scite.ai for citation sentiment, we explored how the research community views commented papers. Citation sentiments could imply the intrinsic

characteristic of the cited study, whether it is a high-reliable study with only supporting citations or a controversial study with both supporting and critical citations.

Scite.ai [2] is a deep learning platform funded by NIH, developed to evaluate the reliability of scientific claims by examining the sentiment orientation of citations. In general, for a given paper, Scite.ai first maps in-text citations to their reference information to identify the referenced-referencing pair; and then categorizes the citation sentiment as either supporting, contradicting, mentioning, unclassified, or none. Note, that instead of merely being a sentiment analysis tool, Scite.ai uses citing authors' factual information in the citation to determine the scientific reliability of a cited article. Specifically, only by detecting both a sentimental statement towards the cited publication and factual evidence (e.g., clinical trials' results) for this statement, a supporting or contradicting categorization would be determined [3]. Trained on 43,665 expert-labeled citation statements and has completed the analysis of over 16 million full-text articles, Scite.ai shows strong performance metrics (precision: supporting 0.800, contradicting 0.8519, mentioning 0.9615) [2-4].

We hypothesized that commented papers, by nature, trigger intense discussion and disputes. Therefore, with all COVID-19 papers in PubMed as a baseline, we examined the inherent controversy of commented papers in both PubMed and WoS through citation sentiment analysis. For each commented paper, we collected data on total citations, supporting, contradicting, and mentioning citation counts. Citation sentiments for a paper were considered "disputing" when both supporting and contradicting citations occurred. We compared supporting, contradicting, disputing, and mentioning rates in commented papers from PubMed, WoS, and the overall COVID-19 baseline. Finally, in the Scite.ai dataset, 141,150 articles out of 270k+ baseline, 9,563 out of 14,222 PubMed commented papers, and 36,112 out of 52,971 WoS commented papers were successfully extracted with at least one citation count.

We conducted a survival analysis to compare the citation distribution of commented papers in PubMed and WoS, as well as the distribution of all COVID-19 papers.

To further explore commented papers, we then analyze their network characteristics for network impact exploration. In the overall network, we categorized the commented paper nodes into three types: exclusive to PubMed, exclusive to WoS, and belonging to both. Given the scarcity of nodes exclusively belonging to PubMed, we then analyzed nodes shared between PubMed and WoS, focusing on the degree centrality, closeness centrality, betweenness centrality, and cycle ratio to assess their significance. This comparison aimed to determine if the nodes captured by both databases hold greater importance in the network.

Degree centrality. In an undirected network, degree centrality equals to the total edges of a node divided by the possible edges maximum it could have, which is the count of total vertices minus 1. In an undirected network with V nodes, node v has E_v edges, the equation of degree centrality C_D of node v shows as below:

$$C_D(v) = \frac{E(v)}{V-1}$$

Closeness centrality. Closeness centrality reflects how close a node reaches the rest of nodes in a network. In a network with n nodes, it equals to the reciprocal of the average distance (shortest path) from node u to all (n -1) reachable nodes, where d (v, u) is the shortest path from v and u. The equation shows as below[5]:

$$C(u) = \frac{n-1}{\sum_{v=1}^{n-1} d(v,\ u)}$$

Betweenness centrality. It reflects the extent to which a node serves as the bridging agent connecting other nodes in a network. Betweenness equals the sum of times a

node participates in the shortest path of any pair of nodes and then it was normalized by the total pairs of nodes as the betweenness centrality. In an undirected network with V nodes, $\sigma(s, t)$ is the total shortest paths from any pair of nodes (s, t); $\sigma(s, t|v)$ is the count of paths through node v; The equation is shown as below[6]:

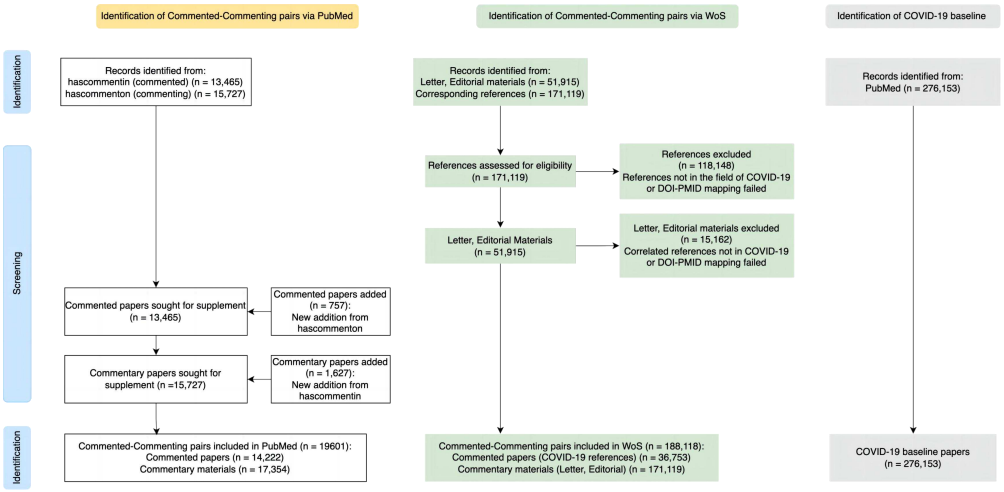
$$C_D(v) = \sum_{s,\, t \in V} \frac{\sigma(s,\ t|v)}{\sigma(s,t)}$$

Cycle Ratio. In this indicator, the importance of a node depends on its degree of participation in the structure and dynamic processes of its neighbors. The cycle ratio refers to the extent to which a node participates in the shortest cycles involving other nodes [7]. Here, the shortest cycle refers to the cycle with the minimum length that includes the node in question. The value of a node is not determined solely by how much its neighbors utilize it but rather by how much it contributes to its neighbors. If a node contributes more to the social network (neighbors in the cycle) and takes on more social roles (involving a higher number of cycles), it is considered more important.

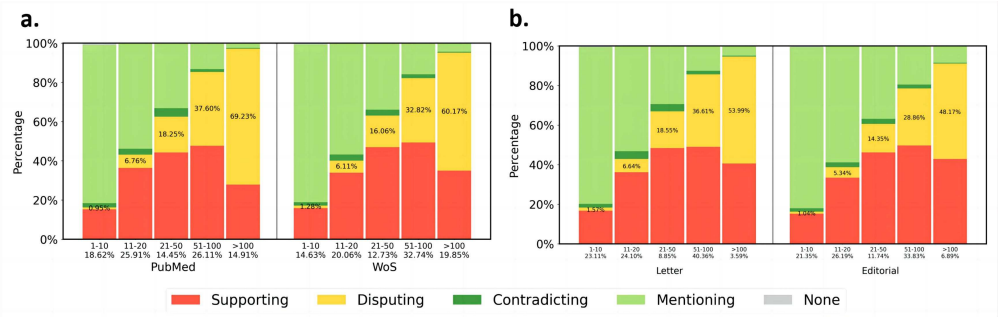
Clustering coefficient. The clustering coefficient of node v represents the total pairs of neighbors who are friends divided by the total pairs of neighbors. In other words, the fraction of possible triangles through node v. In an unweighted network, d (v) denotes the degree of v (total number of neighbors); t (v) denotes the number of triangles through v; the equation of clustering coefficient of node v is shown as below[8]:

$$C_v = \frac{2t(v)}{\mathrm{d}(v)(\,\mathrm{d}\,(v) - 1)}$$

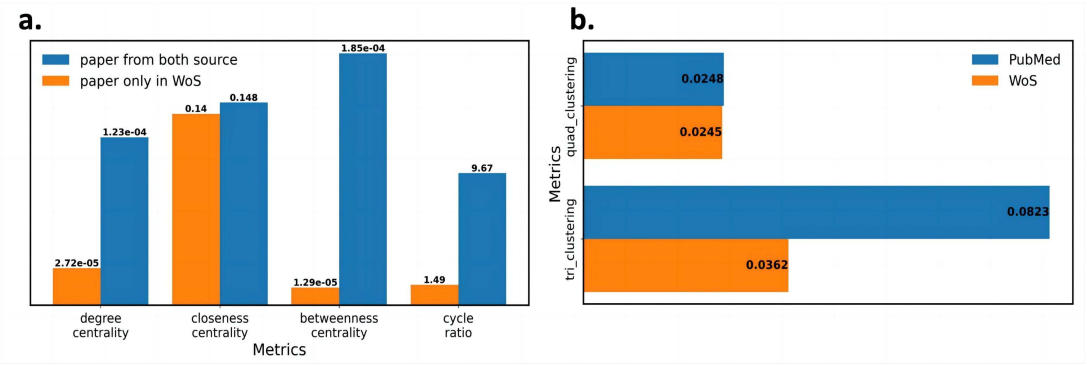
Supplementary Figures



Supplementary Fig. 1. Adapted PRISMA flow chart of systematic selection of data (Updated data results on Sep 2, 2022)



Supplementary Fig. 2 | The distribution comparison of sentiments of commented papers in PubMed and WoS. (a). The Citation sentiment distribution of commented papers in PubMed and WoS in different citation cutoffs. (b). The distribution of citation sentiment types of different comment types in different citation cutoffs.



Supplementary Fig. 3 | Network featrues comparison. (a) The centrality metrics comparison between articles belonging to both and WoS-only. **(b)** The average clustering coefficient metrics comparison (triangular clustering, quadrangle clustering) in PubMed network and WoS network respectively.

Supplementary Tables

Supplementary Table 1. Comment-related publication types in PubMed and WOS

	PubMed	Web of Science
Comment	Work consisting of a critical or explanatory note written to discuss, support, or dispute an article or other presentation previously published. It may take the form of an article, letter, editorial, etc. It appears in publications under a variety of names: comment, commentary, editorial comment, viewpoint, etc.	
Letter	Work consisting of written or printed communication between individuals or between persons and representatives of corporate bodies. The correspondence may be personal or professional. In medical and other scientific publications, the letter is usually from one or more authors to the editor of the journal or book publishing the item being commented upon or discussed. LETTER is often accompanied by COMMENT.	Brief Contributions or correspondence from the readers to the journal editor concerning previously published material. Includes "Readers Write", "Questions and Answers", "Letters to the Editor" and "Comments".
Editorial	Work consisting of a statement of the opinions, beliefs, and policy of the editor or publisher of a journal, usually on current matters of medical or scientific significance to the medical community or society at large. The editorials published by editors of journals representing the official organ of a society or organization are generally substantive.	Editorial Material: An article that gives the opinions of a person, group, or organization. Includes commentaries (depending on the content), editorials, interviews, discussions between individuals, post-paper discussions, round table symposia, conference summary, research highlights, introduction, preface and conclusion.

Supplementary Table 2. The categorization of WOS commentary materials in PubMed article types

PubMed Article Types	Web of Science		#Total (%)
	#Editorial Material (%)	#Letter (%)	
Comment	2891 (17.68%)	7080 (34.70%)	9971 (27.13%)
Editorial	4247 (25.97%)	53 (0.26%)	4300 (11.70%)
Letter	444 (2.72%)	8535 (41.84%)	8979 (24.43%)
Journal Article	7909 (48.37%)	3250 (15.93%)	11159 (30.36%)
Others	813 (4.97%)	1443 (7.07%)	2256 (6.14%)
Not found in PubMed	48 (0.29%)	40 (0.20%)	88 (0.24%)
Total	16352 (100.00%)	20401 (100.00%)	36753 (100.00%)

Note. Percentages indicate proportion in each column. Comment types are defined independently by PubMed and WoS, respectively.

WoS classifies commentary materials into two types: letters and editorial materials. In contrast, PubMed provides more explicit categories, such as letter, editorial, and comment. For example, only 27.13% of WoS commentaries ("letter" or "editorial material") are classified as "comment" in PubMed categorization. The "comment" category in PubMed is significant, which tends to indicate the current commentary as a targeted comment written to appraise a published article or an author's reply to tackle comments received. Manual inspection reveals discrepancies, finding that several papers in WoS classified as letters or editorials despite their nature as research articles or reviews, highlighting inaccuracies in WoS's classification of commentary materials.

Supplementary Table 3. The top 10 comments in PubMed

PubMed ID	#Com	Title (Abbr. Journal)	PubMed Type	WOS Type
33724907	11	Looking Forward: A Response to Commentaries on "Race, Power and COVID-19: A Call for Advocacy within Bioethics". (AJOB)	Comment	Letter*
32552034	7	The Percussive Effects of Pandemics and Disaster. (Medical anthropology)	Comment	/
32687556	7	Vertical Transmission of Severe Acute Respiratory Syndrome Coronavirus 2 From the Mother to the Infant-Reply. (JAMA pediatrics)	Comment, Letter	/
33723027	6	Author Response: A Prospective Study of Neurologic Disorders in Hospitalized Patients With COVID-19 in New York City. (Neurology)	Comment	Letter*
32838086	6	COVID-19 and ESRD: Entering a New Era of Uncertainty. (Kidney international reports)	Comment, Editorial	Editorial Material*
34097930	6	ACE I/D polymorphism and epidemiological findings for COVID-19: One year after the pandemic outbreak in Europe. (The Journal of infection)	Comment, Letter	Letter
32771115	6	COVID-19-a very visible pandemic - Author's reply. (Lancet (London, England))	Comment, Letter	/
32320565	6	First Case of Covid-19 in the United States. Reply. (NEJM)	Comment, Letter	Letter*
35017722	6	Omicron, the great escape artist. (Nature reviews. Immunology)	Comment	Editorial Material*
32888311	6	Letter: Dismantling the Apocalypse Narrative: The Myth of the COVID-19 Stroke. (Neurosurgery)	Comment, Editorial	Letter*

Note. If the PubMed comment is captured by WOS comment dataset, it would be labeled by *.

Supplementary Table 4. The top 10 comments in WOS

PubMed ID	#Com	Title (Journal)	WOS Type	PubMed Type
33395346	194	Update Alert 7: Risks and Impact of Angiotensin-Converting Enzyme Inhibitors or Angiotensin-Receptor Blockers on SARS-CoV-2 Infection in Adults. (Annals of internal medicine)	Letter	Letter
35047183	175	The COVID-19 pandemic in children and young people during 2020-2021: A complex discussion on vaccination. (Journal of global health)	Editorial Material	Editorial
35047182	126	The COVID-19 pandemic in children and young people during 2020-2021: Learning about clinical presentation, patterns of spread, viral load, diagnosis and treatment. (Journal of global health)	Editorial Material	Editorial
34598700	115	The management of type 2 diabetes before, during and after Covid-19 infection: what is the evidence? (Cardiovascular diabetology)	Editorial Material	Journal Article
32993622	114	Repurposing existing drugs for COVID-19: an endocrinology perspective. (BMC endocrine disorders)	Letter	Journal Article
33835905	106	Update in COVID-19 2020. (American journal of respiratory and critical care medicine)	Editorial Material	Review
34670351	105	Prevalence of comorbid tuberculosis amongst COVID-19 patients: A rapid review and meta-analysis. (International journal of clinical practice)	Letter	Review & Letter
34101091	95	Harnessing Type I IFN Immunity Against SARS-CoV-2 with Early Administration of IFN- β . (Journal of clinical immunology)	Editorial Material	Editorial
35715738	93	SARS-CoV-2: phenotype, genotype, and characterization of different variants. (Cellular & molecular biology letters)	Review	Letter
34119673	88	Guillain Barré syndrome associated with COVID-19- lessons learned about its pathogenesis during the first year of the pandemic, a systematic review. (Autoimmunity reviews)	Letter	Letter

Note. If the WOS comment is captured by PubMed comment dataset, it would be labeled by *.

To reveal the distribution difference of citation sentiments in commented papers among groups, we conducted the two-sample independent Chi-Square tests for PubMed and baseline, WoS and baselinel, and PubMed and WoS respectively. Note, when comparing PubMed/WoS with baseline data, we use baseline data as the expected values which are viewed as the standard (population) distribution of commented papers' citation sentiments. The statistical analysis of sentiment distribution of commented papers in PubMed, WoS, and Baseline is show below.

Supplementary Table 5: Comparison of PubMed and Baseline

Chi-Square Test Results

Statistic	Value
Chi-square	2643.40
Degree of Freedom	4
P-value	0.0

Standardized Residuals

Sentiment category	PubMed Standardized Residual
None	-4.29
Contradicting	1.13
Disputed	48.10
Supporting	9.85
Mentioning	-23.31

Supplementary Table 6: Comparison of WoS vs Baseline

Chi-Square test results

Statistic	Value
Chi-square	6125.60
Degree of Freedom	4
P-value	0.0

Standardized Residuals

Sentiment category	WoS Standardized Residual
None	-11.90
Contradicting	3.10
Disputed	70.63
Supporting	36.19
Mentioning	-47.58

Supplementary Table 7: Comparison of PubMed vs WoS

Chi-Square test results

Statistic	Value
Chi-square	134.09
Degree of Freedom	4
P-value	5.19e-28

Standardized Residuals

Sentiment category	PubMed Standardized Residual	WoS Standardized Residual
None	1.46504523	-0.65
Contradicting	-0.19047351	0.08
Disputed	9.22820041	-4.06
Supporting	-4.3957953	1.94
Mentioning	-2.37454146	1.05

Supplementary Table 8. Claims and graph attributes of the top 10 subgraphs of COVID-19 (PubMed dataset)

Rank	Content of the Subgraph	Claims Category	#Node	#Edge	Avg degree	Avg clustering coefficient	Avg path length
1	Overall clinical characteristics and systems symptoms of COVID-19	Clinical characteristics	182	191	2.10	0.02	6.94
2	The inefficacy with HCQ + A on COVID-19 & The association between COVID-19 and cardiac injury	Drug efficacy	142	157	2.21	0.14	7.30
3	The association between COVID-19 and cancer	Clinical relevance	56	60	2.14	0.00	3.43
4	COVID-19 and abnormal coagulation: The importance of anticoagulation	Complications	53	53	2.00	0.00	4.63
5	The origin of COVID-19 and the receptor of ACE2	ELSI, Biological mechanism	43	43	2.00	0.00	3.77
6	The rational allocation of scare medical resources during COVID-19	ELSI	33	39	2.36	0.07	3.65
7	The effectiveness with remdesivir/ lopinavir/ ritonavir on COVID-19	Drug efficacy	32	34	2.13	0.13	3.76
8	The phenotypes of COVID-19 and acute respiratory distress syndrome	Clinical characteristics, Complications	31	31	2.00	0.07	3.89
9	Ethical challenges during COVID-19 and lessons learned	ELSI	31	37	2.39	0.00	2.83
10	The transmission of COVID-19	Epidemiological characteristics	31	36	2.32	0.00	2.90

Note. Avg denotes the average of the metric. ELSI denotes ethical, legal, and social issues.

We manually went through the top ten subgraphs of PubMed to uncover highly commented topics. Supplementary Table 5 illustrates subgraph themes and network structural features. It is noteworthy that, four subgraphs focus on drug related issues, specifically addressing drug efficacy (2nd and 7th graphs) and complications (4th and 8th graphs). Three subgraphs concentrate on issues beyond medicine, categorized as ethical, law, and social issues (ELSI) [9]. This aligns with the finding that controversial topics tend to attract comments. Clinical applied issues, carrying higher risks and harmfulness, may lead to increased disputation. Furthermore, according to the hierarchy of sciences, social disciplines, characterized by higher complexity [10] and uncertainty involved may deepen discussions and controversies.

Supplementary Table 9. Network metrics of the top 10 subgraphs in WOS

Rank	Nodes	Edges	Average degree	Average clustering coefficient
1	75205	185453	4.93	0.04
2	20	19	1.90	0.00
3	18	17	1.89	0.00
4	18	17	1.89	0.00
5	17	16	1.88	0.00
6	16	18	2.25	0.10
7	16	15	1.88	0.00
8	14	13	1.86	0.00
9	14	13	1.86	0.00
10	13	20	3.08	0.21

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