

BIBLIOMETRIC ANALYSIS OF THE INCIDENCE OF NON-COVID RESPIRATORY DISEASE UNDER NPI CONDITIONS DURING THE PANDEMIC

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ABSTRACT. Publications associated with the incidence of respiratory diseases in light of the COVID-19 pandemic have skyrocketed. Using bibliometric analysis, this study assessed the characteristics of published articles regarding non-pharmaceutical interventions (NPIs) on other respiratory infections during the COVID-19 pandemic. On July 06, 2023, a systematic review of literature on the incidence of respiratory diseases was conducted using the Scopus database. VOS viewer software was used to visualize the network. This study yielded a total of 910 articles, which were eventually narrowed down to 148 articles. The findings of the bibliometric analysis revealed a trend in research that included not only the investigation of the incidence of other respiratory diseases but also that of gastrointestinal infections during the

COVID-19 pandemic. Most of the research output was created by American and Chinese authors. Kim J. H. was the most productive and cited researcher, with three research articles. There is a scarcity of data on the effectiveness of NPI in preventing the spread of other respiratory diseases among various age groups, including children, adults, and vulnerable populations. Countries should consider increasing their support for COVID-19 research, to generate knowledge pertaining to NPIs and, by extension, other infectious diseases with similar transmission mechanisms.

Keywords: bibliometrics; COVID-19; incidence; keyword analysis; nonpharmaceutical interventions; respiratory disease.



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INTRODUCTION

The rapid spread of coronavirus disease 2019 (COVID-19) led to the implementation of public health measures across the globe by various governments. These measures were enacted to limit or interrupt the transmission of the disease. Public health interventions fall into two broad categories, namely pharmaceutical and nonpharmaceutical interventions. While pharmaceutical measures (e.g. antibodies, vaccines) tend to be pathogen specific, nonpharmaceutical measures target a broad range of pathogens. For example, a suite of interventions, such as case identification, isolation and personal hygiene, were crucial to stopping the Ebola outbreak of 2014 (Tuncer *et al.*, 2018). Evidence also abounds on the effectiveness of measures such as surveillance coupled with isolation and social segregation (contact restriction) as well as oral and hand hygiene in reducing the spread of influenza (Lee *et al.*, 2010; Smith *et al.*, 2015).

In light of the emergence of COVID-19, numerous studies exploring the impact of nonpharmaceutical interventions (NPIs) on the incidence of other diseases have been conducted with largely positive outcomes (Song *et al.*, 2015; Sugimura *et al.*, 2022; Shi *et al.*, 2021; Duffy *et al.*, 2022; Ndeh *et al.*, 2022). For example, a decline in asthma exacerbation rates and respiratory infection hospitalizations was reported in Denmark and Brazil following the introduction of social distancing and sanitary measures, respectively (Toennesen *et al.*, 2022; Altizani *et al.*, 2022). Overwhelmingly, most of these

studies have focused on pathogens that cause respiratory tract infections, such as the influenza virus and respiratory syncytial virus. Besides the obvious reason of having a shared transmission mechanism with COVID-19, interest in other respiratory infections is due to them being a leading cause of death globally, especially among the elderly and immunocompromised (Hyams *et al.*, 2022). Furthermore, understanding the far-reaching impact of nonpharmaceutical interventions on respiratory infectious diseases helps the scientific community to craft better preventive strategies for future disease outbreaks.

The onset of the COVID-19 pandemic led to a rapid increase in research on the topic at hand. Consequently, it is important to evaluate the current publication trends and identify potential research gaps in the niche. Bibliometric analysis is a suitable tool for quantitative exploration of enormous data sets, to provide insight on the relatedness, impact and current and future publication trends in a field of research (Donthu *et al.*, 2021; Lee *et al.*, 2020). To the best of our knowledge, no studies have systematically reviewed the impact of NPIs instituted during the COVID-19 pandemic on other respiratory infections. Thus, this paper seeks to determine, via bibliometric analysis, the publication trends and future research gaps pertaining to the impact of NPIs during the pandemic.

MATERIALS AND METHODS

Study selection and data collection

A systematic review of the literature was performed using the electronic scholarly database Scopus.

Bibliometric analysis of the incidence of non-covid respiratory disease under NPI conditions

The search string used consisted of different combinations of the keywords “respiratory diseases”, “Covid-19” and “trend” as the primary themes upon which the current review is built. Accordingly, the following search string was constructed and searched for in the title field of the database: (“respiratory disease” OR “respiratory disease*” OR “respiratory infection*”) AND (“COVID-19” OR “Coronavirus” OR “SARS-COV-2” OR “pandemic”) AND (“incidence” OR “trend”).

The initial database search performed on July 06, 2023, was limited to peer-reviewed journal articles and reviews in the English language published between 1 January 2020 and the date of the search. The search result yielded a total of 910 articles. The pool of generated articles was further inspected with a focus on research pertaining to the incidence of respiratory disease in the context of the COVID-19 pandemic. This process also entailed disqualifying publication duplicates, whether relevant or not relevant to the focus. As a result, a total of 148 articles met the eligibility criteria for conducting bibliometric analyses. *Figure 1* summarizes the aforementioned steps on data collection.

Data analysis

Bibliometric analysis is a statistical tool enlisted to evaluate large volumes of literature in order to provide quantitative information on the influence of publications or specific research areas in the scientific community (Iftikhar *et al.*, 2019).

It facilitates the identification of research themes, future research trends and directions within a study area by furnishing visual representations of the relationships among articles, journals, keywords, citations and co-citation networks (Ranjbari *et al.*, 2021). VOSviewer software (version 1.6.18) was used to perform bibliometric analysis (van Eck and Waltman, 2010). Consequently, bibliometric variables such as citation, collaboration, bibliographic coupling network and keyword analyses are discussed in this research within the context of the incidence of respiratory diseases following the application of nonpharmaceutical measures during the COVID-19 pandemic.

Additionally, all descriptive statistics with data relating to citation and collaboration analysis were analysed using Microsoft Excel.

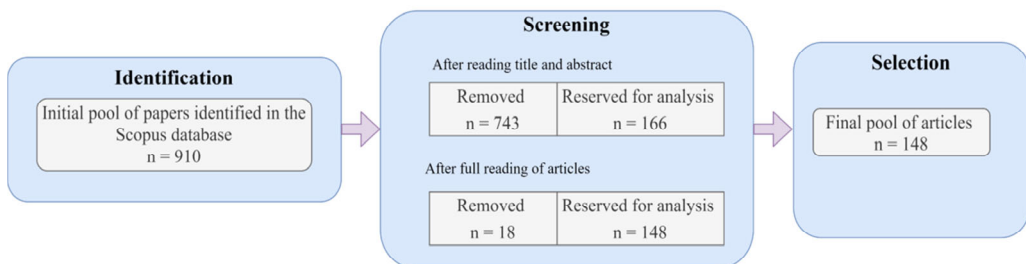


Figure 1 – Flow chart summarizing the selection and filtration of articles from the database

RESULTS AND DISCUSSION

Citation analysis

Citation analysis takes advantage of quantitative data obtained from citations sourced from a variety of publication types (in this case, articles) to assess academic impact. To generate a citation analysis and journal analysis table for export to excel, the minimum threshold for citation by an author and source was set to 1. As such, a total of 914 citations were recorded in the Scopus database from the 148 articles analysed with an average of six citations per document.

The majority of articles (62, 42.18%) have not received citations. Of all the articles, 68 (46.25%) were cited between 1 and 20 times. Moreover, 16 articles (10.88%) received between 20 and 40 citations. By contrast, two articles, titled “decreased influenza incidence under COVID-19 control measures, Singapore”, published in 2020, and “changes in the incidence of invasive disease due to *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitidis* during the COVID-19 pandemic in 26 countries and territories in the Invasive Respiratory Infection Surveillance Initiative: a prospective analysis of surveillance data”, published in 2021, received 146 and 57 citations, respectively. The most cited article was one authored by Soo *et al.* discussing the reduction in the incidence of influenza in Singapore by comparing pre- and post-public health measure implementations. The second most cited article was authored by Brueggemann *et al.* and studied surveillance data on *S. pneumoniae*, *H. influenzae* and *N. meningitidis* between 2018 and mid-

2020 gathered from 26 countries and territories.

The 148 articles filtered from the database were published in 104 journals of similar fields. The top journals in terms of the number of documents were Pediatric Pulmonology (six articles), Influenza and Other Respiratory Viruses (six articles), Clinical Infectious Diseases (five articles) and Frontiers in Pediatrics (five articles) (*Table 1*). Overall, these journals comprised 15% (22 articles) of the documents, with a total of 232 citations. Clinical Infectious Diseases received 187 citations and a total link strength (TLS) of 0, followed by Frontiers in Pediatrics with 25 citations (TLS = 0).

Collaboration analysis

Collaboration analysis, which aids in the evaluation of the number of shared publications among authors and their relatedness, is assessed via the co-authorship function by using a minimum threshold of one document for countries and two documents for organizations. The number of publications and citations per institution were analysed to determine the top institutions that published research on the incidence of respiratory diseases during the pandemic. *Table 2* depicts the top four institutions in terms of productivity. University College Medicine, South Korea and Sungkyunkwan University School of Medicine, South Korea had the highest productivity (2 publications) and impact (53 citations).

Two institutions were based in South Korea, with another two in United States and China. In about three and half years of the global pandemic, 148 published articles were obtained from

Bibliometric analysis of the incidence of non-covid respiratory disease under NPI conditions

the Scopus database. These publications originated from 53 countries around the globe. The top countries that published

research on COVID-19 are depicted in *Table 2*.

Table 1 – Cited journals analysis

Source	Documents	Citations	Total Link Strength
Pediatric Pulmonology	6	15	2
Influenza and Other Respiratory Viruses	6	5	0
Clinical Infectious Diseases	5	187	0
Frontiers in Pediatrics	5	25	0

Table 2 – Top countries, institutions and authors with the most publications

Subject	No of publication	Citations	Total Link Strength
Country			
United States	23	163	15
China	15	101	28
Italy	13	78	6
United Kingdom	13	152	32
South Korea	12	137	22
France	10	81	25
Germany	9	131	23
Israel	9	97	23
Brazil	6	108	22
Canada	6	82	30
Australia	5	31	7
Denmark	5	102	24
Japan	5	5	1
Spain	5	57	23
Organization			
Department of Pediatrics, Severance Children's Hospital, Yonsei University College of Medicine, Seoul, South Korea	2	53	2
Division of Infectious Diseases, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea	2	53	2
Department Of Epidemiology of Microbial Diseases, Yale School of Public Health, New Haven, Ct, United States	2	36	0
Center For Disease Control and Prevention of Central Theater Command, Shijingshan District, Beijing, China	2	28	2
Authors			
Kim J.-H.	3	60	29
Blanchon T.	3	6	65
Hanslik T.	3	6	65

The table was generated based on the number of documents associated with each country. However, documents co-authored by many countries were excluded from the analysis. United States had the most published research articles (23 publications), while South Korea had the most significant impact, as evidenced by the total of 137 citations. There were 13 publications on the subject from Italy and United Kingdom. China provided 15 research articles, while Germany and Israel provided 9 articles. "Kim J.-H." was the researcher with the most total citations, with 3 publications and 60 total citations. South Korea was home to six researchers.

Bibliographic coupling network analysis

Author data analysis shows a total of 582 authors were responsible for 148 publications. The average number of authors per article was four. A total of 78 articles representing 52.7% was written by 2–3 authors (*Figure 2*). Articles written by 4–9 authors accounted for 33%, while those with 10 or more authors represented 13.5%.

Bibliographic coupling maps group articles based on the references they have in common. Articles are grouped in clusters distinguished by colour based on similarity in themes. Bubble sizes are indicative of the volume of citations linked to the articles. *Figure 3* was created by setting the minimum publication number to 2 with 25 authors meeting the threshold. On that account, three authors distinguished themselves; Kim J.-H., Blanchon T. and Hanslik T., with three articles each. *Figure 3* depicts

the relationship between these co-authors.

The bibliographic coupling map grouped articles into three clusters (*Figure 3*). Across all clusters, the running theme was the impact of nonpharmaceutical interventions in containing the spread of COVID-19 and their incidental benefits of reducing the incidence of respiratory infections. Cluster 1 (red colour) articles largely investigated the effectiveness of NPIs on respiratory and gastrointestinal infections (GII) in different age groups (Friedrich *et al.*, 2021a, b; Huh *et al.*, 2021). A smaller subset of papers within this cluster went a step further by focusing on how the incidence of respiratory and gastrointestinal infections changed depending on the intensity of NPIs (Park *et al.*, 2021). The consequence was that these infections decreased massively due to more stringent NPIs but resurged in later phases due to relaxation of these measures (Tanislav *et al.*, 2022). Epidemiological nuances in the diseases were observed before and after implementation of pandemic measures. For example, influenza and GII decline were more pronounced in children than in adults (Heinzinger *et al.*, 2021); the average median age of influenza and RSV patients increased during the pandemic (Debin *et al.*, 2022), while the severity of these diseases decreased (Park *et al.*, 2021; Debin *et al.*, 2022). A possible cause of the more noticeable difference in the decline of respiratory and gastrointestinal diseases among children might be differences in compliance (Launay *et al.*, 2021). Papers in this cluster were largely from China

Bibliometric analysis of the incidence of non-covid respiratory disease under NPI conditions

(8), followed by four each for South Korea and Germany, and a single article each for France, Singapore and Vietnam. Cluster 2 (green colour) examined the impact of nonpharmaceutical measures on hospitalization in infants and children suffering from non-COVID-19 respiratory infections (Souty *et al.*, 2021; Wang *et al.*, 2022). Papers in this cluster originated from Brazil.

Like those in cluster 2, articles in cluster 3 (blue) studied how pandemic-related interventions altered the transmission of communicable diseases ranging from respiratory to gastrointestinal infections among different age groups (Huang *et al.*, 2021; Tanislav and Kostev, 2022; Sun *et al.*, 2022). All the research in this cluster was conducted in France.

The incidence of gastrointestinal diseases was studied alongside that of respiratory diseases because of similarities in the transmission mechanisms of these pathogens (Heinzinger *et al.*, 2021). A nonpharmaceutical intervention such as hand hygiene hinders the transmission of viruses and other pathogens via the faecal–oral route (Tanislav and Kostev, 2022).

Keyword analysis

To determine hot topics and possible future research trends, the most relevant keywords were determined by performing keyword co-occurrence analysis. Co-occurrence analysis measures the relatedness of items based on the number of shared publications.

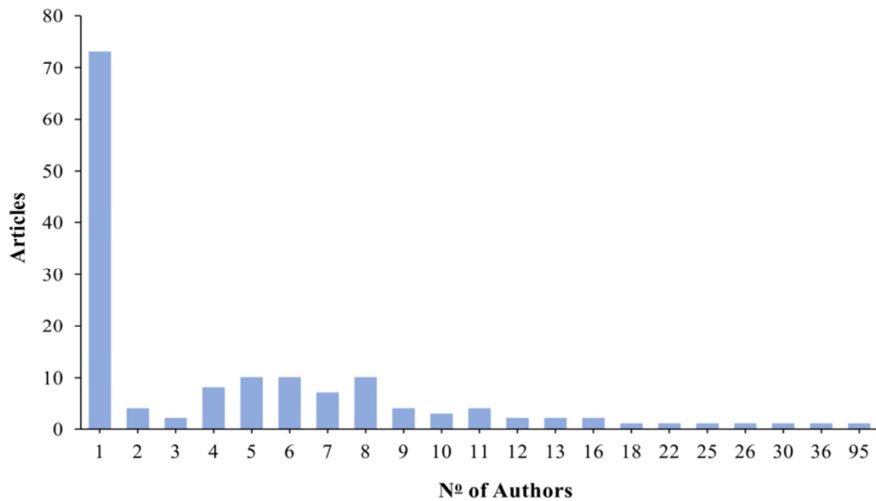


Figure 2 – Number of authors in contrast to the number of articles

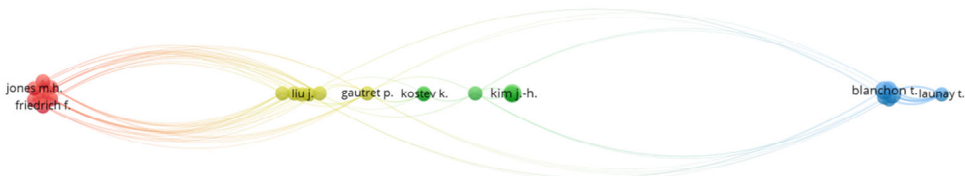


Figure 3 – Bibliographic coupling author map

The threshold of keyword usage was set to three prior to processing. Of the 307 keywords found, 34 met the threshold. The keyword “COVID-19” (total link strength (TLS) 153) appeared most, with 81 co-occurrences, followed by SARS-CoV-2 (occurrences = 32, TLS = 80) and influenza (occurrences = 21, TLS = 65). Twenty-nine unique words classified in 4 clusters were found after cleaning of the keyword data. Circles of the same colour belonged to the same topic cluster, and the sizes of the circles were an indication of the occurrence frequency of the keywords (*Figure 4*).

The keywords associated with the red cluster were focused on the incidental benefits of non-pharmaceutical measures on communicable and non-communicable respiratory diseases in children, using hospital data. Examples of keywords in this cluster include social distancing, asthma, bronchiolitis and children. The keywords linked to the green cluster examined the incidence of other respiratory viral infections following the adoption of measures to prevent the spread of SARS-CoV-2 infection and to treat the infected. Some of the keywords in this cluster included SARS-CoV-2, influenza, respiratory virus, syncytial virus, surveillance and primary care. The keywords related to the blue cluster explored the impact of NPIs on respiratory disease incidence and mortality. Some keywords in this cluster included non-pharmaceutical intervention, prevention and mortality. The keywords affiliated with the yellow cluster hinted at the use of antibiotics during the COVID-19 pandemic, the trajectory of the disease, and other acute

respiratory infections attributed to non-COVID-19 respiratory pathogens or allergies. Some of the keywords in this cluster include respiratory infections and antibiotics.

Social distancing measures, be they individual (e.g. keeping a physical distance of at least 1 m), communal (e.g. working from home) or on a regional level (e.g. lockdown), are one of the most important nonpharmaceutical intervention tools that was implemented to stem the spread of COVID-19 (Prakash *et al.*, 2022). Many governments adopted a mix of social distancing measures to varying degrees of intensities, with the most extreme form being total lockdowns. Numerous accounts back the varied extent of the effectiveness of social distancing measures in containing COVID-19 (Moosa, 2020; Haapanen *et al.*, 2021). Undoubtedly, the effectiveness of these measures hampered the diffusion of other respiratory pathogens with a similar epidemiology (Rotulo *et al.*, 2021; Michaels *et al.*, 2022).

During the pandemic, surveillance was focused on detection and isolation of infected individuals, contact tracing and sampling of environmental media (e.g. wastewater and air) to anticipate possible outbreaks (Litwin *et al.*, 2022; Jané *et al.*, 2022). Traditional surveillance measures are constrained by their reactive approach as opposed to a proactive approach that anticipates and puts in place measures long before an outbreak. The pros of active surveillance, such as the early detection of circulating viruses, facilitates the implementation of measures reflective of disease trends; this helps the

Bibliometric analysis of the incidence of non-covid respiratory disease under NPI conditions

containment of pathogens such as influenza and respiratory syncytial virus (Groves *et al.*, 2022). A pathogen such as the influenza virus is responsible for the hospitalization and death of infants and children, especially in the winter (Cardoso Pinto *et al.*, 2022). A disruption in childhood immunization programs during the pandemic (Kadambari *et al.*, 2022) gives greater urgency for research in this population. Therefore, research geared at understanding the dynamics of paediatric respiratory infections informs public health policies (Huang *et al.*, 2022).

Another upside to keyword analysis is that it indicates potential areas of interest that either have not been investigated or have not been investigated sufficiently, for example, the extent to which each of the nonpharmaceutical interventions contribute to limiting the spread of COVID-19 and, by extension, other

respiratory diseases. Admittedly, this is very challenging because governments across the globe employed a mix of NPIs. For example, Moosa (2020) argues that the success of social distancing measures is dependent on an array of factors, ranging from border control and testing and contact tracing to the quality of healthcare systems.

Furthermore, the effectiveness of the precautionary measures among different age groups needs to be explored to have a comprehensive understanding of disease incidence. Although some studies implied that the reduction in the incidence of other respiratory diseases is higher among children than among adults (Heinzinger *et al.*, 2021), the evidence is not conclusive. For example, the incidence of other communicable respiratory diseases among children of certain ages, adults, older people, and people with compromised immunity could be further investigated.

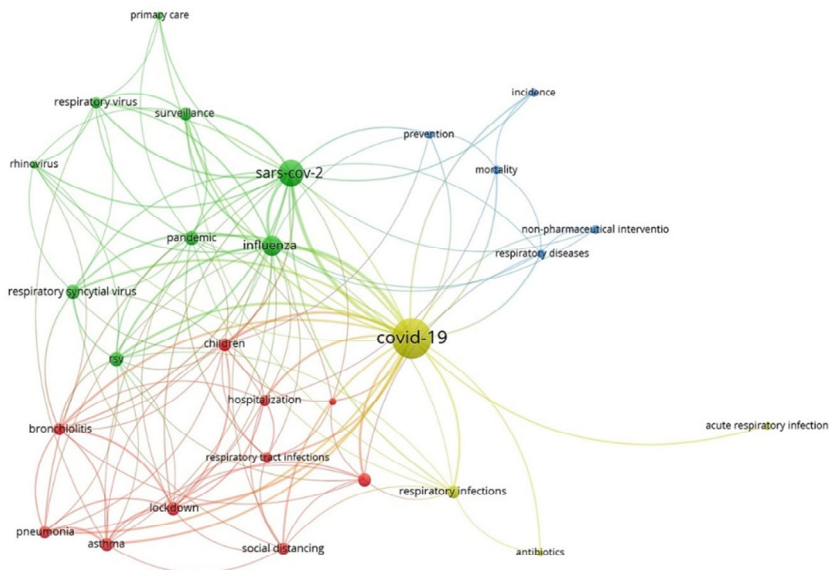


Figure 4 – Keyword analysis map

The limitations of this study are that the articles were only sourced from the Scopus database and were limited to content published in English. The implication of that is the potential to leave out high-quality relevant material. Furthermore, lapses in database updates with respect to citations that influence bibliographic coupling may decrease the extent of relatedness of articles within a cluster. The affiliation of the corresponding author as the origin of the research does not always equal the author's nationality.

CONCLUSIONS

As the COVID-19 pandemic spread throughout the globe, nonpharmaceutical interventions such as face mask wearing, hand hygiene and physical distancing were implemented and recommended by WHO, governments, public health authorities and professionals. NPIs implemented to contain COVID-19 were found to decrease the incidences of other communicable respiratory diseases. Although the reduction in disease incidence varies across studies, most studies indicated that influenza, scarlet fever and pneumonia have decreased significantly (Horita *et al.*, 2022; Wang *et al.*, 2021). Moreover, the studies emphasized that the reduction in respiratory infectious disease is higher in children than in adults (Launay *et al.*, 2021; Wang *et al.*, 2022). All the studies compared the incidence of other respiratory diseases before, during and after easing of public health measures (NPIs).

The majority of the research outputs were produced by USA (23),

followed by China (15), Italy and United Kingdom, with 13 articles each. The most impactful article was published by Soo *et al.* (2020) in the journal *Emerging Infectious Diseases*. The article has received 146 citations, and during the submission of this paper the article had reached 221 citations on Google Scholar. Furthermore, keyword analysis implied that there are research gaps in addressing the effectiveness of each NPI measure in containing other respiratory diseases. There is a paucity of information on the effectiveness of NPI in limiting the spread of other respiratory diseases among different age groups such as children, adults and vulnerable populations. Addressing those research gaps will pave the way to develop targeted interventions aimed at containing communicable respiratory diseases.

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Availability of data and material: Data used in this study are available upon request.

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