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Bibliometric Analysis of Post-Covid-19 Rehabilitation Research

Özlem Karataş[1]

[1] Department of Physical Medicine and Rehabilitation, Akdeniz University Faculty of Medicine, Antalya, Türkiye

Abstract

The long-term effects of the COVID-19 pandemic have adversely impacted individuals' physical and psychosocial health, creating new research areas in rehabilitation. A comprehensive review of post-COVID-19 rehabilitation literature is essential to understand the current state of the field and identify future research priorities.

This study aims to conduct a bibliometric analysis of the literature on post-COVID-19 rehabilitation to evaluate the development of research areas and trends. Articles and related publications indexed in the Web of Science database until December 10, 2024, were reviewed. Using relevant keywords, 81 publications were identified and analyzed bibliometrically. Descriptive statistics were performed using IBM SPSS 22.0, and collaboration networks of authors, keyword co-occurrence relationships, and citation connections were visualized using VOSviewer software. The analysis revealed a significant increase in publications on post-COVID-19 rehabilitation, particularly in 2023. Pulmonary rehabilitation, musculoskeletal recovery, fatigue management, and cognitive dysfunction emerged as key research areas. Keywords such as "Covid-19," "Rehabilitation," and "Pulmonary Rehabilitation" were the most frequently used. Collaboration network analysis highlighted the United Kingdom, the United States, and Italy as central contributors.

The findings suggest that post-COVID-19 rehabilitation has become a multidisciplinary research focus, addressing neurological and psychological effects alongside fatigue and cognitive rehabilitation. Future studies should focus on cellular mechanisms and long-term clinical outcomes to enhance the effectiveness of rehabilitation programs.

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Özlem Karataş **(Corresponding author);** ORCID: 0000-0003-3053-9333 e-mail adress ozlemkir@akdeniz.edu.tr

1. Introduction

The COVID-19 pandemic has become a crisis that significantly challenges healthcare systems worldwide, not only during the acute phase but also due to its long-term effects (World Health Organization, 2021). Post-acute manifestations, known as long COVID or post-COVID syndrome, present a complex array of both physical and psychosocial complications (Nalbandian et al., 2021). These complications range from musculoskeletal disorders and reduced respiratory function to fatigue syndrome and cognitive dysfunction. Consequently, the long-term impacts of COVID-19 have necessitated the development of new approaches in the field of rehabilitation medicine (Greenhalgh et al., 2020).

Post-COVID-19 rehabilitation has emerged as a crucial area of focus, aiming to restore functionality and enhance the quality of life for individuals during and after the pandemic (Chen et al., 2021). The literature in this domain has rapidly expanded, with researchers from various disciplines contributing significantly (Sivan & Taylor, 2020). However, systematically analyzing this growing body of work is essential to understand the current state of the field, and bibliometric approaches play a critical role in this endeavor.

This study aims to present a bibliometric analysis of the post-COVID-19 rehabilitation literature. By examining authorship, country of origin, journals, keywords, and citation trends, the research seeks to identify key developments and areas for growth within the field. We believe that the findings will guide academic endeavors and inform future practices in post-COVID-19 rehabilitation.

2. Material and Methods

The study included articles, reviews, and other relevant publications indexed in the Web of Science (WoS) database up to December 10, 2024. A bibliometric analysis was conducted on 81 publications retrieved using the following keywords: ("Post-COVID-19 rehabilitation" OR "Long COVID rehabilitation" OR "Post-acute COVID-19 rehabilitation" OR "COVID-19 recovery rehabilitation" OR "COVID-19 sequelae treatment" OR "COVID-19 physical therapy" OR "COVID-19 physiotherapy" OR "COVID-19 rehabilitation outcomes") (Topic). The analysis focused on co-authorship among authors, co-occurrence of keywords, and co-authorship among countries. Descriptive statistics of the bibliometric data were analyzed using IBM SPSS 22.0 (SPSS Inc., Chicago, USA). Key metrics such as publication trends, citation counts, influential countries, and journals were examined. Author collaboration networks, keyword co-occurrence relationships, and citation links were visualized using VOSviewer 1.6.16 software.

Data preprocessing, visualization, and clustering were performed using VOSviewer 1.6.16. Co-authorship among authors, co-occurrence of keywords, and co-authorship among countries were evaluated with VOSviewer. Total Link Strength (TLS) reflects the overall connection weight by indicating the total links of a node (e.g., a country, author, or journal) with other nodes and the significance of these links. In this study, TLS values were used to assess collaborations between countries, joint works among authors, and connections between journals. Nodes with high TLS values demonstrate significant contributions to the

academic network through strong collaborative links with other nodes.

The obtained data were examined based on authors, journals, countries, and keywords. Descriptive statistics were generated using SPSS 25, and categorical data were presented as counts and percentages.

Since bibliometric studies are conducted on open data, they do not require ethical committee approval (Levin et al., 2023). As the data used in this study are publicly available, ethical committee approval was not sought.

3. Results

When examining the distribution of publications by year, it was observed that 7 studies (8.6%) were published in 2020, 16 studies (19.8%) each in 2021 and 2022, reaching the highest number in 2023 with 24 studies (29.6%). The number of publications for 2024 was determined to be 18 (22.2%).

In terms of document types, articles accounted for the highest proportion at 76.5% (n=62), followed by conference abstracts at 12.3% (n=10), editorial writings and reviews at 4.9% (n=4), and letters at 1.2% (n=1).

Regarding language distribution, English was the most common at 96.3% (n=78), with Spanish at 2.5% (n=2) and Portuguese at 1.2% (n=1).

Only four journals had more than three publications, all indexed in the "Science Citation Index-Expanded." The distribution is as follows: "Journal of Clinical Medicine" with 6 publications (7.4%), "BMJ Open" with 4 publications (4.9%), "European Respiratory Journal" with 4 publications (4.9%), and

"International Journal of Environmental Research and Public Health" with 3 publications (3.7%).

In terms of citations, the average number of citations per study was calculated as 13.1±48.6, with a median of 2. The citation range varied between 0 and 428, with 34.6% of the studies not receiving any citations.

4. Author Collaboration

In this section, the relationships and interactions among 599 authors collaborating in a specific area across 81 publications are analyzed and visualized. In the analysis conducted using VOSviewer, the criterion of having at least one document was applied; however, not all authors were connected to each other. The 51 authors with the highest collaboration or relationship were visualized, while those unrelated were excluded. The 4 identified clusters enhance the precision and effectiveness of the results. These clusters represent the connections among authors (Figure 1).

"Total link strength" reflects the overall link weight and importance of a node with others in the network. The authors with the strongest total link strength are as follows: Brown, Darren A. (37 link strength, 3 publications, 24 citations), Gross, Douglas P. (26 link strength, 2 publications, 24 citations), O'Brien, Kelly K. (21 link strength, 2 publications, 21 citations), Tarrant, Rachel (19 link strength, 2 publications, 29 citations), O'Connor, Rory J. (17 link strength, 2 publications, 67 citations), Preston, Nick (17 link strength, 2 publications, 67 citations), and Sivan, Manoj (17 link strength, 2 publications, 67 citations). These authors stand out both in terms of their link strength within the collaboration network and their number of publications and citations.
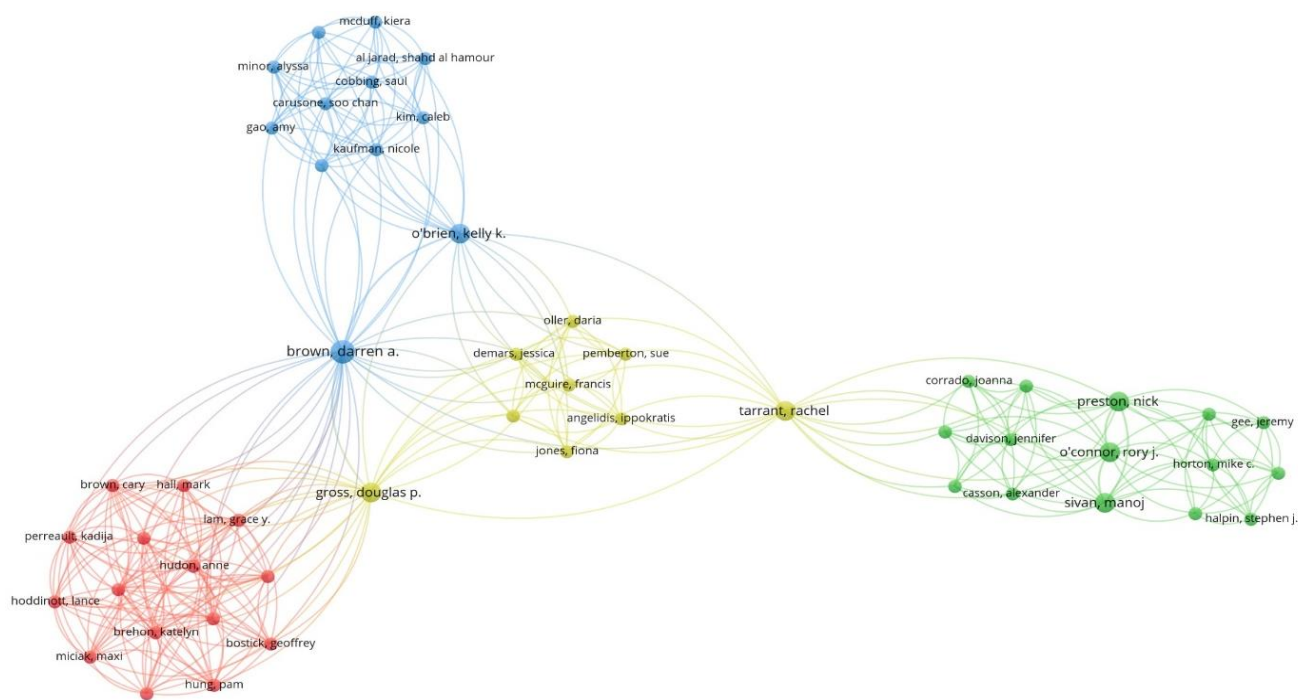
Figure 1. Collaboration Network Among Authors. (The network includes a total of 599 authors; however, some of them are not connected to each other. The 51 authors with the highest collaboration or relationships have been visualized, while unconnected authors are not shown).
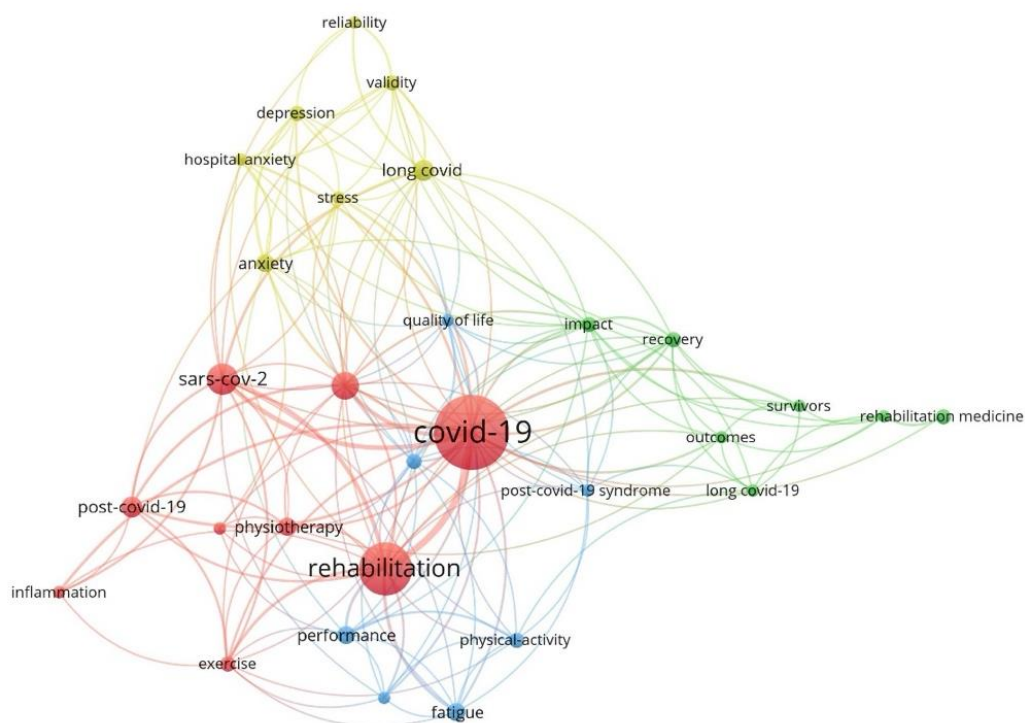

Figure 2. Keyword Network Analysis

5. Keyword Analysis: Co-occurrence Network Analysis

In this section, a "Co-occurrence Keywords" analysis was conducted to examine how frequently the keywords used in the publications appear together. According to the analysis results, a total of 351 keywords were identified across 81 publications, and these keywords were divided into 4 different clusters based on their co-occurrence and relationships with each other (Figures 2). These clusters represent keywords that are frequently used together around a specific topic, method, or research area. To be included in the analysis, a keyword had to appear at least 3 times, and out of the total 351 keywords, only 30 met this criterion (minimum 3 occurrences).

The total link strength indicates how frequently a keyword appears together with other keywords. A high total link strength value signifies that the keyword has a strong relationship with other keywords. In the keyword co-occurrence analysis, the most frequently used keywords with the highest total link strength are as follows: Covid-19 (39 occurrences, 79 link strength) and Rehabilitation (24 occurrences, 52 link strength) emerged as the most commonly used keywords. These were followed by SARS-CoV-2 (11 occurrences, 33 link strength) and Pulmonary Rehabilitation (9 occurrences, 27 link strength).

Other significant keywords include Long Covid (6 occurrences, 18 link strength), Anxiety (5 occurrences, 17 link strength), Exercise (4 occurrences, 17 link strength), and Post-COVID-19 (6 occurrences, 16 link strength).

6. International Collaboration Network

The Co-authorship by Countries analysis was conducted to examine and visualize the relationships between countries of authors collaborating on documents published in a specific field. Using VOSviewer, 41 countries with at least one publication were included in the analysis. However, due to some countries remaining independent in the network, only 23 countries were included in the geographic distribution graph. Countries such as the United Kingdom, Italy, and the United States are central to the network both in terms of collaborations and citation counts (Figure 3).

Based on total link strength, the collaboration between countries is as follows: the United Kingdom (20 link strength, 18 publications, 567 citations) holds the highest link strength. This is followed by Italy (12 link strength, 7 publications, 127 citations), Switzerland (11 link strength, 3 publications, 47 citations), and the United States (11 link strength, 10 publications, 90 citations). Spain (10 link strength, 6 publications, 90 citations), Germany (9 link strength, 5 publications, 33 citations), and the Netherlands (8 link strength, 2 publications, 19 citations) are also among the significant countries.

These countries occupy a central position in the collaboration network, making substantial contributions in terms of publication counts and citation values.
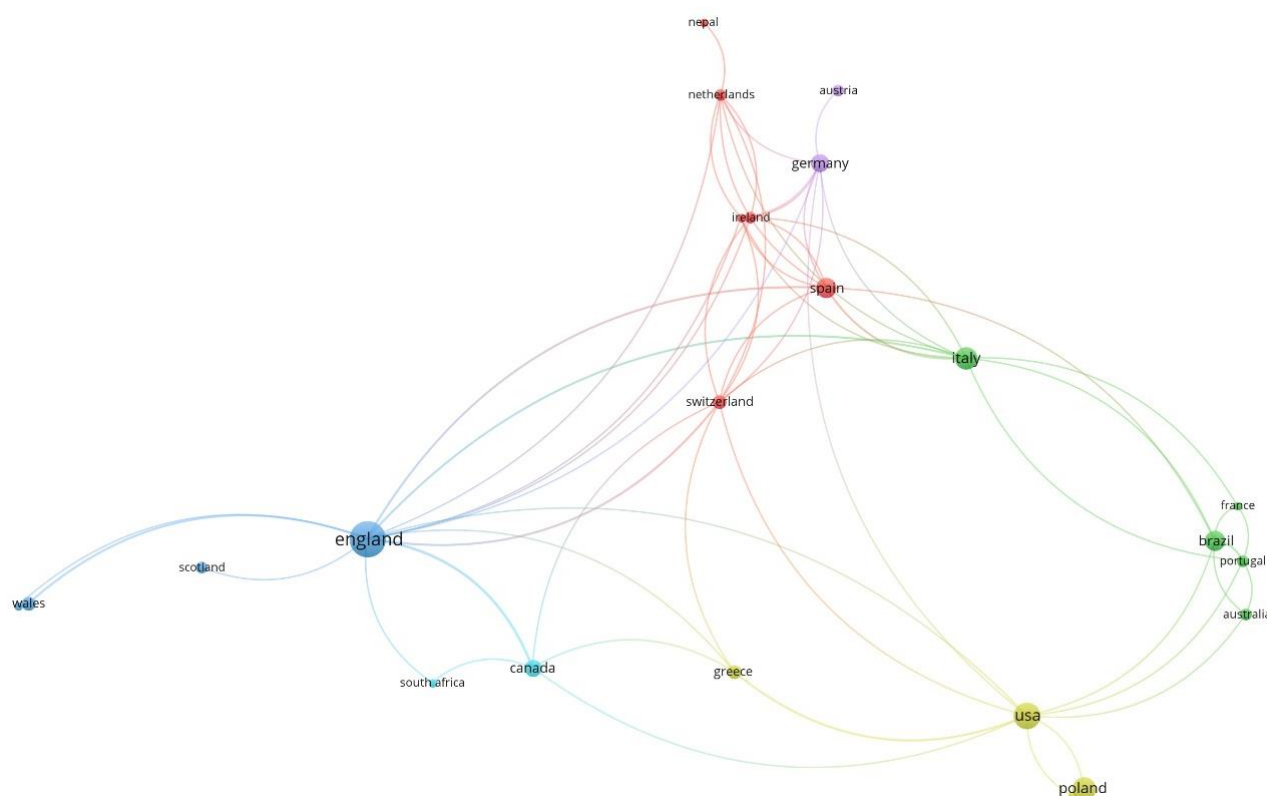
Figure 3. Collaboration Network Among Countries

7. Discussion

This study objectively presents a comprehensive bibliometric analysis of the literature on post-COVID-19 rehabilitation. Insights have been obtained that can guide researchers and healthcare professionals to predict the future development of this field. Additionally, through analyses of co-authorship among authors, co-occurrence of keywords, and co-authorship among countries, the overall structure and interaction network of this field have been examined in detail.

The key topics highlighted in studies on post-COVID-19 rehabilitation focus on accelerating recovery processes after the pandemic and improving quality of life. The bibliometric findings show that there is intense global collaboration in this field, with contributions from researchers across multiple disciplines. For instance, studies aimed at improving lung functions emphasize the importance of pulmonary rehabilitation in this process. Furthermore, topics such as the effects on the musculoskeletal system and fatigue management have also become primary focal points of rehabilitation programs (Huang et al., 2021).

The results of the keyword analysis indicate that the most frequently used terms in the post-COVID-19 rehabilitation literature are "Covid-19" and "Rehabilitation." These are followed by "SARS-CoV-2" and "Pulmonary Rehabilitation." These findings support the prominence of respiratory rehabilitation and physical recovery processes as key topics in the literature. Additionally, the use of keywords such as

"long COVID" and "post-COVID-19" highlights the focus on managing chronic symptoms and investigating long-term effects as current research priorities. This provides an essential foundation for understanding the current dynamics and future research opportunities in the field (Xue et al., 2022). The trends in post-COVID-19 rehabilitation indicate increasing interest in this topic, supported by a steady rise in the number of published studies. Current data reveal that reports are frequently published on the significant role of COVID-19 rehabilitation in improving both respiratory functions and physical capacity. In particular, the widespread findings on the safety and effectiveness of rehabilitation point to its potential to make greater contributions to future research. Trend lines obtained from bibliometric analyses show that intensive knowledge production in this research area will continue, and new findings will be added to the literature (Sivan et al., 2020).

Among the journals with the highest number of publications, Journal of Clinical Medicine ranks first in terms of impact factor (IF), CiteScore, and citation frequency. The journal's category is medicine, with a subcategory of general clinical medicine; its ranking places it among high-impact journals in this field. This indicates that academic articles published in this journal are of high quality and possess a strong impact. In terms of publishing countries, the journal originates from the United Kingdom, suggesting that the UK has invested more in this field and placed greater importance on it.

The analysis of the strongest citation bursts helps to predict research trends and boundaries in the field of post-COVID-19 rehabilitation. In the early periods (2020–2021), the prominence of keywords such as respiratory function and pulmonary rehabilitation indicates a focus on addressing the acute respiratory system effects of COVID-19. In the mid-term period (2022–2023), the increased use of terms like long COVID, mental health, and neurological rehabilitation reveals a tendency to explore the long-term neurological and psychosocial effects of COVID-19. In recent years, concepts such as cognitive dysfunction, fatigue management, and physical activity have become central research focuses, emphasizing the importance of comprehensive and multidisciplinary interventions in post-COVID-19 rehabilitation processes. These trends suggest that future studies will focus on innovative strategies aimed at mitigating the long-term effects of COVID-19.

These trends indicate that post-COVID-19 rehabilitation has become an important research focus regarding the management of diseases associated with chronic effects and applications aimed at improving quality of life. In the future, detailed studies on cellular and molecular mechanisms are anticipated to be one of the significant areas of development in this field. For example, some studies have shown that interventions enhancing neuroplasticity are effective in post-COVID-19 rehabilitation. Additionally, recent studies have found that physical exercise provides positive effects on the musculoskeletal system damaged by COVID-19 and activates cell repair mechanisms to alleviate chronic fatigue syndrome (Spruit et al., 2020; Fathi & Rezaei, 2020).

These findings suggest that further research into the biological foundations of post-COVID-19

rehabilitation will be conducted, and new discoveries in this area will enhance the effectiveness of rehabilitation programs.

In this bibliometric and visualization analysis, we focus on non-invasive and effective interventions, which are an important research topic in post-COVID-19 rehabilitation. The initial studies on post-COVID-19 rehabilitation began to be published in 2020, following the acute effects of the pandemic. In these early studies, pulmonary rehabilitation and musculoskeletal effects were particularly prominent (Spruit et al.,2020). The effects of physical interventions aimed at improving respiratory functions and the efficacy of exercise programs were extensively examined during this period (Greenhalgh et al.,2020).

In recent years, research on topics such as cognitive dysfunction, fatigue management, and neurological rehabilitation has rapidly increased. For example, some studies have reported that physical exercises improve neurological and musculoskeletal damage caused by COVID-19 (Nalbandian et al., 2021). However, research on the long-term effects of COVID-19 has also revealed some conflicting results. Specifically, it has been reported that certain interventions do not increase respiratory capacity or have limited effects on physical performance (Carvalho-Schneider et al., 2021). Conversely, the positive effects of psychosocial support and multidisciplinary rehabilitation programs on patients' quality of life have been repeatedly emphasized (Sivan & Taylor, 2020).

This study has certain limitations. First, only the Web of Science database was used in this research, and other databases were excluded; therefore, some relevant articles may have been missed. However, based on the published literature, Web of Science is the most widely used database in bibliometric analyses (Suelzer et al., 2019; Sugimoto et al., 2019). Web of Science contains a significant portion of the literature in this field and offers a broad enough scope to reflect research trends and perspectives in post-COVID-19 rehabilitation treatment.

Second, the literature in the database is continuously updated, but we selected only articles published between 2020 and 2024, excluding studies that may be published in 2025. Finally, this analysis is a timeline-based bibliometric analysis. Therefore, high-quality articles published in recent years may not have received sufficient citations yet and could potentially be undervalued.

Based on these limitations, researchers should conduct a comprehensive review of the relevant literature to gain a deeper understanding of the field.

8. Conclusion

This study comprehensively examined the literature on post-COVID-19 rehabilitation, highlighting current research trends and future potential research areas. According to the results of the bibliometric analysis, post-COVID-19 rehabilitation studies focus on topics such as improving respiratory functions, musculoskeletal rehabilitation, fatigue management, and cognitive dysfunction. In recent years, this field has emerged as an area of research where multidisciplinary approaches are increasingly prominent.

The long-term effects of COVID-19 are not limited to the respiratory system but also include neurological, psychological, and physical issues. This underscores the importance of developing customized rehabilitation programs tailored to individual needs. To enhance the effectiveness of rehabilitation interventions, more in-depth studies focusing on both clinical applications and cellular and molecular mechanisms are needed.

The findings indicate that post-COVID-19 rehabilitation holds significant potential for future research, particularly in areas such as neuroplasticity, cellular repair mechanisms, and multidisciplinary approaches. High-quality, long-term studies in this field will enhance the effectiveness of rehabilitation programs and contribute to the development of new strategies aimed at improving the quality of life for post-COVID-19 patients.

Ethical Statement

This study is a bibliometric analysis and does not require ethical approval.

Financial Support for the Study

Presentation Information

The findings of this study have not been presented at any conference or meeting prior to this publication.

Conflicts of Interest

The authors declare no conflicts of interest regarding this study. Any institution or organization providing funding for this research did not have any role in the design, data collection, analysis, interpretation, or publication to influence or distort the findings.

Author Contributions

All stages of this study (study design, data collection, analysis, interpretation, writing, and editing) were conducted by a single author. The full responsibility for the study rests with the author. Author: Özlem Karataş

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