

---

# MAPPING AND BIBLIOMETRIC ANALYSIS OF SCIENTIFIC PUBLICATIONS ON THE USE OF TEXTILE MATERIALS FOR PROTECTION IN PANDEMICS

*Mapeamento e análise bibliométrica de publicações científicas sobre o uso de materiais têxteis para proteção em pandemias*

---

**Ana Aline Mendes Paim (1), Morgana Carneiro de Andrade (2) Fernanda Steffens (3)**

(1) Federal University of Santa Catarina, Brazil, [anaalinemendespaim@gmail.com](mailto:anaalinemendespaim@gmail.com)

(2) Federal University of Espírito Santo, Brazil, [morganaandrade@gmail.com](mailto:morganaandrade@gmail.com)

(3) Federal University of Santa Catarina, Brazil, [fernanda.steffens@ufsc.br](mailto:fernanda.steffens@ufsc.br)



## Abstract

One of the main segments of technical textiles are textile materials applied in the medical field. These are products specifically developed to meet the demands of healthcare applications. These products are commonly used in personal protective clothing, in order to avoid or minimize the risks of cross-infections. The occurrence of pandemics is associated with a worldwide spread of an epidemic causing an excessive number of deaths. In that regard and considering the role of medical textiles for personal protection, the purpose of this work was to map and investigate the main research focuses related to the use of textile materials for protection in pandemics, published in the period from 2017-2021. The methodology used is the ProKnow-C, following all of its steps from the selection of databases (Scopus, Medline and Web of Science) and keywords, to obtaining and bibliometric analyzing the final portfolio with 16 articles. From this portfolio, it was possible to identify the most relevant works within this research segment (Konda et al., 2020, Liao et al., 2020, and Dbouk and Drikakis, 2020), which reflects the main trends of studies carried out in the last five years on the use of textile materials for protection during pandemics and the most prominent journals: ACS Nano, New England J Med, and Scientific Reports. From these data, contributes to the field by providing important bibliometric indicators to help other researchers in future works. From these data, it is possible to contribute to this area by providing important bibliometric indicators to help researchers in future studies.

**Keywords** Technical textiles; Protection; Sars-CoV-2; Systematic review; ProKnow-C.

## Resumo

Um dos principais segmentos dos materiais têxteis são os têxteis médicos, produtos desenvolvidos especialmente para atender demandas da área da saúde. Geralmente são empregados em vestuário de proteção pessoal com a finalidade de minimizar ou evitar os riscos da exposição a substâncias perigosas e infecções cruzadas. A ocorrência de pandemias está associada à disseminação mundial de uma epidemia causando um excessivo número de mortes. Tendo em vista o papel dos têxteis médicos para proteção pessoal, o objetivo deste trabalho foi mapear e investigar os principais focos de pesquisas relacionados ao uso de materiais têxteis para proteção em pandemias, publicadas no período de 2017-2021. Para isso, utilizou-se a metodologia ProKnow-C, seguindo as etapas de seleção de bases de dados (Scopus, Medline and Web of Science) e palavras-chave até a obtenção e análise bibliométrica de um portfólio bibliográfico, com o total de 16 artigos. A partir desse portfólio foi possível identificar os autores Konda et al. (2020), Liao et al. (2020), e Dbouk e Drikakis (2020) e os periódicos ACS Nano, New England Journal of Medicine, and Scientific Reports como os mais relevantes e, também, compreender os atuais focos de pesquisas sobre o desenvolvimento de máscaras para proteção respiratória. A partir desses dados, é possível contribuir com essa área fornecendo importantes indicadores bibliométricos para auxiliar pesquisadores em estudos futuros.

**Keywords** Têxteis técnicos. Proteção; Sars-CoV-2; Revisão sistemática; ProKnow-C.

## 1 Introduction

---

Technical textiles are textile materials designed for specific applications. These materials usually have high levels of mechanical, thermal and or chemical properties. Their use can be seen in many fields like medical textiles, which are specific for healthcare applications (such as dressings, sutures, masks and prostheses) (Patnaik 2020).

The main use of medical textiles is in personal protective clothing for healthcare workers and patients. Examples of products are overalls, shoe covers, gloves, lab coats, surgical suits, surgical masks and caps. These types of equipment are designed to mitigate exposure to hazardous substances and minimize the risks of cross-infections (Karim et al. 2020).

Medical protective clothing is usually made of synthetic fibers due to their hydrophobic properties. Nonwovens represent more than half of the medical textiles used and often the products are disposable such as caps, masks and surgical gowns. Woven fabrics used are commonly made of cotton (CO) or blends with polyester (PES). These fabrics are used in the manufacture of curtains and bedding for hospital environments, as well as dressings and bandages among other products (Karim et al. 2020).

Polypropylene (PP) is the most common material in the manufacturing of nonwovens for medical applications. For surgical masks, the use of three layers of PP with SMS (spunbond – meltblown – spunbond) technology is very common (Karim et al. 2020; Wibisono et al. 2020; Yamn and Ng 2020). In this technology, each layer has a function: the outer layer has a hydrophobic finish that repels particles, the middle layer acts as the filter element because of its thin fibers, and the inner layer has hydrophilic properties to ensure comfort to the user (Wibisono et al. 2020; Yam et al. 2020). The function of these masks is to create a barrier for fluids and particulates. Although they were initially conceived for surgical use for healthcare professionals, the use of masks is highly recommended in pandemics of respiratory diseases (Akin and Gözel 2020).

Most pandemics have occurred due to pathogens that cause respiratory infections whose transmission usually occurs by expiratory droplets through contact or by aerosols of these particles at close range (Akin and Gözel 2020). This explains the recommendation to use facemasks in times of pandemic, as in 1918 during the Spanish Flu and currently with the global spread of the COVID-19. Nowadays the technological and scientific advances allow obtaining the knowledge needed to improve the performance of textile masks. That is why the number of scientific publications about the use of textile materials for personal protection increased in the last two years since the beginning of the COVID-19 Pandemic (Beesoon et al. 2020).

In that regard, mapping of scientific publications concerning textile materials for protection during pandemics is essential to outline the current panorama of these materials for personal protection. This can enable the identification of the main types of materials used, as well as recent advances and discoveries in this area.

Thus, taking into account the event of the COVID-19 Pandemic and the role of medical textiles, the main objective of this article is to present a Bibliographic Portfolio that represents the “selected fragment of literature” on the main research focuses related to the use of textile materials for protection in pandemics and the bibliometric analyses of the portfolio.

There are many methodologies and tools proposed to assist in the fulfillment of systematic reviews, which assist different research areas (Conforto et al. 2011). An example is State of the Art through Systematic Review (StArt), a tool developed by the Software Engineering Research

Laboratory in the Federal University of São Carlos, which aims to support the systematic review of literature process (Zamboni et al. 2010). Another example is Prisma (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), a guide developed by an international group focused on the selection of reports from meta-analyses of randomized clinical trials (Moher et al. 2015).

In this study, we adopt the methodology Process Knowledge Development – Constructivist (ProKnow-C) (Afonso et al. 2011; Castelli 2018). The choice of this methodology is due to the following contributions: definition of a bibliographic portfolio on a topic, based on systematized procedures; in the systemic analysis of the content; and the quantitative dimension of the portfolio when performing the bibliometric analysis. (Afonso et al. 2011; Castelli 2018; Lacerda et al. 2012). The methodologic structure of the ProKnow-C is suitable to the purpose of this work, which is to obtain knowledge about the research topic and identify new research opportunities in this field. Another reason that justifies the use of this methodology is that until the present moment there are no publications on the textile field using ProKnow-C.

In addition to this introduction, the article is structured in three more sections: Section 2, Design Research, where the procedures adopted to obtain the bibliographic portfolio and the development of bibliometric analysis are presented; in Section 3, it refers to the Analysis and Discussion on indicators related to the portfolio; and finally, final considerations and suggestions for future work are carried out.

## **2 Research Design**

---

This study is exploratory theoretical research, as it aims to provide greater familiarity with the topic. It is also a descriptive work, by describing the characteristics of the phenomenon explored by relating variables (Berlato et al. 2018).

The search for articles about the use of textiles for protection in pandemics occurs through the realization of a systematic literature review following the ProKnow-C methodology that comprise 4 steps: articles selection, bibliometric analysis, systemic analysis and search question.

The complete research on this topic carried out contemplated all ProKnow-C procedures. However, in this paper, only the selection of the bibliographic portfolio and bibliometric analysis are presented.

The first goal of ProKnow-C is defining the bibliographic portfolio (BP). This starts with defining the databases and choosing the keywords. The next procedure is to research and export the results obtained to a bibliographic manager. Then, the process of filtering and selecting articles begins, initially removing the duplicate files. The following approach consists of reading the title of the articles. Then considering the scientific recognition of each article (based on citations), after that reading the abstract and finally by reading the full text.

## 2.1 Selection of databases

---

A preliminary search on Google Scholar, was performed in order to identify the most suitable databases for this search. This is possible because the results on Google Scholar are very embracing. They allow the researcher to identify in which databases is possible to find the articles closely aligned to the study. Using the words textile, fabric, and pandemic it was possible to identify articles related to this research topic and the respective databases.

After this analysis, it was possible to notice that Scopus, Medline and Web of Science indexed most of the articles that seemed to relate to the research topic. Thus, these databases were selected to addressing the searches.

## 2.2 Keywords Definition

---

During the preliminary search on Google Scholar to choose the database, the keywords present in the articles were also observed. The choice of the keywords sought to contemplate the subject in a specific way, however, maintaining a certain amplitude so as not to over restrict the results. The keywords were carefully chosen to contemplate two axes of this research, which are textile materials for protection and pandemics.

The main words observed in the articles related to the theme were: fabric, fiber, cloth, and mask. In addition to these words, the term fibre (British English) and all variations of the word cloth (cloth\*) were included. To test the adherence of these words, a search was performed using

them in Scopus database, which is the base with the greatest coverage among those identified. The combination of words used was: (textiles OR fiber OR fibre OR fabric OR cloth\* OR mask) AND (pandemic).

After reading the first 30 articles (in relevance order), it became clear that the combination of the word mask and the word pandemic resulted in too many articles that were not necessarily related to the research theme. The most suitable articles, beyond the word mask, also had some of the other terms from the first group (Textile, Fiber /Fibre, Cloth, Fabric or Mask). Thus, the word mask was disregarded. After a new test of adherence of terms in the Scopus, it was identified the term garment. Accordingly, the following keywords were selected: Textiles, Fiber / Fibre, Cloth, Fabric, Garment, and Pandemic.

After choosing the bases and defining the keywords, the next step consisted of performing the searches in the databases, using the Boolean operators AND, OR, and NOT. However, when performing the search with terms in the three selected databases, it was observed that relating the term fiber with pandemic. Some misaligned results occurred, such as articles focused on the area of nutrition, relating fiber intake with improved immunity in periods of pandemic. To avoid these results the Boolean operator AND NOT was used to exclude articles with the terms diet and nutrition.

The bibliographic search was carried out from March 12th to 15th, 2021, with the following combination of keywords: Scopus: (textiles OR cloth\* OR fabric OR fiber OR fibre OR garment) AND pandemic AND NOT (diet OR nutrition); Web of Science: (Textiles OR cloth\* OR fabric OR fiber OR fibre OR garment) AND pandemic AND NOT (diet OR nutrition); Medline (PubMed): (Textiles OR cloth\* OR fabric OR fiber OR fibre OR garment) AND pandemic AND NOT (diet OR nutrition).

The search period was limited to the last five years. Furthermore, only articles were considered, thus literature reviews of narrative type and other documents such as books, letters and patents were not included. No language restrictions were applied. The keywords selected must appear in the article title or abstract or keywords.

### 2.3 Articles selection

---

The results obtained from the databases (raw articles bank) were exported to the Zotero© reference manager software. Afterward, the ProKnow-C filtering process begins, eliminating duplicate articles. The next step, reading of all the publications titles in the raw articles bank begins removing those whose titles are not aligned with the research theme (Carvalho et al. 2020). The next filter uses relevance indices based on citation count, publication time and author importance. In this step, all article citation counts are identified, which can be performed in Google Scholar when searches occur in more than one database.

The representativeness criterion is based on a generalization of the Pareto principle (Carvalho et al. 2020; Lacerda et al. 2012). ProKnow-C does not specify a cut-off percentage, which will depend on the review theme. However, most articles that use it recommend seeking a representativeness of approximately 85% (Castelli 2018; Lacerda et al. 2012). Thus, this was the percentage pursued in this work.

In addition to articles considered scientifically relevant, the methodology recommends contemplating articles with less than two years of publication, even if they don't have citations enough to be considered relevant in previous step. The next step is reading all the relevant articles' summaries to see if their content is aligned to the research theme. Those that are approved after the summary reading have their authors identified. The identification of these authors is important to recognize other articles they wrote that haven't been approved in the previous steps (because did not have enough citations and/or were published over two years ago). These articles should be analyzed, as they can be important and related to the research.

In the last step, the full-text reading occurs to confirm the articles' alignment with the research topic. Confirming the alignment, they are integrated into the final bibliographic portfolio (BP). (Carvalho et al. 2020; Lacerda et al. 2012). ProKnow-C also suggests that articles cited in the BP to be evaluated. If the researcher identifies that these cited articles are related to the research topic and meet the inclusion parameters, they are added to the BP.

## 2.4 Bibliometric Analysis

---

The next step corresponds to the bibliometric analysis of the BP articles. This analysis has the objective of quantitatively highlighting some parameters of this set of articles and their references, such as the number of citations, keywords, authors and relevance of the journals (Castelli 2018; Lacerda et al. 2012). In ProKnow-C it is determined that the analysis is done both in articles of the BP and in their references. These analyses extract important information such as the most prolific authors, which journals are most relevant to the topic, the most prominent publications, the impact factor and the co-occurrence of keywords (Castelli 2018; Donthu et al. 2021).

The software VOSViewer assisted the development of the bibliometric analysis. The tables that VOSViewer generated with the data exported from the databases were transferred to Microsoft® Excel to elaborate maps (Eck & Waltman 2010). When exporting data from bibliographic organizers, there is a limitation in the items analyzed. On the other hand, data exported directly from the databases make it possible to analyze a larger number of items.

Thus, we sought to identify whether a single database covered all the articles of the final BP. Since Scopus covered the articles of the final BP, the data was exported in CSV format directly from this database.

Then, the articles underwent the following bibliometric analyses:

- a) relating to the origin of the articles in the BP. The number of articles per journal and the number of citations of these journals were measured,
- b) regarding the most cited periodicals in the references. For this, a cutoff of at least seven citations was established as a parameter in the software. It means that only journals with seven or more citations were considered. This parameter aimed to obtain a restricted number of journals, to make sure that only the ones relevant would be analyzed;
- c) the cited journals impact factor, according to indicators defined by the Web of Science databases, through the Journal of Citations Report (JCR), and Scopus, through the Scimago Journal Ranking (SJR);



- d) identification of the most cited authors in BP. Only BP authors with 50 or more citations were considered. The cut-off number of citations allows restricting the result so that only the most relevant authors appear. The co-authorship network of these authors was also created, aiming to understand how they collaborate;
- e) identification of the most cited authors by the BP references. In this analysis, only authors with at least ten citations were considered relevant. This way it was possible to obtain a not very large number of authors, who are, in fact, relevant to the topic. Also, to facilitate the visualization of the co-citation network generated;
- f) number of documents per country. For this analysis, the software considers the institutional affiliation of the authors;
- g) regarding the most frequent keywords. Only keywords with five or more occurrences were considered. From the results obtained, a network of co-occurrence of these terms was created using VOSViewer. The cutoff number chosen aims to generate a significant number of terms, however, without compromising the visualization and understanding of the network. Furthermore, for a portfolio of sixteen articles, the occurrence of a term in at least five articles means that it is present in 31.2% of the BP articles, a significant value.

### **3 Results and Discussion**

---

The results achieved in each database in the searches carried out between March 12th and 15th, 2021 are presented below. The search strategy with the combination of keywords used (search algorithm) for bibliographic research in each database had a following results: Scopus, 370; Web of Science, 169; and Medline, 145. In the total of 684 articles was obtained.

The results show the greater scope of the Scopus database, as it contains about 54% of the total documents obtained. Next, the Web of Science database stands out with 26% of the total. These two bases are multidisciplinary, because of that their results are more comprehensive. The PubMed database contains about 20% of the total. It is an exclusive basis for the Medicine domain, which explains the lower number of results.

### 3.1 Obtaining the Bibliographic Portfolio: Filtering and Selecting Articles

---

After organizing the 684 files into folders on Zotero© according to the database from which they were exported, 261 duplicate articles were identified and excluded. Subsequently, the remaining 421 documents went through another filtering. From reading the titles of the works, those that were in line with the research theme were identified (100 articles), excluding the others that were not aligned (321 articles).

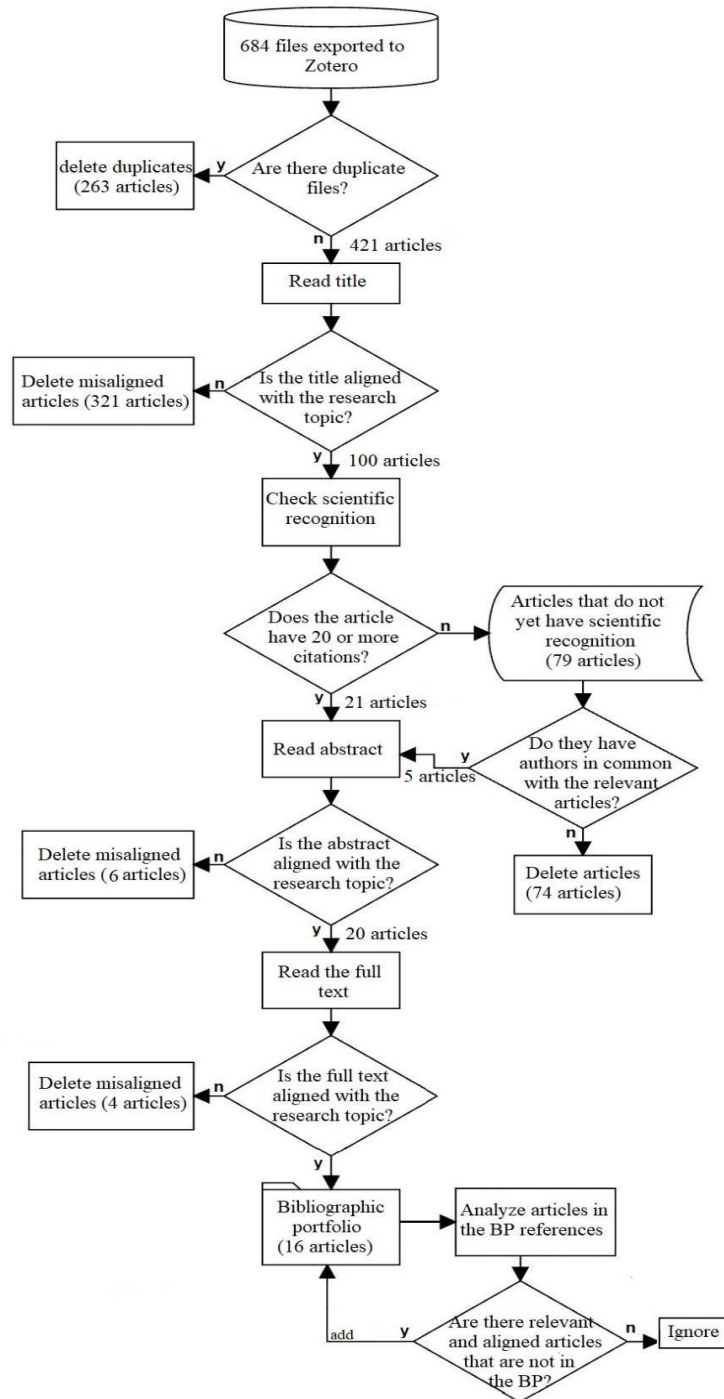
According Proknow-C methodology, the next step was to verify the number of citations of the remaining articles. For this, Google Scholar was used to consult the number of citations of each article. After placing the articles in descending order by number of citations, the cutoff criterion was applied. Only articles with about 85% of citations representativeness were sought. Thus, applying the Pareto principle a representativeness of 85% was sought. Therefore, all articles with 20 or more citations (21 articles) corresponded to 84.7% of all citations. These 21 articles were approved at this stage, with the others (79 articles) being filed.

After reading the approved articles' abstract, their alignment with the research theme was verified. Only 16 articles passed this criterion. The next step is to retrieve potentially useful articles among those 79 articles filed (those that did not pass the citations number cutoff criterion). As most of the articles obtained in the searches had less than 2 years of publication, the time criterion established by ProKnow-C was not used. Thus, instead of retrieving articles with less than two years, only those that had authors in common with any of the 16 articles with proven scientific relevance (whose abstracts were aligned with the research topic) were considered. Five articles were retrieved at this stage.

Thus, 21 articles remained for the final evaluation, which consisted of reading their full text. Those whose alignment with the research theme was confirmed after reading composed the BP. Finally, the final bibliographic portfolio with 16 articles was obtained. After that, the references of these articles were analyzed to identify relevant works that were not present in the final BP. After this analysis, the authors did not find other relevant articles and within the objectives and boundaries of the research which could be added to the portfolio.

The 16 articles were carefully obtained based on their alignment with the research proposal and scientific relevance. Thus, they constitute a fragment of the literature which reflects the main trends in research carried out in the last five years on the use of textile materials for protection in pandemics. Most of the articles in the BP were published from 2020, with only one from 2017. This reflects the results of searches carried out in the databases, in which it was possible to observe a significant increase in publications on this topic in recent years. This is explained by the event of the COVID-19 Pandemic, which stimulated research aimed at preventing virus transmission. Figure 1 illustrates all the steps taken to filter and select the articles until the definition of the BP.

Figure 1 – Process of filtering and selecting the set of raw articles.



Source: The authors.

From the BP, it is clear that the focus of research on this subject is respiratory protection devices. This is justified by the current moment when the use of masks has become mandatory

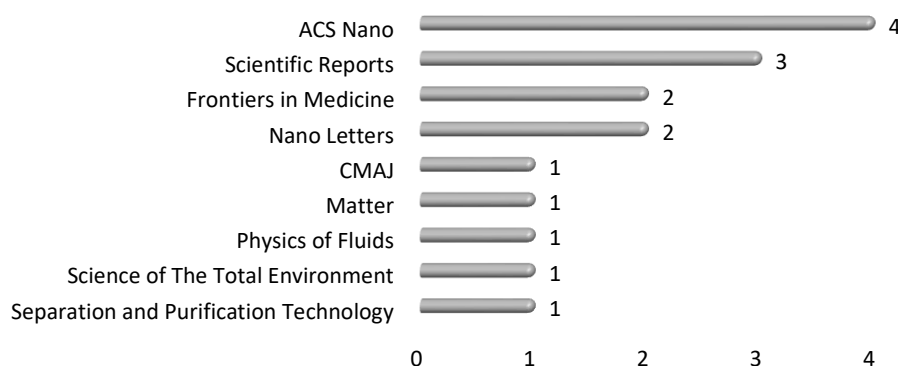
everywhere. Thus, these studies present ways to test the effectiveness of masks using different compositions and types of fabrics and combinations of different substrates. Another subject covered is the possibility of disinfection of N95 surgical respirators. In addition to computational methods to understand the behavior of expiratory particles and masks filtration mechanism.

### 3.1 Bibliometric Analysis Results

#### 3.1.1 Journal Analysis

Regarding the origin of the articles, nine different journals were identified in the BP. Figure 2 shows the distribution of articles published in each journal.

Figure 2 – Number of articles per journal

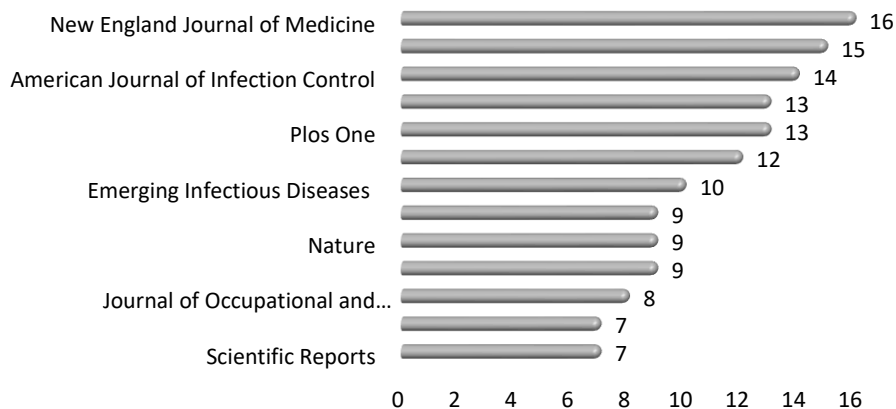


Source: Research data.

The journal ACS Nano has the largest share in the portfolio, with four articles published in it (25%). The two articles with the higher number of citations were published in this journal. The second prominent journal is Scientific Reports with three publications (18.7%). Next comes Frontiers in Medicine and Nano Letters, both with two publications. The other journals have only one publication, including Physics of Fluids, whose article is the third most cited in the portfolio.

Regarding the most cited articles in the BP references, VOSviewer identified 13 journals within the criterion of seven or more citations. Figure 3 shows the journals with their respective number of citations.

Figure 3 – Number of citations for each journal



Source: Research data.

The most cited journal by the BP references is the New England Journal of Medicine with 16 citations, followed by ACS Nano with 15 citations. In third place, with 14 citations, is the American Journal of Infection Control. The fourth place is occupied by the journals Annals of Occupational Hygiene and Plos One, both with 13 citations each.

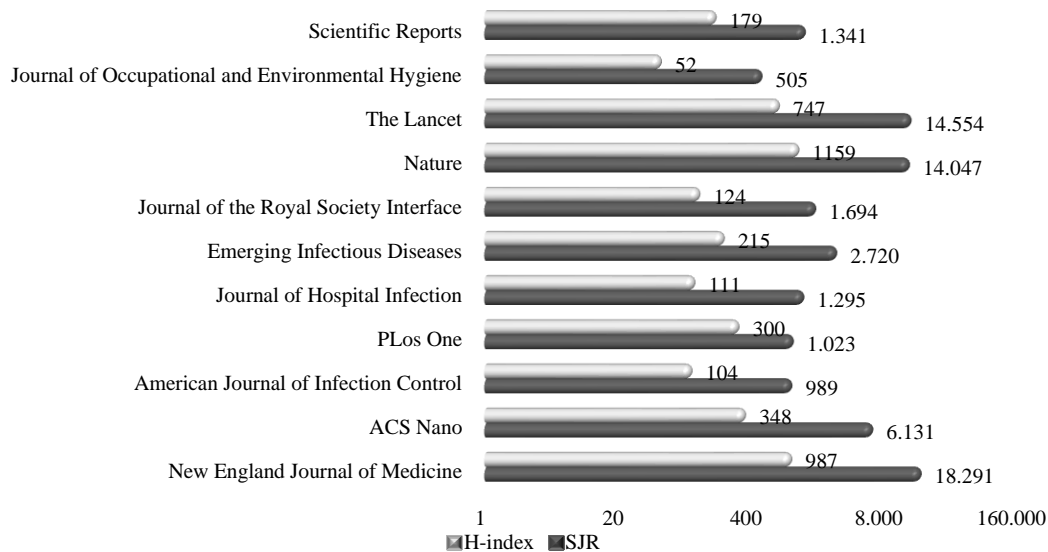
Following is the Journal of Hospital Infection with 12 citations, Emerging Infectious Diseases with 10 citations and Journal of Royal Society Interface, The Lancet and Nature with nine citations each. Then Journal of Occupational and Environmental Hygiene with eight citations and lastly the preprint repository MedRxiv and Scientific Reports both with seven citations.

Among the most cited journals in the BP references, two of them have articles of the BP. ACS Nano, which stands out for being the second most cited. Scientific Reports also shows up with seven citations. The journals' relevance was obtained from the Scopus database, through the Scimago Journal Rankings (SJR) indicator. SJR measures the scientific prestige of journals based on the average number of citations that articles published in a given journal received in the last three years.

Another index used, provided by the same base, is the H-index. This index expresses the number (x) of articles in a journal that received at least x citations, that is, the number of articles that received a number of citations greater than or equal to this number (for example, an H-index = 300 indicates that in that journal 300 articles received 300 or more citations). Thus, it seeks to

quantify the scientific productivity and scientific impact of the journal. Figure 4 shows the results obtained for the SJR and H-index. Unable to get values for Annals of Occupational Hygiene and Medrxiv.

Figure 4 – Relevance of journals, according to the SJR and H-index indexes



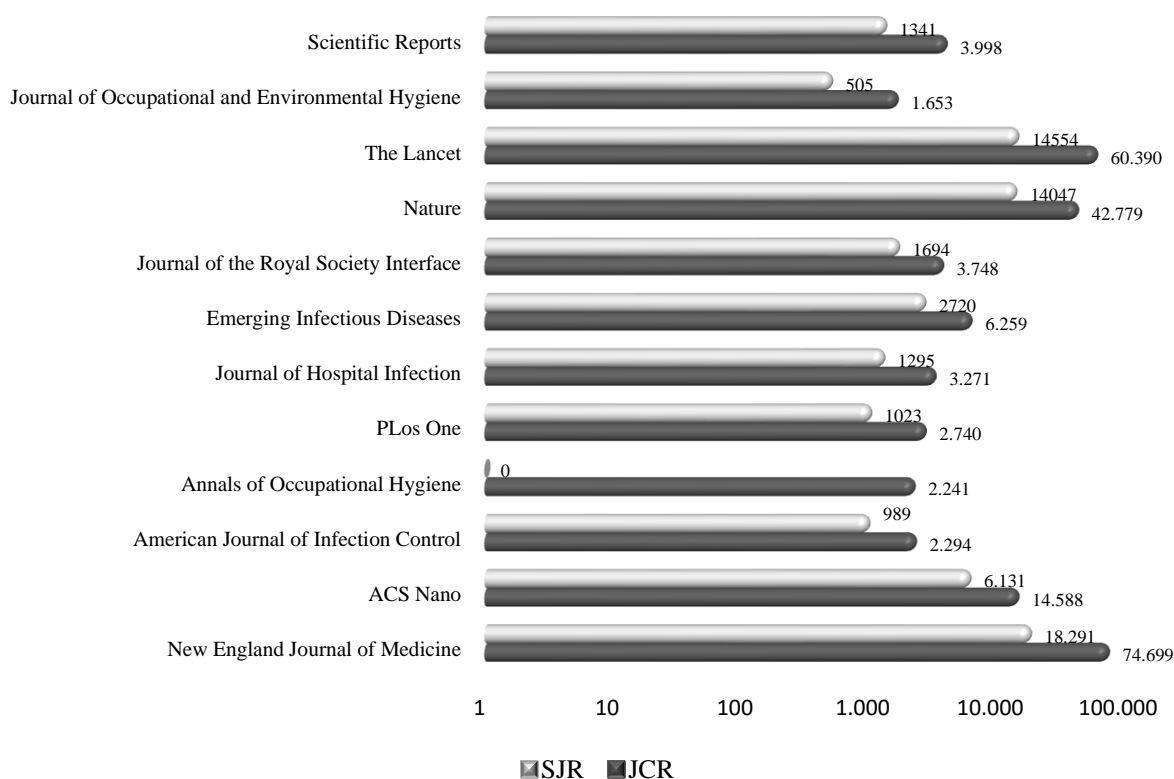
Source: Research data.

Figure 4 presents the most prominent journals. The one with the greatest impact factor by the SJR index is the New England Journal of Medicine (18,291). In the sequence, The Lancet (14,554), Nature (14,047) and ACS Nano (6,131) also stand out.

Looking at the H-index, the journal Nature has the highest index (1,159), with the New England Journal of Medicine in second (987) and The Lancet in third (747). Based on the definition of both indexes, this indicates that the New England Journal of Medicine and The Lancet are the most prestigious journals, while the journal Nature, although less prestigious, has greater productivity and scientific impact.

Another indicator observed was the JCR of the Web of Science database, which measures the average number of citations of articles published in each journal in the last two years. In Figure 5 it is possible to visualize the two indexes, JCR and SJR. The impact factor of the journal Annals of Occupational Hygiene was found only in the JCR.

Figure 5 – Journal impact factor according to JCR and SJR



Source: Research data.

Since they are indicators that have different calculation methods, the values are not comparable. However, it is possible to notice that in both indicators the same journals stand out, with the greatest impact factor for the New England Journal of Medicine, followed by The Lancet and Nature. This shows that these periodicals stand out, each within its domain.

The journal ACS Nano proves, after all the analyses, to be one of the most relevant to the research topic. In addition to the fact that most of the articles in the portfolio are published in this journal, it is also one of the most cited by references in the BP. ACS Nano is among the four most prestigious and with the highest productivity. The American Society of Chemistry (ACS) publishes this journal; it focuses on nanotechnology and nanoscience, encompassing the areas of Engineering, Materials Science, Physics, and Chemistry.

Another prominent journal is the New England Journal of Medicine, one of the most highly regarded in the field of Medicine, published by the Massachusetts Medical Society. Although not



present in the BP, it is the most frequent journal in the references of the articles analyzed and the most prestigious. The Lancet and Nature journals also stand out for their SJR, H-index and JCR indexes, in addition they have a significant number of citations in the portfolio (9 citations each).

It is noticed that most of the articles were published in journals in the areas of Engineering and Materials Science, such as ACS Nano, Nano Letters, Separation and Purification Technology, Matter and Physics of Fluids. Most of the studies published in these journals try to assess the efficiency of different types of fabrics to filter aerosolized particles, as in the case of the study by Konda et al. (2020), which is also the most cited article in BP. The papers published in journals of this field also cover other topics such as the disinfection of N95 respirators, studied by Liao et al. (2020), the second most cited article in the portfolio. Also, the development of an electrostatically charged filter, to increase the efficiency of particle capture of masks, elaborated by Leung and Sun (2020).

The multidisciplinary Scientific Reports is also noteworthy, with three studies. Two of them is the development of a system of coatings with salt for virus deactivation, proposed by Quan et al. (2017) and also by Rubino et al. (2020). The other is the study by Asadi et al. (2020) who tested the effectiveness of some types of masks in reducing particulate emissions. Only two journals are of the Medicine field, CMAJ and Frontiers in Medicine. All BP studies published in these journals used pathogens, such as the studies by Rodriguez-Palacios et al. (2020a) and Rodriguez-Palacios et al. (2020b) that tested the efficiency of the filtrations of fabrics with bacteria contained in aerosols sprayed on them. The study by Daeschler et al. (2020) used SARS-CoV-2 to inoculate N95 respirators and thus test disinfection methods.

Among the most cited periodicals in the BP references, the vast majority belong to the Medicine field, with emphasis on the most renowned periodicals in the area such as the New England Journal of Medicine and The Lancet. It happens because although these are works developed in the areas of Engineering and Materials Science, they aim to study the effectiveness of textile materials to meet a specific healthcare demand.

### 3.1.2 Authors analysis

The next analysis performed was in relation to the authors. Table 1 shows the list of the most cited authors in the BP with more than 50 citations.

Table 1 – Most cited authors of the Bibliographic Portfolio

<b>Author</b>	<b>Articles in BP</b>	<b>Citations</b>
Lei Liao	3	119
Steven Chu	3	119
Wang Xiao	3	119
Yi Cui	3	119
Haotian Wang	2	116
Mervin Zhao	2	116
Qiqi Wang	2	116
Xuanze Yu	2	116
Abhinav Prakash	1	176
Abhiteja Konda	1	176
Supratik Guha	1	176
Gregory D. Grant	1	176
Gregory A. Moss	1	176
Michael Schmoldt	1	176
Dimitris Drikakis	1	63
Talib Dbouk	1	63

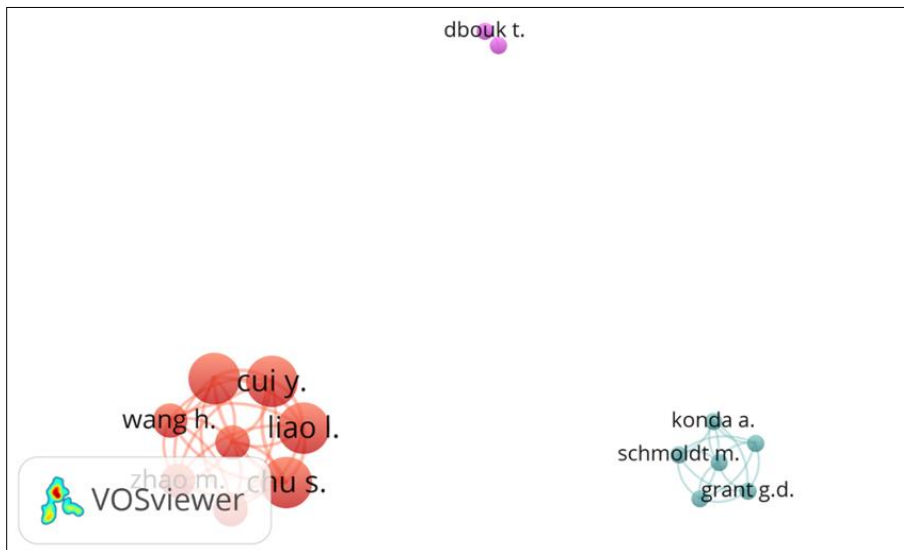
Source: Research data.

The six most cited authors have 176 citations. These are the authors of the most cited article in the BP. Next comes a group of four authors with 119 citations who have authorship in three BP articles. Then there is another group of authors with two articles in the portfolio and 116 citations. Finally, there are the authors of the third most cited article.

In the co-authorship network created with these authors, it is possible to see the authors who collaborate with each publishing articles together (Figure 6). Each node represents an author, the size of the nodes indicates the number of articles of each author in the sample (BP). Authors with three publications are represented by the largest circles, then authors with two articles represent the medium circles, and last, the smaller nodes indicate authors with only one article. The edges indicate the relation between nodes. The proximity between the nodes represents the frequency in which authors published together, that is, the closer they are more articles they published together.

Analyzing the network (Figure 6), it is observed that the most cited authors are concentrated in different clusters (indicated by colors), which represent the groups of authors who collaborated. We can notice that authors with only one article in the BP are concentrated in isolated groups.

Figure 6 – Co-authorship network of the 16 most cited authors of the Bibliographic Portfolio



Source: Research data.

The first cluster in red color represents authors who have more than one article in the BP (two and three articles). It is possible to observe that the edges relate them all, which means that they all published articles together. These authors are involved in three articles of the BP, the major nodes represent the ones that participate in the three articles and the others only in two of them. Of the articles in question, two of them were published in Nano Letters. One of them testing the efficacy of synthetic and natural fabrics, and the other reports a three-dimensional internal analysis of N95 filtration layers via X-ray tomography supported by Deep Learning (Lee et al. 2021). The third article published in ACS Nano investigates multiple commonly used disinfection schemes for N95 respirator, aiming to discover which one is best for keeping its efficiency after the disinfection.

The second cluster in blue color indicates the six most cited authors, who are the authors of the most cited article in the portfolio published in ACS Nano. The study tests the filtration efficiency of different types of fabrics as well as combinations between them.

The third cluster in purple color has two nodes that represents the last two authors in Table 1, which article is the third most cited in the portfolio. The article presents a fluid dynamics study of the transmission of respiratory droplets through and around a facemask filter. It was published in Physics of fluids.

Another search performed to find authors relevant to the research topic was in the BP article references. For this, only authors with at least 10 citations were considered relevant and it was obtained eight authors. Table 2 presents the list of these authors and their respective numbers of citations.

Table 2 – Most cited authors in Bibliographic Portfolio references

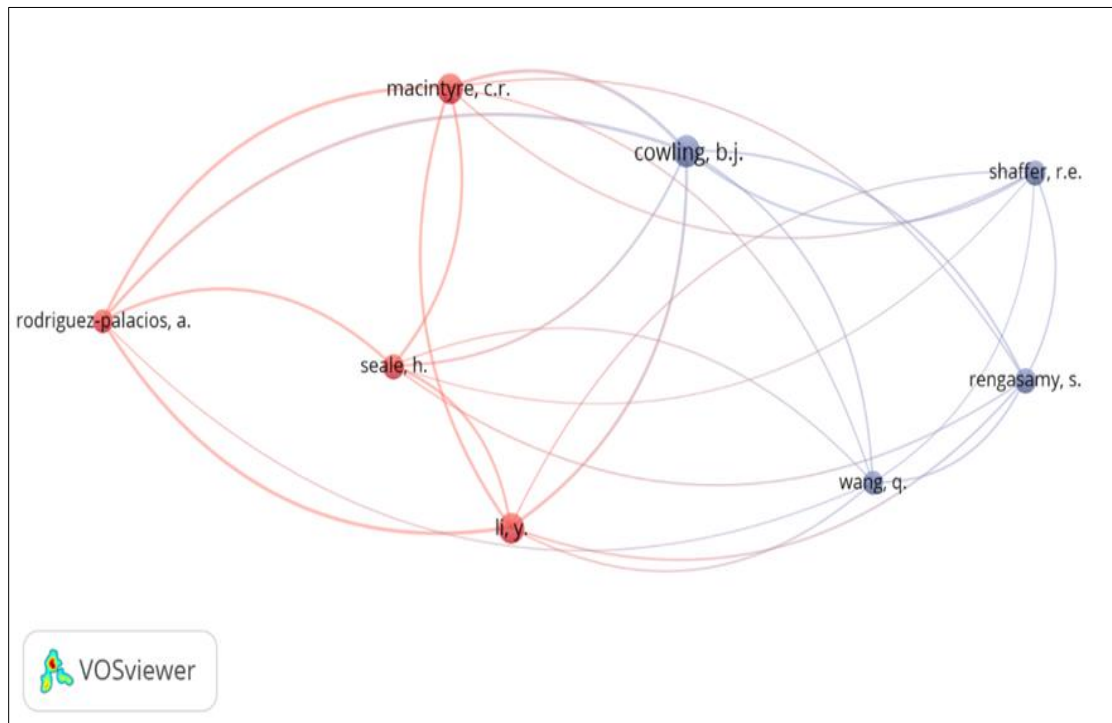
Author	Citations
Benjamin John Cowling	14
Yiping Li	13
Raina Macintyre	13
Samy Rengasamy	11
Holly Seale	11
Ronald E. Schaffer	11
Alex Rodriguez-Palacios	10
Qiqi Wang	10

Source: Research data.

Among these authors, only two of them have articles in their portfolio Alex Rodriguez-Palacios and Qiqi Wang. Wang is among the authors of the BP with the higher number of citations, with two articles in the BP and 116 citations. Alex Rodriguez-Palacios, although not among the most cited authors of the BP, is a prominent author on the research subject. This is because, in addition to being among the most cited in the references, two articles in BP are of his authorship.

Figure 7 represents the co-citation network of these authors, which indicates the frequency which they are cited together. In this network, the number of citations of each author defines the size of the nodes, which represent the authors. The larger circles represent the most cited authors. The proximity of the edges indicates how often the authors are cited together, thus, the closer they are, the more often they are co-cited.

Figure 7 – Co-citation network of the most cited authors in the Bibliographic Portfolio references



Source: Research data.

Observing Figure 7, there is the formation of two clusters. The first one, in red color, presents the authors Yiping Li (Li, y.), Raina Macintyre (Macintyre, C.R.), Holly Seale (Seale, H.) and Alex Rodriguez-Palacios (Rodriguez-Palacios, A.), who have greater proximity indicating that their works are frequently cited together. The second cluster, in blue color, contains the authors Benjamin John Cowling (Cowling, B.J.); Samy Rengasamy (Rengasamy, N.); Ronald E. Shaffer (Shaffer, R.E.) and Qiqi Wang (Wang, K.).

It is possible to observe in the network that the most cited author, Benjamin John Cowling has a co-citation relationship with all the other authors represented in the network, indicating that he appears cited with all of them. The same occurs with the author Raina Macintyre. Macintyre and Cowling are frequently cited together in the BP references. This is indicated by the greater proximity between their nodes. Another author who has a co-citation relationship with all other authors represented in the network is Qiqi Wang, who found more frequently in co-citation with Samy Rengasamy.

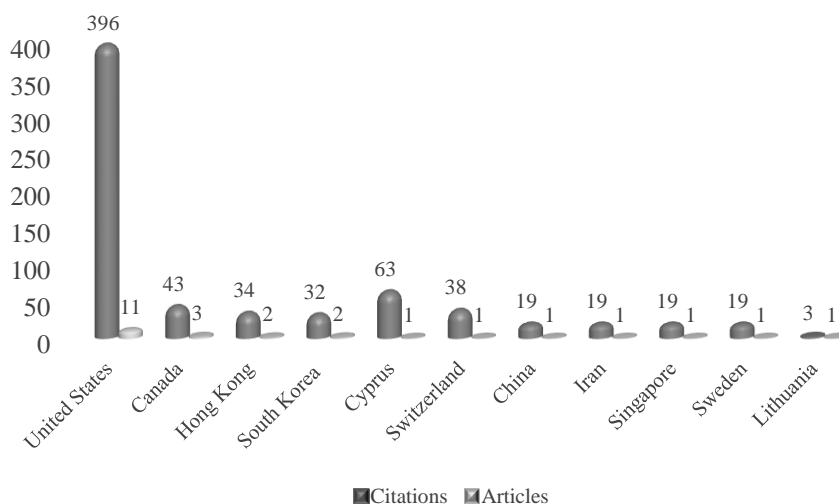
The network shows that the two most cited authors have a strong co-citation relationship (because they are close). However, the software places them on different clusters. The cited papers of Benjamin John Cowling (the most cited author in the references) are mostly about influenza virus infection. They cover everything from the transmission of the virus through aerosols to the influence of the mask use. Thus, we can conclude that the other authors in the blue cluster published in the same line. For example, Samy Rengasamy and Ronald E. Shaffer have published together papers evaluating the filtration performance of masks, common fabric materials and respirators. Qiqi Wang's cited papers are mostly about filtration efficiency of different kinds of materials for masks.

It may also be noted that, the papers of Raina Macintyre (second most cited author) are focused on the use of facemasks and respirators to prevent infections in the respiratory tract. Most of her works are aimed at protecting healthcare workers and were published between 2014 and 2015. The same focus on facemask use is noticed in the papers the other authors in the red cluster published. Holly Seale's cited papers we published with coauthorship of Raina Macintyre. Yiping Li research are focused in aerosol transmission of infectious agents, and Alex Rodriguez-Palacios also produces papers related to public health and prevention of infectious diseases.

### *3.1.3 Articles by country*

Figure 8 shows the distribution of articles by country, obtained according to the origin of the institutions linked to the authors. Through this analysis, it is possible to perceive the participation of different countries in the articles that make up the BP.

Figure 8 – Number of articles and citations per country



Source: Research data.

The orange bars indicate how many articles from the BP are linked to each country (institutions). The blue bars indicate the total number of citations from the countries according to the citations of the articles to which they are linked.

From Figure 8 it is noticed that most of the studies took place in North American institutions, with the United States and Canada being the countries with the most articles and citations. Regarding the number of articles in the portfolio, Hong Kong and South Korea come next, with two articles and 34 and 32 citations, respectively. The other countries have only one linked article in the portfolio and by the number of citations Cyprus and Switzerland stand out with 63 and 38 citations, respectively.

China, despite being the country where, according to indications, the COVID-19 Pandemic originated and being one of the main producers of disposable masks in the world, does not present great prominence within the selected BP.

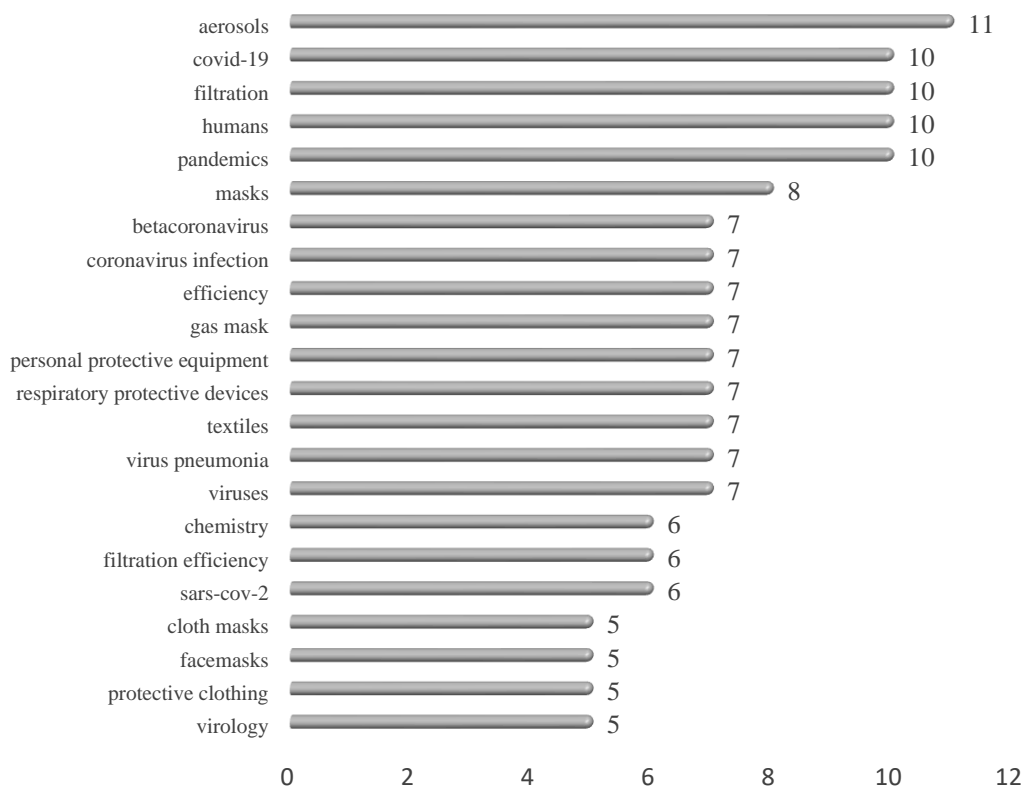
This result can be compared with the bibliometric study on COVID-19, developed by Yu et al. (2020), in which it is observed that Chinese researchers have a great impact on the production of articles about COVID-19. However, those researches focus on the viral genome, disease transmission, vaccine, treatment and Spike protein.

### 3.1.4 Keyword analysis

The keyword co-occurrence analysis indicates the frequency in which it is possible to find a given term, whether in the title, abstract, or keyword (all keywords option in VOSviewer which also considers the keywords defined by the database). The number of articles where the keywords occur together determines the co-occurrence relationship between them.

To facilitate the visualization of the network, only words with five or more occurrences were considered, resulting in 22 words. Figure 9 shows the keywords and the number of occurrences each one has.

Figure 9 – Keyword occurrence number



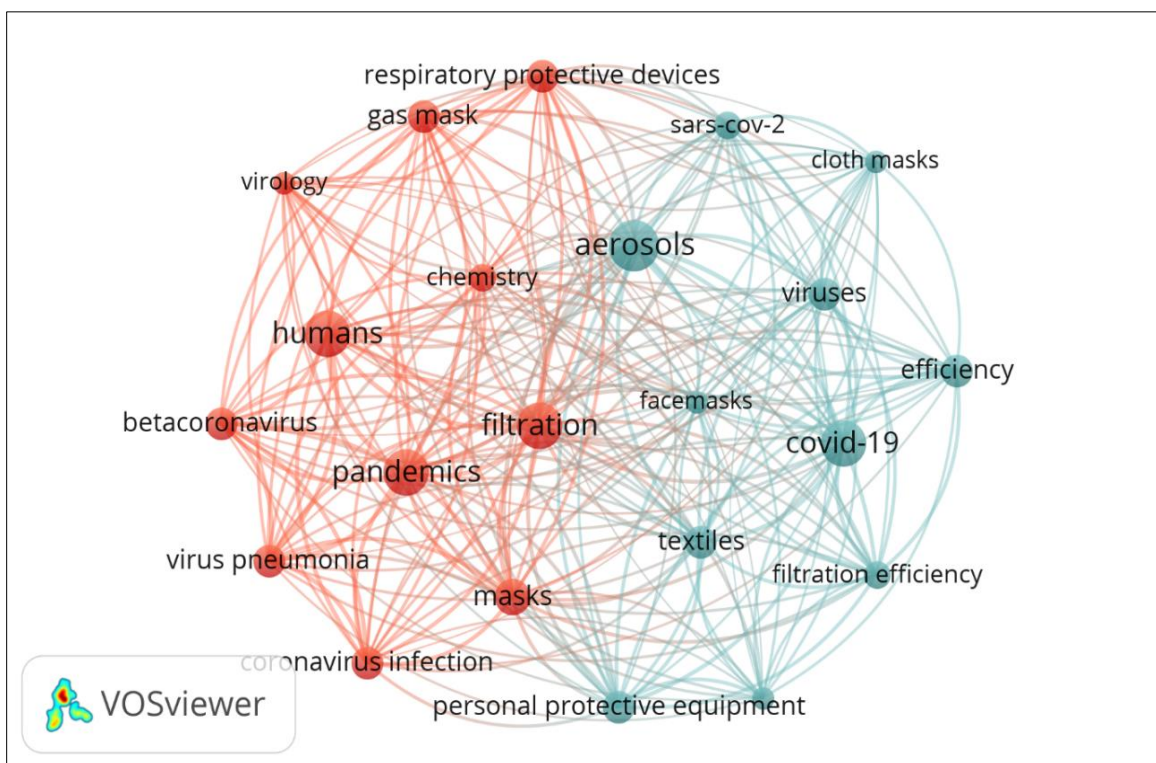
Source: Research data.

Since most of the work is recent and was prepared during the Coronavirus Pandemic, these words reflect the significant number of studies analyzing the efficiency of masks, which have



become mandatory worldwide to filter aerosolized expiratory particles. Figure 10 presents the co-occurrence network of these keywords.

Figure 10 – Keyword co-occurrence network



Source: Research data.

Each node represents a keyword. The size of the nodes is proportional to the number of occurrences and the proximity between them is equivalent to the frequency with which the terms occur simultaneously. Hence, edges indicate not only whether there is a relation between two nodes or not but also the strength of the relation. The terms aerosol and filtration are at the center of the network, and next to them we can see terms related to masks such as the term mask itself and the terms face masks, cloth masks and respiratory protective devices. This reflects the core content of the portfolio articles that study the use of different types of masks for personal protection and their filtration efficiency.

The software divided the network into two clusters, each with 11 words. The first cluster, in red color, contains the terms more focused on the second axis of the research, that is, pandemics; the terms relate to pathologies, such as betacoronavirus (is one of the four genera of coronavirus,

Paim, Ana Aline Mendes, et al. Mapping and bibliometric analysis of scientific publications on the use of textile materials for protection in pandemics. *Brazilian Journal of Information Sciences: Research trends*, vol. 16, publicação contínua, 2022, e02145. DOI: 10.36311/1981-1640.2022.v16.e02145

SARS-CoV-2 belongs to this genus, Agca et al. 2021), viral pneumonia, coronavirus infection, virology and the term pandemics. From this result, it is possible to see that the documents deal with viral infectious diseases, especially the recent one caused by the new Coronavirus, precisely because they are documents published recently.

The second cluster in blue color, groups words more related to the first research axis, which are textile materials and their use for protection. Terms such as facemasks, cloth masks, textiles, filtration efficacy, personal protective equipment, reflect this. Thus, it is clear that textile materials were researched in order to prove or improve their effectiveness in protecting against viral agents, all of this motivated by the COVID-19 Pandemic.

The analysis of keyword co-occurrence reflects the focus of the articles, which are facemasks and their filtering efficiency. It is also noted the frequent mention of coronaviruses and other viruses in general, since this type of organism causes most of the epidemics and pandemics that occur. In addition, these pathogens are transmitted through contact with droplets of saliva and aerosols generated when coughing or sneezing. This justifies the term aerosol being the most frequent, since half of the BP studies carried out tests with the generation of aerosol particles.

Another factor that the keyword co-occurrence analysis shows is the need to use fabric masks (as evidenced by the term cloth masks). This happened because of commercial masks shortage during the Coronavirus Pandemic, forcing the population to use masks made of alternative materials whose efficiency is not yet proven. Thus, the studies seek to study the types of materials used and assess their filtration efficiency as seen in Lustig et. al (2020), Mueller et al. (2020), Zangmeister et al. (2020) and Zhao et al. (2020). But also, the efficacy of N95 respirators were evaluated in the study of Lee et al. (2021). Bio-based materials to produce eco-friendly masks were also proposed by Das et al. (2020).

## **4 Final considerations**

---

From the systematic literature review supported by the ProKnow-C method, it was possible to obtain a set of articles, which reflects the main trends of studies carried out in the last five years on the use of textile materials for protection during pandemics. With the set of articles captured by

the established process, it was possible to obtain knowledge about the research topic, and also to understand the main focus of research at the present. Thus, it was possible to select the most relevant articles to the theme, among a high number of publications, which facilitates the researcher's work. It is noteworthy that so far, no other works in the textile area were found that carried out a review using ProKnow-C. Thus, this research contributes to the field by providing important bibliometric indicators to help other researchers of this area in future works.

The development of bibliometric analyzes allows us to observe which are the most relevant works within this research segment. In this case, the works by Konda et al. (2020), Liao et al. (2020), and Dbouk and Drikakis (2020). It was also possible to identify the most prominent journals on the subject, with emphasis on ACS Nano, New England Journal of Medicine, and Scientific Reports. The countries with the greatest participation in this field are the United States and Canada.

The use of VOSviewer allowed a visual analysis of the relationship between authors and the co-occurrence of keywords. This facilitates the interpretation and discussion of data. It is noticed that the development of these analyzes generates a significant amount of information that allows an understanding of the current scenario within this field of research.

Finally, the results show an intense synergy between Textile Engineering and Materials Science to solve a global problem in the health area. Several studies aimed at analyzing and developing facial masks to prevent the spread of diseases such as COVID-19. Thus, it is clear that this research topic has a high potential to result in promising innovations in medical textile segment.

As future work, it is proposed the identification of synergy networks between researchers (textile and health areas); collaboration between specific topics, eg material types, contamination, modelling; and interactions between authors and author institutions. Motivated by the use of the Proknow-C methodology, it is possible to develop a bibliometric study on this methodology.

## References

---

- Afonso, M. H. F., et al. “Como construir conhecimento sobre o tema de pesquisa? Aplicação do processo Proknow-C na busca de literatura sobre avaliação do desenvolvimento sustentável”. *Revista de Gestão Social e Ambiental*, vol. 5, no. 2, 2011, pp. 47–62, doi: 10.5773/rgsa.v5i2.424. Accessed 12 mar. 2021.
- Agca, H., et al. “Alpha and Beta Coronavirus Infections in a University Hospital”. *Journal of Advances in Medicine and Medical Research*, vol. 33, no. 4, 2021, pp. 10-16, doi: 10.9734/jammr/2021/v33i430829. Accessed 15 mar. 2021.
- Akin, L., and Gözel, M. G. “Understanding dynamics of pandemics”. *Turkish Journal of Medical Sciences*, vol. 50, no. 2, 2020, pp. 515–519, doi: 10.3906/sag-2004-133. Accessed 15 mar. 2021.
- Asadi, S., et al. “Efficacy of masks and face coverings in controlling outward aerosol particle emission from expiratory activities”. *Scientific Reports*, vol. 10, no. 1, 2020, pp. 1-13, <https://doi.org/10.1038/s41598-020-72798-7>. Accessed 12 mar. 2021.
- Beesoon, S., et al. “Universal masking during COVID-19 pandemic: Can textile engineering help public health? Narrative review of the evidence”. *Preventive Medicine*, vol. 139, no. 8, 2020, doi: 10.1016/j.ypmed.2020.106236. Accessed 15 mar. 2021.
- Berlato, L. F., et al. “Uma informação visual da revisão sistemática da literatura sobre Design de Serviço para Inovação Social”. *Estudos em Design*, vol. 6, no. 2, 2018, pp. 141–165. Accessed 15 mar. 2021.
- Carvalho, G. D. G., et al. “Bibliometrics and systematic reviews: A comparison between the Proknow-C and the Methodi Ordinatio”. *Journal of Informetrics*, vol. 14, 2020, pp. 1751–1577, <https://doi.org/10.1016/j.joi.2020.101043>. Accessed 10 mar. 2021.
- Castelli, T. M. *Análise da metodologia Knowledge Development Process - Constructivist (ProKnow-C) e suas contribuições a avaliação de desempenho organizacional: Um estudo à luz do apoio à decisão*, 2018, <http://repositorio.furg.br/handle/1/7721>. Universidade Federal do Rio Grande. Masters Dissertation. Accessed 10 mar. 2021.
- Conforto, E. C., et al. “Roteiro para revisão bibliográfica sistemática: aplicação no desenvolvimento de produtos e gerenciamento de projetos”. *Congresso brasileiro de gestão e desenvolvimento de produto*. 2011, <https://repositorio.usp.br/item/002833837>. Accessed 09 mar. 2021.
- Daeschler, S. C., et al. “Effect of moist heat reprocessing of N95 respirators on SARS-CoV-2 inactivation and respirator function”. *CMAJ*, vol. 192, no. 41, 2020, pp. 1189–1197, <https://doi.org/10.1503/cmaj.201203>. Accessed 15 mar. 2021.
- 
- Paim, Ana Aline Mendes, et al. Mapping and bibliometric analysis of scientific publications on the use of textile materials for protection in pandemics. *Brazilian Journal of Information Sciences: Research trends*, vol. 16, publicação contínua, 2022, e02145. DOI: 10.36311/1981-1640.2022.v16.e02145

- Das, O., et al. “The need for fully bio-based facemasks to counter coronavirus outbreaks: A perspective”. *Science of the Total Environment*, vol. 736, 2020, pp. 1-7, doi: 10.1016/j.scitotenv.2020.139611. Accessed 12 mar. 2021.
- Dbouk, T., and Drikakis, D. “On respiratory droplets and face masks”. *Physics of Fluids*, vol. 32, no. 6, 2020, pp. 1- 11, <https://doi.org/10.1063/5.0015044>. Accessed 12 mar. 2021.
- Donthu, N., et al. “How to conduct a bibliometric analysis: an overview and guidelines”. *Journal of Business Research*, vol. 133, 2021, pp. 285-296, [https://cld.pt/dl/download/0511abac-211d-47fe-af57-cbb70348edac/sapotransfer-5c29a9714e9beFt/s\\_psppt.pdf](https://cld.pt/dl/download/0511abac-211d-47fe-af57-cbb70348edac/sapotransfer-5c29a9714e9beFt/s_psppt.pdf). Accessed 25 apr. 2021.
- Eck, N. J. Van, and Waltman, L. “Software survey: VOSviewer, a computer program for bibliometric mapping”. *Scientometrics*, vol. 84, 2009, pp. 523–538, doi: 10.1007/s11192-009-0146-3. Accessed 10 mar. 2021.
- Karim, N., et al. “Sustainable personal protective clothing for healthcare applications: A review”. *ACS Nano*, vol. 14, no. 10, 2020, pp. 12313–12340, <https://doi.org/10.1021/acsnano.0c05537>. Accessed 12 mar. 2021.
- Konda, A., et al. “Aerosol filtration efficiency of common fabrics used in respiratory cloth masks”. *ACS Nano*, vol. 14, no. 5, 2020, pp. 6339–6347, <https://doi.org/10.1021/acsnano.0c03252>. Accessed 15 mar. 2021.
- Lacerda, R. T. O., et al. “Uma análise bibliométrica da literatura sobre estratégia e avaliação de desempenho”. *Gestão da Produção*, vol. 19, no. 1, 2012, pp. 59-78, <https://doi.org/10.1590/S0104-530X2012000100005>. Accessed 09 mar. 2021.
- Lee, H. R., et al. “Three-dimensional analysis of particle distribution on filter layers inside N95 respirators by deep learning”. *Nano Letters*, vol. 21 no. 1, 2021, pp. 651–657, <https://doi.org/10.1021/acs.nanolett.0c04230>. Accessed 15 mar. 2021.
- Leung, W. W. F., and Sun, Q. “Electrostatic charged nanofiber filter for filtering airborne novel coronavirus (COVID-19) and nano-aerosols”. *Separation and Purification Technology*, vol. 250, 2020, pp. 1-17, <https://doi.org/10.1016/j.seppur.2020.116886>. Accessed 15 mar. 2021.
- Liao, L., et al. “Can N95 Respirators be reused after disinfection? How many times?” *ACS Nano*, vol. 14, no. 5, 2020, pp. 6348–6356, <https://doi.org/10.1021/acsnano.0c03597>. Accessed 15 mar. 2021.
- Lustig, S. R., et al. “Effectiveness of common fabrics to block aqueous aerosols of virus-like nanoparticles”. *ACS Nano*, vol. 14, no. 6, 2020, pp. 7651–7658, <https://doi.org/10.1021/acsnano.0c03972>. Accessed 15 mar. 2021.

- Mueller, Amy V., et al. “Quantitative method for comparative assessment of particle removal efficiency of fabric masks as alternatives to standard surgical masks for ppe”. *Matter*, vol. 3, no. 3, 2020, pp. 950-962, <https://10.1016/j.matt.2020.07.006>. Accessed 15 mar. 2021.
- Moher, D., et al. “Principais itens para relatar revisões sistemáticas e Meta-análises: A recomendação PRISMA”. *Epidemiol. Serv. Saúde*, vol. 24, no. 2, 2015, pp. 335-342, <https://doi.org/10.5123/S1679-49742015000200017>. Accessed 09 mar. 2021.
- Patnaik, Asis. “Technical textiles and recent development”. *Fibers to smart textiles: Advances in manufacturing, technology and applications*. Edited by Asis Patnaik. CRC Press, 2020, pp. 315-331.
- Quan, F.-S., et al. “Universal and reusable virus deactivation system for respiratory protection”. *Scientific Reports*, vol. 7, 2017, pp. 1-10, <https://doi.org/10.1038/srep39956>. Accessed 12 mar. 2021.
- Rodriguez-Palacios, A., et al. “Germ-free mice under two-layer textiles are fully protected from bacteria in sprayed microdroplets: A functional in vivo test method of facemask/filtration materials”. *Frontiers in Medicine*, vol. 7, 2020a, pp. 1-10, doi: 10.3389/fmed.2020.00504. Accessed 15 mar. 2021.
- Rodriguez-Palacios, A., et al. “Textile masks and surface covers: A spray simulation method and a “universal droplet reduction model” against respiratory pandemics”. *Frontiers in Medicine*, vol. 7, 2020b, pp. 1-11, doi: 10.3389/fmed.2020.00260. Accessed 15 mar. 2021.
- Rubino, I., et al. “Salt coatings functionalize inert membranes into high-performing filters against infectious respiratory diseases”. *Scientific Reports*, vol. 10, no. 1, 2020, pp. 1-10, doi: 10.1038/s41598-020-70623-9. Accessed 15 mar. 2021.
- Wibisono, Y., et al. “Facile approaches of polymeric face masks reuse and reinforcements for micro-aerosol droplets and viruses filtration: A review”. *Polymers*, vol. 12, no. 11, 2020, pp. 1-18, <https://doi.org/10.3390/polym12112516>. Accessed 12 mar. 2021.
- Yam, J. Y. L., et al. “Basics of Face Masks and Respirators Purpose of Surgical Face Masks”. *Basic Science*, vol. 10, 2020, pp. 1–13.
- Yu, Li, et al. “A bibliometric analysis using VOSviewer of publications on COVID-19”. *Annals of Translational Medicine*, vol. 8, no. 13, 2020, doi: 10.21037/atm-20-4235. Accessed 15 mar. 2021.
- Zamboni, A. B., et al. “StArt Uma Ferramenta Computacional de Apoio à Revisão Sistemática”. *Brazilian Conference on Software: Theory and Practice - Tools session*: Salvador, UFBA, 2010.
- Zangmeister, C. D., et al. “Filtration Efficiencies of nanoscale aerosol by cloth mask materials used to slow the spread of SARS-CoV-2”, *ACS Nano*, vol. 14, no. 7, 2020, pp. 9188-9200, <https://doi.org/10.1021/acsnano.0c05025>. Accessed 12 mar. 2021.
- 
- Paim, Ana Aline Mendes, et al. Mapping and bibliometric analysis of scientific publications on the use of textile materials for protection in pandemics. *Brazilian Journal of Information Sciences: Research trends*, vol. 16, publicação contínua, 2022, e02145. DOI: 10.36311/1981-1640.2022.v16.e02145

Zhao, M., et al. "Household materials selection for homemade cloth face coverings and their filtration efficiency enhancement with triboelectric charging." *Nano Letters*, vol. 20, no. 7, 2020, pp. 5544–5552, <https://doi.org/10.1021/acs.nanolett.0c02211>. Accessed 15 mar. 2021.

---

Copyright: © 2022 Paim, Ana Aline Mendes, et al. This is an open-access article distributed under the terms of the Creative Commons CC Attribution-Share Alike (CC BY-SA), which permits use, distribution, and reproduction in any medium, under the identical terms, and provided the original author and source are credited.

---

Received: 21/12/2021

Accepted: 20/05/2022