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Nutritional Aspects related to COVID-19: A Bibliometric Analysis using Scopus Database

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Abstract

Nutrition therapy has lately gained attention as an effective way of combating the novel Coronavirus 2019 (COVID-19), especially to address the immunity in an individual and their overall health. The present study is a bibliometric assessment of research conducted to understand the role of nutrition in treating COVID-19 which was carried out since the pandemic's sudden outburst during 2020 and 2021 and published in the Scopus database. A total of 93 publications were found, and the results were studied by evaluating these documents. The present analysis identifies the active countries where the research was conducted, various types of documents wherein the research was published, the most prominent scientific subject areas under which these documents were published, top 10 authors in this research area, their affiliations, publications as per the number of authors, top funding agencies, month-wise analysis of publications and list of active journals which have published the documents. The study examines the content of papers published by listing the top 5 most cited articles and analyzing them using word cloud. The present analysis reveals the current research trend of nutritional therapy to combat COVID-19 symptoms and provides potential hot spots for future research.

Keywords: Micronutrient, nutrition, nutrients, diet, nutrition therapy, dietary supplements, COVID-19, Coronavirus

Introduction

An unforeseen and sudden outbreak of a new infection known as the new 2019 coronavirus disease (COVID-19) has caused significant health problems affecting all people worldwide. It has a high mortality rate, especially in patients with critical illnesses. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused by COVID-19 is now officially declared a pandemic by the World Health Organization (WHO). The global COVID-19 pandemic has sparked an urgent quest for successful interventions. Up to now, however, no particular treatment has been found for this virus. Coronavirus infection prevention is also carried out with the aid of dietary therapies. Currently, many researches are working to suggest effective therapy and know the effect of nutritional therapy. Scopus database provides information on the published papers and therefore, to analyze the research carried out in this field, we opted for bibliometric analysis. This analysis would highlight the trends in research and identify the areas in which research can be conducted.

Literature review

Nutritional support is an indispensable part in the treatment of patients with coronavirus disease 2019 (COVID-19). Nutritional status of individuals has been used as resilience

towards destabilization during this COVID-19 pandemic. Optimal nutrition and dietary nutrient intake impact the immune system, therefore the only sustainable way to survive in current context is to strengthen the immune system (Horowitz & Freeman, 2020). A proper diet can ensure that the body is in the proper state to defeat the virus. However along with the dietary management guidelines the food safety management and good food practices is compulsory (Aman and Masood, 2020). The medical and scientific community is trying to figure out and adopt effective strategies that can lead to (i) preventing virus expansion; (ii) identifying medications for the management of critical care and reducing rates of mortality; and (iii) finally discovering the highly anticipated vaccine. Nutritional interventions have also attained considerable scientific evidence in disease prevention and treatment (El Ghoch et al., 2020). Therefore, the best patient care should mingle clinical reasoning and scientific knowledge, and the latter requires adequate methods. It is thus necessary to critically appraise the scientific literature, in order to provide adequate nutrition therapy to Covid-19 infected individuals (Correia, 2020). While certain medications initially garnered attention as potential treatment options, further studies failed to demonstrate great promise but did demonstrate the need to reduce the cytokine storm experienced by patients with this potentially life-threatening virus. Members of the medical community are beginning to evaluate the potential role of vitamins and supplements as potential treatment options or addition to other treatments for COVID-19 (Michienzi et al., 2020). Few studies also stated that medical doctors have acknowledged the crucial role of nutritional therapy among COVID-19 patients (de Watteville et al., 2020).

Indeed, there is no clinical trial evidence that a dietary or pharmacological supplementation of any particular substance will increase the effectiveness of the immune defenses. There are however three nutritional issues that deserve special attention under the present circumstances, namely vitamin D deficiency, excess salt intake and inappropriate alcohol consumption (Iaccarino Idelson et al., 2021). Lockdown due to COVID-19 influenced food habits and lifestyles with potential negative health impact. A cross sectional study in Spain concluded that different patterns of change in lifestyles in confinement need to tailor support and advice to different population groups on choice of food and physical activity regime (Pérez-Rodrigo et al, 2021). Fruits like citrus fruits, sitaphal, apple papaya; vegetables including broccoli, onion, garlic and green leaves; and some of the miscellaneous dietary supplements like nuts, ginger, turmeric, pepper, egg yolk, shellfish, mushroom have both properties-which can increase the immunity and some antiviral properties (Suchitra et al., 2020). Anti-viral properties are also found in many dietary supplements, including black seeds, garlic, ginger, cranberry, orange, omega-3 and -6 polyunsaturated fatty acids, vitamins (e.g., A, B vitamins, C, D, E), and minerals (copper, iron, magnesium, manganese, sodium, selenium, zinc) (Islam et al, 2021). Few of the herbal supplements, including curcumin, ginger, echinacea, garlic, green tea, cinnamon and ginseng, also play essential and complementary roles to boost the immune system (Shirani et al., 2020). These nutrients can be used as therapeutic modalities to potentially reduce the morbidity and mortality rates of COVID-19 patients above the Recommended Dietary Allowance (RDA), but within the recommended upper safety limits (Shakoor et al, 2021). Similar review had been published by Bhutada et al, (2020) which also talks about the various foods having potential effects on strengthening immune function. Chowdhury et al (2020), have suggested foods to consume and avoid, and have encouraged physical exercise . It was also suggested that daily moderate exercise will not only contribute to reducing the virus risk but also help in improving the quality of sleep during quarantine (Alkhatib, 2020).

Balanced nutrition can help in maintaining immunity and is essential for prevention and management of viral infections. A review suggested that among vitamins, A and D showed a potential benefit, especially in deficient populations; trace elements like selenium and zinc have also shown favourable immune-modulatory effects in viral respiratory infections. Several nutraceuticals and probiotics may also have some role in enhancing immune functions (Jayawardena et al., 2020). Jovic et al., (2020) reported that via antioxidant effects, immunomodulation, enhancing natural barriers, and local paracrine signaling, vitamins A to E highlighted potentially beneficial roles in the battle against COVID-19. Multivitamins have also shown to reduce acute respiratory tract infections -related symptoms such as headache, conjunctivitis, and restriction of movement, but not the overall symptom scores (Cramer et al, 2020). Thus the introduction of optimal nutrition with supplementation of micronutrients and omega-3 fatty acids may therefore be a cost-effective, underestimated strategy to help reduce the burden of worldwide infectious diseases, like COVID-19 (Pecora et al, 2020).

Vitamin D can play a role in innate immunity, coronary heart disease, and asthma, in addition to bone health (Matsui, 2020). Although the data for its supplementation is not extremely strong, it can be argued that almost 50% of the population worldwide has a vitamin D deficiency thus correcting this deficiency would be beneficial regardless of any impact of COVID-19 (Stratton et al., 2020). Laird et al., (2020) reported that the magnitude of responses to Covid-19 can be affected by vitamin D status and the incidence of vitamin D deficiency in Europe would be closely aligned to Covid-19 mortality. Evidence supporting the role of vitamin D in reducing the risk of COVID-19 includes that the outbreak occurred in winter, when concentrations of 25-hydroxyvitamin D (25(OH)D) are lowest (McKenna et al., 2020). Several observational studies and clinical trials have indicated that supplementation of vitamin D has decreased the risk of influenza. Kow et al., (2020) has also highlighted the same in their recently published article. It is recommended that individuals at risk of influenza and/or COVID-19 consider taking 10,000 IU/d of vitamin D3 for a few weeks to rapidly increase 25(OH)D levels, followed by 5000 IU/d, to reduce the risk of infection (Grant et al., 2020). In a representative sample from 26 counties, the Irish Longitudinal Study on Ageing (TILDA) looked at particular 'at-risk' classes for vitamin D deficiency in those over 50 years. TILDA offers a good evidence base for interfering with supplementary vitamin D (10 μg to 20 μg per day) in older adults. A third study recommends that large doses of vitamin D (20 μg to 50 μg daily) should be taken by every adult to protect against Covid-19 (McKenna et al., 2020).

Due to increased metabolic requirements, vitamin C levels in the serum and leukocytes are reduced during the acute stage of infection. A high-dose vitamin C supplement helps to normalize the vitamin C levels in both serum and leukocyte cells. In China and the United States, the use of a high dose of intravenous vitamin C for COVID-19 management has shown promising results with no reported adverse effects. Given that vitamin C is an inexpensive, accessible and safe medication with beneficial effects on the management of viral infections and critically ill patients reported in previous clinical trials, it is reasonable to add it to the management protocol of COVID-19 (Abobaker et al, 2020). Chen et al., (2020) developed a novel combination of vitamin C, curcumin and glycyrrhizic acid (VCG Plus) that has potential against CoV infection, based on recent advances in nutrient and phytonutrient science. The findings showed that VCG Plus can function on 88 targets in the hub that are closely related and linked to immune and inflammatory responses. Therefore, to prevent the onset of cytokine storm, VCG Plus may be helpful in controlling immune response to fight CoV infections and inhibit excessive inflammatory responses. COVID-19 infection has shown to regulate the synthesis of cobalamin, impair microbial intestinal proliferation, and

leads to cobalamin deficiency symptoms. There are few related signs and symptoms of vitamin B12 deficiency to those of infection with the coronavirus. Based on these findings, it can be concluded that vitamin B12 therapy can also be useful in the recovery of patients with COVID-19 (Alshammari 2021).

Recent studies in patients with COVID-19 have shown that in patients with acute respiratory tract infections, selenium deficiencies are obvious. Selenium is essential for maintaining the maturation and function of T cells, as well as for the production of T cell-dependent antibodies (Bae & Kim, 2020). While blood levels of selenium can be increased by different pharmacological preparations, only one chemical type (sodium selenite) can provide real protection. Selenite blocks the entry of viruses into healthy cells in this way prevents their infectivity. It is also possible to use this basic chemical compound in the recent war against the coronavirus epidemic (Kieliszek & Lipinski, 2020). Similarly Zinc possesses antiviral properties and can provide inexpensive and efficient adjunct therapy for a wide range of infections. Current evidence suggests that antiviral effects could be exerted by zinc by suppressing viral replication and increasing immune responses. The tolerable upper intake level for zinc is 40 mg/day, which would probably increase the resistance of the host to viral infection. (Razzaque et al., 2020). In addition, the rapid analysis performed by Hunter et al (2020) showed that zinc has the ability to shorten the length and severity of the disease. Copper is another mineral being thought over closely. Closer understanding of copper signaling, its vulnerability, evaluation and analysis process, route of administration and dosage opens up new perspectives on the administration of therapeutic copper against critically ill patients with COVID-19. However, attention should be paid to the toxicity of copper and the prediction of adverse reactions based on the copper dose or magnitude of the restriction of copper, as well as the length of the copper imbalance (Fooladi et al, 2020).

Lactoferrin which is classically present in mammalian milk has strong immunological properties, anti-inflammatory effects and is antibacterial as well as antiviral. In particular, there is evidence that it can bind to and thus block the entry of at least some of the receptors used by coronaviruses. It could prevent the attachment of SARS-CoV-2 to the host cells (Chang et al, 2020; Kell et al., 2020). Similarly Omega-3 fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have an anti-inflammatory effect and immunomodulation effects. Some studies, on the other hand, have documented that EPA and DHA can make cell membranes more susceptible to reactive oxygen-mediated non-enzymatic oxidation, leading to the production of potentially toxic oxidation products and increasing oxidative stress. Although the improved inflammatory resolution of EPA and DHA might lead to the rehabilitation of SARS-CoV-2 infected patients, supplementation with Omega-3 fatty acids cannot be prescribed before randomized and controlled trials are carried out (Chang et al, 2020, Rogero et al., 2020).

COVID-19 pandemic has caused a loss of a lot of lives too. The mortality rate of COVID-19 (about 5–7%), and the percentage of positive patients admitted to intensive care units (9–11%), makes it mandatory to consider and take all necessary measures to contain the COVID-19 infection (Messina et al., 2020). Cardiovascular disease (CVD), diabetes, being immunocompromised by cancer, and serious kidney disease with a senile immune system are major comorbid conditions associated with increased mortality (Rao et al., 2020). According to specialists from the Chinese Medical Association for Parenteral and Enteral Nutrition (CSPEN), certain activities are crucial for both the therapy success and reduction of mortality rates and nutritional approach should be an inseparable element of therapy in patients with COVID-19 (Stachowska et al., 2020). COVID-19 has a negative effect on nutritional status,

therefore recognition of nutritional risk and awareness of the need for nutritional support should be fundamental during the treatment and even after the treatment period. Cawood et al, (2020) has summarised the importance of following: screening for malnutrition; treatment plans with sufficient nutritional support that may include food-based interventions, oral nutritional supplements and dietitian referral; continuity of nutritional care between environments, including rapid contact at discharge of malnutrition risk and continuing nutritional support requirements. Likewise, review by Wells Mulherin et al, (2020) also highlighted the importance of overall nutrition therapy, assessment of nutritional status, enteral and parenteral nutrition measure, and food and oral supplements. Hence nutritional therapy has shown that different nutrients and minerals play a direct and indirect role in the control and prevention of COVID-19 viral infection, which has recently emerged. However, prior to prescribing any medication, the nutritional status of patients with COVID-19 must be assessed and nutritional supplements should be provided to the affected individuals along with regular treatment (Junaid et al, 2020). Additionally, assessment of nutritional status before the beginning of generalized treatments will help to establish a particular nutrition intervention (Budhwar et al., 2020).

High risk of disease-related malnutrition (DRM) and sarcopenia is envisaged in patients with SARS-CoV-2 infection due to symptoms resulting from the infection, acute inflammation, high stress, and high catabolism. Nutritional support is critical and the nutritional approach is a complex process involving improving the regular diet and specialized nutritional treatment (SNT) by using oral nutrients, enteral/parenteral nutrition according to the needs and requirements of each patient (Álvarez et al, 2020). Besides, there is an urgent need for nutritional indications aimed at preventing or contrasting hospital malnutrition by enhancing the response of the patient to treatment and promoting the management of nutritional interventions on patients by healthcare professionals, reducing their already high workload due to the state of emergency (Cena et al., 2020). Moreover, malnutrition may affect the length of hospital stay and delay recovery, particularly in groups at risk (geriatrics and those with chronic illnesses). The immune system is weakened by underlying malnutrition, that potentially makes people more susceptible to viruses such as COVID-19 and affects recovery (Holdoway, 2020). Therefore, the patients must be tested for nutritional risk with NRS-2002 or Nutric method, Subjective Global Assessment (SGA) or the Global Leadership Initiative on Malnutrition (GLIM) (Hu et al., 2020). Hospital-based study conducted by Formisano et al, (2021), demonstrated that screening COVID-19 patients using Quick age-adjusted Nutritional Risk Screening to identify the risk of malnutrition and suggesting customized nutritional regimen accordingly has helped to manage the clinical outcomes more efficiently.

Another nutritional aspect to the COVID-19 pandemic is the discussion surrounding it on various social platforms. In the times of COVID-19, the general population rather became conscious of their nutritional requirements. Studies undertaken to investigate dietary diversity during the time of the lockdown in China and to assess dietary diversity factors, sources of food and food transactions, showed that online ordering and delivery services were widely used and could help maintain a diverse diet (Zhao et al., 2020). As a precaution, dietary supplements have been used by many people and their sales have risen rapidly. Google trend (GT) findings suggest these interests were positively correlated with COVID-19 interests. There is no clear and compelling research supporting the role of supplements in the prevention and treatment of COVID-19, except for the role of vitamins D and C, zinc, and selenium. In addition, there is a risk of increased consumption of certain nutrients (Hamulka et al, 2021). "Immune boosting" during the pandemic is a trending issue however dissemination of misinformation including topics such as immune boosting to stop COVID-

19, has followed the coronavirus pandemic. Design Content research has been undertaken to investigate how immune boosts are represented on the internet during the COVID-19 pandemic in webpages of Canada and USA. Vitamin C, diet, sleep, exercise and zinc supplementation and safe diet, exercise, sleep were the main immune-boosting strategies (Rachul et al, 2020). Review by Wagner et al, (2020) provides information of Instagram's successful immune-boosting content. The posts were supporting "immune boosting" as advantageous, almost all of them included corporate interests, and many used science and medical rhetoric in their messaging. However, they also included scientifically inaccurate and unproven drugs. It is the need of hour to establish successful consumer education in the rational use of supplements against COVID-19.

Method

The present bibliometric analysis covers studies conducted in the years 2020 and 2021. The descriptors “micronutrient”, “nutrition”, “nutrients”, “diet”, “nutrition therapy”, “dietary supplements”, “COVID19”, “Coronavirus” were used to search the “publications in Scopus. The Boolean operators “AND” and “OR” were used to combine the above-mentioned descriptors and conduct the literature search. This search strategy yielded a total of 93 publications (as of 15 February 2021). The publications were critically examined by reading the title, abstract and the full text and included in the present analysis.

The publications were analysed by considering some of the following key parameters. The active countries were mapped using the imapbuilder software (www.imapbuilder.net). The types of documents published in this research area were segregated using rawgraphs software (https://app.rawgraphs.io/) and represented as ‘circle packing’ where the circles allow comparison of values. The prominent subject areas were represented using a pie diagram (created using Microsoft Excel) and the top 10 authors, their affiliations, top funding agencies, and month-wise analysis of publications were represented as horizontal bar diagrams. The publications were also segregated based on the number of authors per publication and depicted in a doughnut shaped pie diagram. The list of active journals was also analysed and represented in the pie diagram. The top 5 most cited publications in Scopus were identified and word clouds were created for each publication using word cloud software (www.wordclouds.com).

Results

Active countries

Overall about 45 countries participated actively in research involving COVID19 and nutrition (Figure 1). Research articles were found majorly in the United States (23 publications), followed by the United Kingdom (13 publications), Italy (12 publications) and China (9 publications). About six publications were contributed from each country, including India, Iran, Poland, and Australia's five publications.

Figure 1: Map showing the countries who were involved in research of Covid-19 and Nutrition. (Imapbuilder software) (Date: 12 February 2021)

Analysis by document type

Attributing to the importance of nutrition therapy in Covid-19 treatment has influenced researchers to conduct proper investigations in a short period of about a year and confirm the potential benefits of dietary supplements. Figure 2 shows the distribution of the type of document in which the information related to this field. While conducting our literature search, we could identify 48.4% of research articles and 35.5% reviews, highlighting the quantum of work carried out in this field. However, it is also important to note that letters (9.7%), notes (3.2%), editorials (2.2%) and short surveys (1.1%) were also found in this research area.

Prominent subject areas

Figure 3 shows subject areas specific information for the selected publications extracted from the Scopus database. The maximum percentage of the publications is concentrated in the area of Medicine (38%), then Nursing (23%) followed by Agricultural and Biological sciences (14%).

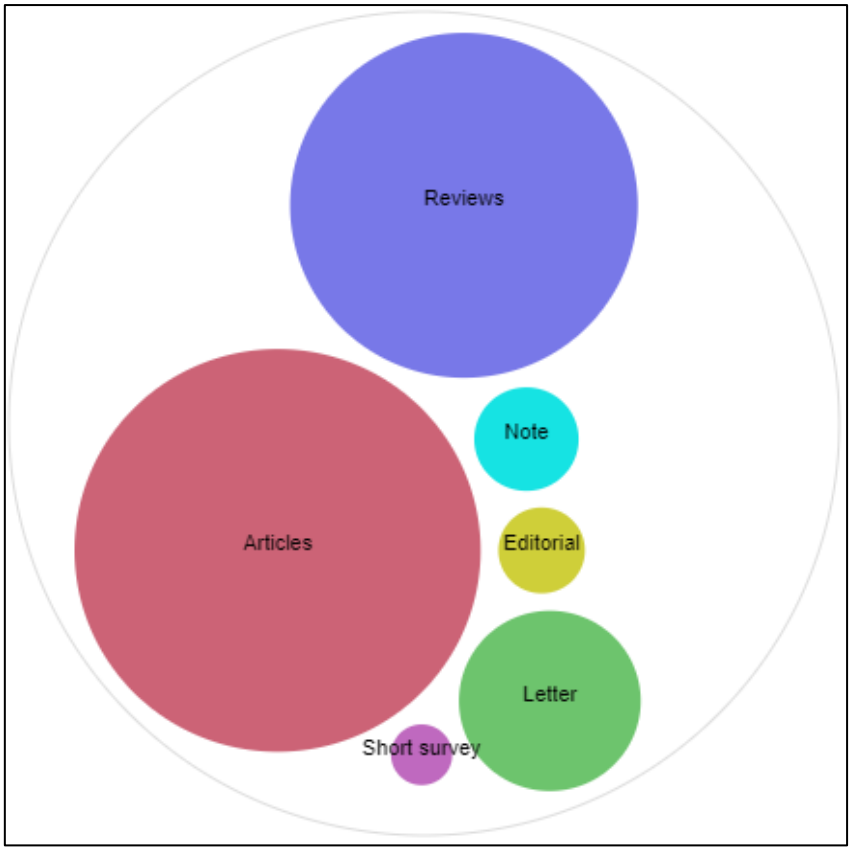

Figure 2: Different types of documents (Source: Image using Rawgraphs software)

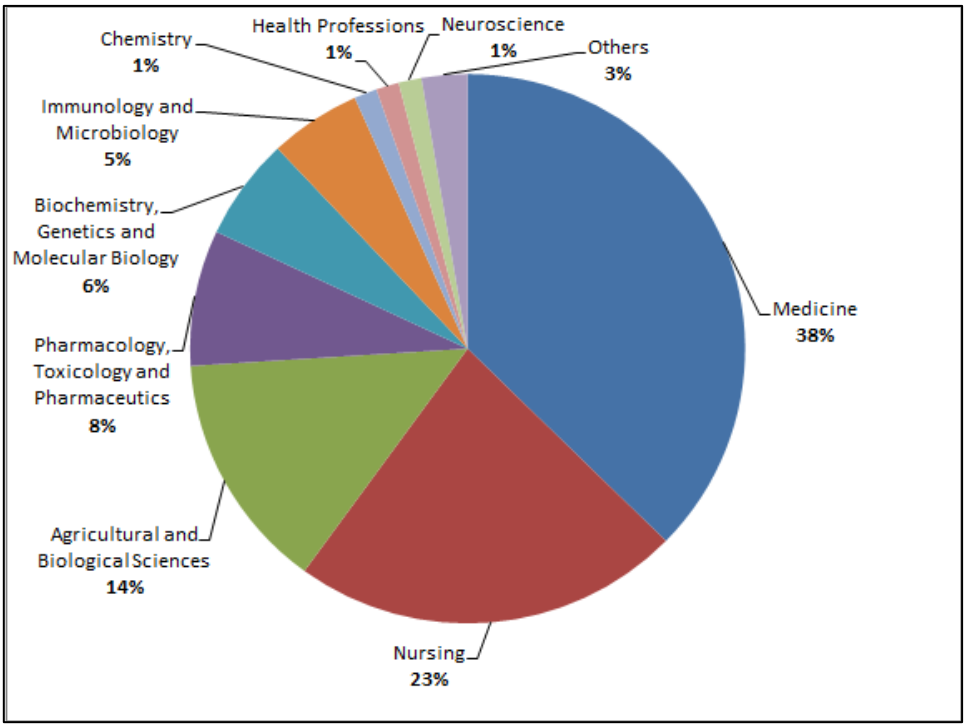

Figure 3: Subject Area

Authors and Affiliation statistics

Figure 4 shows the top 10 authors who are contributing to the area of our interest. The first two authors, Calin Daniela Cornelia and Docea Anca Oana have co-authored three publications and are affiliated with University of Medicine and Pharmacy of Craiova, Romania. The other eight authors have contributed to two publications each and among them four authors are from the United States, two authors from China, and one author each from Canada and Poland.

The top 10 affiliations are shown in Figure 5. The first three affiliations were found in three publications each while the other seven affiliations were found in two publications. The first affiliation in the list, the universitatea de medicina si farmacie din craiova, Romania which is translated as the University of Medicine and Pharmacy of Craiova is from Romania, a southeastern European country. The second affiliation, Peking University is located in Beijing, China while the third affiliation, Szkoła Główna Gospodarstwa Wiejskiego (translated as Warsaw University of Life Sciences) is located in Poland. Among the other affiliations, three were from the United States (Nutrition and Health Research Center, Grassroots Health and Johns Hopkins Blommberg School of Public Health), two from Poland (Copernicus Hospital and Gdanski Uniwersytet Medyczny - translated as Medical University of Gdańsk), one from Portugal (Universidade do Porto - translated as University of Porto) and the other one is from Lombardy, Italy (Universita degli Studi di Pavia - translated as The University of Pavia).

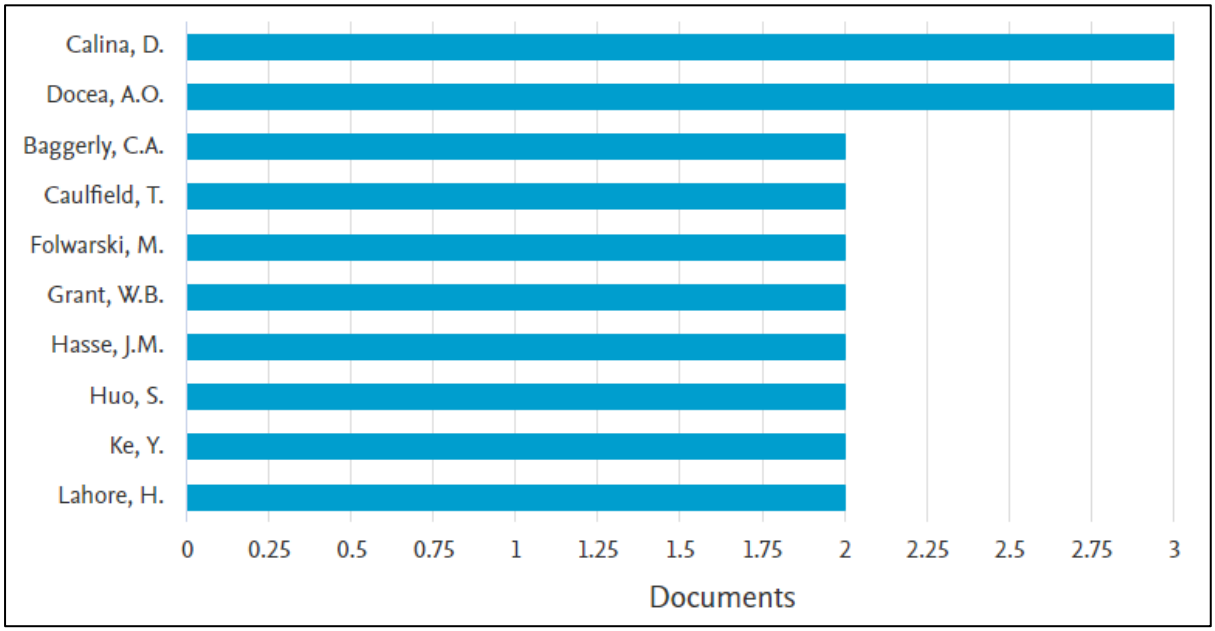

Figure 4: Top 10 authors contributing to the area of Covid-19 and nutritional management

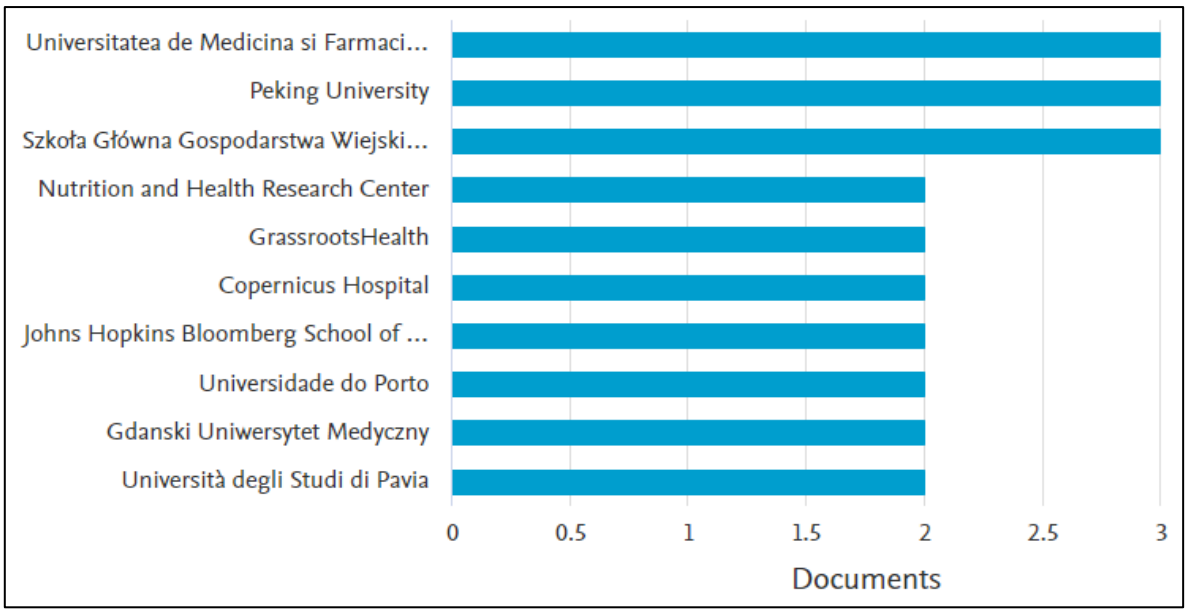

Figure 5: Affiliations statistics

Publications as per number of Authors

The doughnut below (Figure 6) shows the percent of publications as per the number of authors involved in writing the manuscript. The legends for the doughnut is as follows- Cinderella=1 author; Dyad=2 authors; Triumvirate= 3 authors; Quartet= 4 authors; Quintet=5 authors; Hexad=6 authors; Rainbow=7 authors; Galaxy= 8 or more authors. Out of the total 93 articles selected for this bibliometric analysis, 25 manuscripts were written by a group of eight or more authors followed by 17 manuscripts written by a group of three authors.

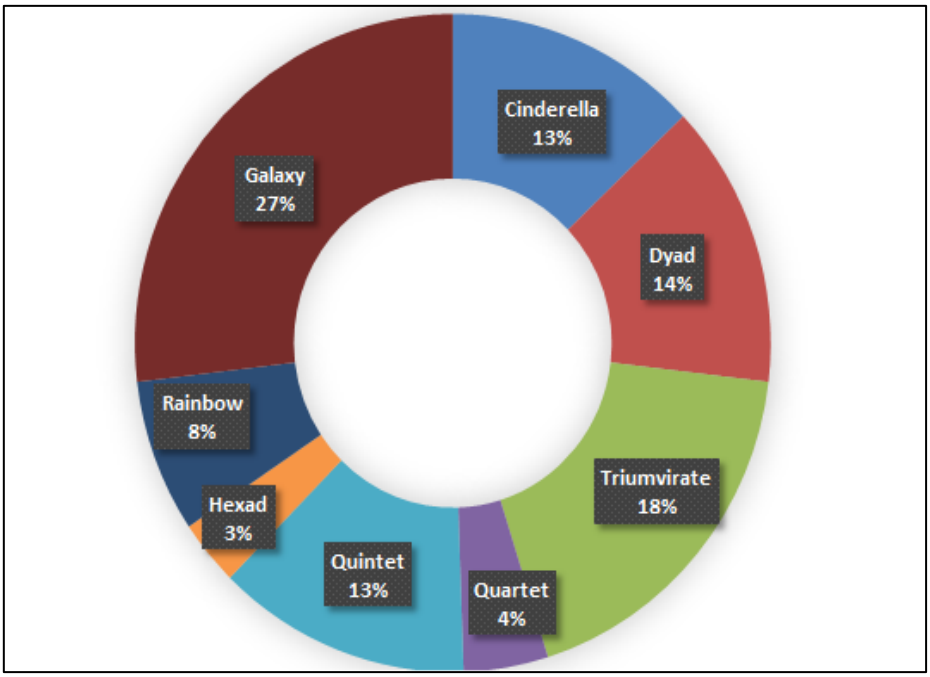

Figure 6: Publications as per number of Authors

Funding

Figure 7 depicts the top 10 funding agencies leading to publication in the area of Covid-19 and nutritional management. The top funding agency is the Princess Nourah Bint Abdulrahman University located in Riyadh, Saudi Arabia and two documents have been published. The other agencies have contributed for the publication of a single document each. Among these agencies, three are located in the United States (American Association of Plastic Surgeons, American Society for Parenteral and Enteral Nutrition and Anschutz Foundation), two each are from the United Kingdom (Action Medical Research, and Biotechnology and Biological Sciences Research Council), Canada (Alberta Innovates and Canadian Institutes of Health Research) and China (China Medical University and China Medical University Hospital).

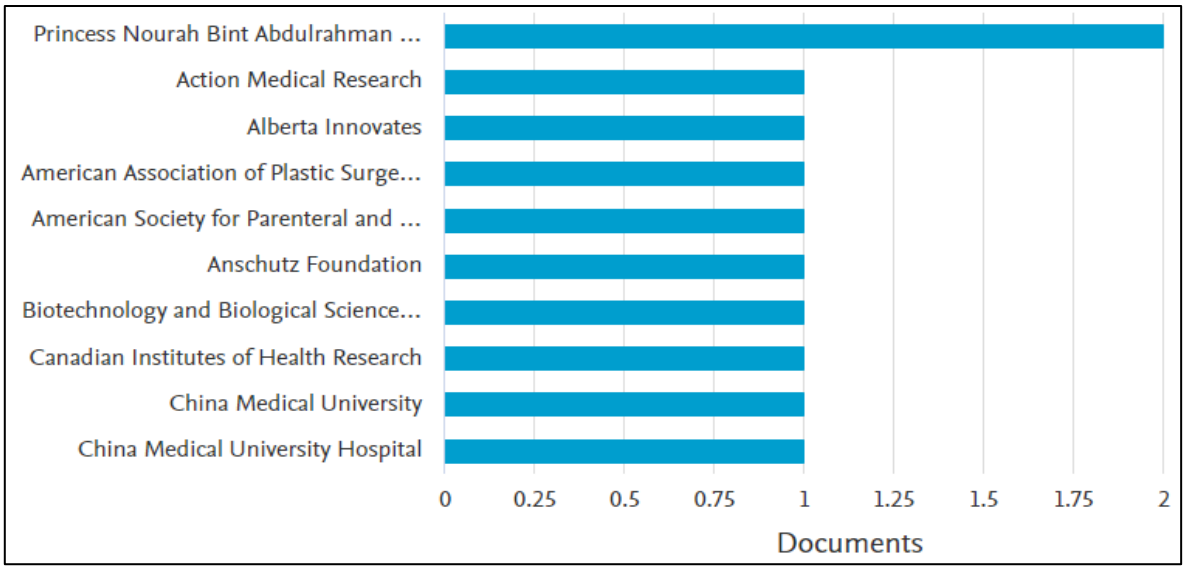

Figure 7: Top 10 funding agencies (Scopus)

Analysis of Publications

Figure 8 gives the details of the number of publications in various months for the years across the time range of the search. It is observed that maximum publications were contributed in the months of June and September 2020, followed by 11 publications in December 2020 and 10 each in October and November 2020. This trend directs at the fact that as curiosity about the present pandemic of Covid19 increased, the scientific fraternity explored the various aspects of nutrition and dietary supplements as a long term strategy and geared up for relevant publications.

Active journals

The number of publications across various journals revealed that 49 journals published one article each contributing to 54% of the publications (Figure 9).

Five journals namely *Clinical Nutrition ESPEN*, *Frontiers in Immunology*, *Medical Hypotheses*, *Nutrition in Clinical Practise* and *International Journal of Research in Pharmaceutical Sciences* published 3 articles each, thus contributing to 16% of the total publications.

Similarly six journals published 2 articles each, making a contribution of 13% to the total number of publications. The journals are- *Nutrition*, *Trials*, *Irish Medical Journal*, *Medicina*

(Lithuania), Journal of Infection & Public Health and *Diabetes & Metabolic Syndrome: Clinical Research and Reviews*.

The journal- *Nutrients* singley published 16 articles with two in 2021 and rest in 2020 across various months. Thus its contribution was a good 17% to the total publications. This journal has been covered in Scopus database since 2009 and has a citation score of 6.3 as reported by the cite score tracker 2020. Its major subject areas are Agriculture & Biological sciences, Food science, Nursing and Nutrition & Dietetics. It ranks #37 for the various articles published under the broad umbrella of Nutrition & Dietetics.

Figure 8: Month wise number of publications across the years of search

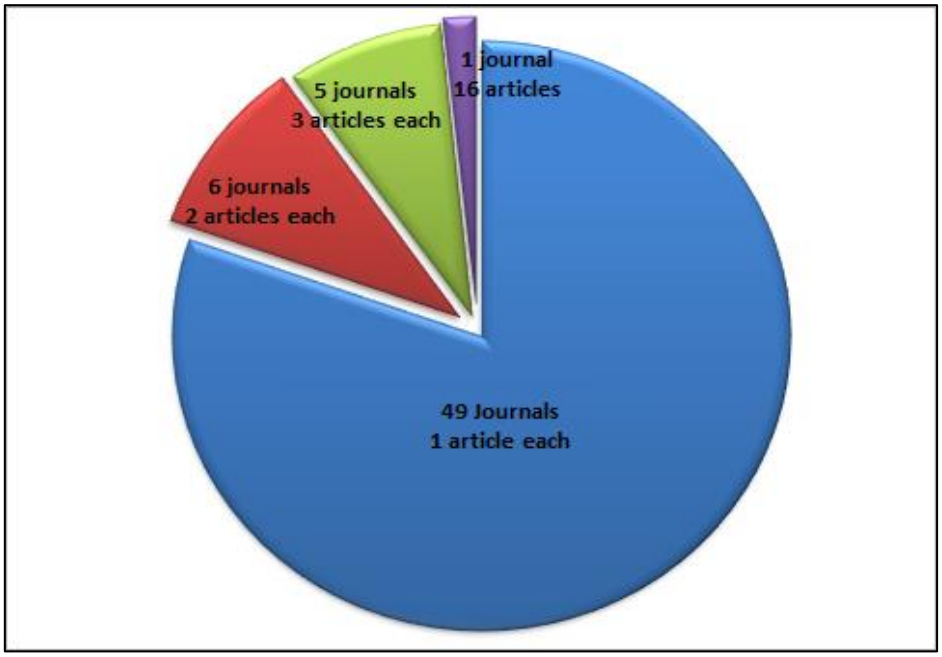

Figure 9: Number of publications across various journals

Most cited articles

Citation Analysis may be used to calculate the influence of a specific document, reflecting the use of information and resources, and the importance carried by that article. About 64 articles were cited at least once and totally till date (as on 15th February 2020), there are 1057 citations for these publications. Table 1 presents the most frequently cited articles. It was found that the most frequently cited article was, "*Evidence that vitamin D supplementation could reduce risk of influenza and covid-19 infections and deaths*" which was published in the journal "*Nutrients*" during April, 2020 and authored by Grant et al., 2020.

Table 1: Citation analysis of the top five publications (As on 15th February 2021)

Details of the paper	Total citations
Evidence that vitamin D supplementation could reduce risk of influenza and covid-19 infections and deaths (Grant et al., 2020)	404
Enhancing immunity in viral infections, with special emphasis on COVID-19: A review (Jayawardena et al., 2020)	81
Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel coronavirus disease (COVID-19): Rationale and feasibility of a shared pragmatic protocol (Caccialanza et al., 2020)	70
A retrospective cohort study of methylprednisolone therapy in severe patients with COVID-19 pneumonia (Wang et al., 2020)	49
Functional role of dietary intervention to improve the outcome of COVID-19: A hypothesis of work (Messina et al., 2020)	37
Vitamin D and inflammation: Potential implications for severity of Covid-19 (Laird et al., 2020)	37

Analysis using word cloud

Figures 10-14, drawn using www.wordclouds.com, represent the word cloud of the top five papers that are found during the citation analysis to gain a better visualization of the present bibliometric analysis. The concept behind the use of word cloud for the articles is to examine the most prevalent terms, implying that most of the work is conducted in those fields. A Word Cloud or Tag Cloud transforms text data into tags, generally single words whose relative value can be visualized in the created cloud by their size and color. Words in smaller fonts often indicate the potential directions for study. Figure 10 shows the word cloud for the article, "*Evidence that vitamin D supplementation could reduce risk of influenza and covid-19 infections and deaths*". It is evident from Figure 10 that most prevalent words are Covid-19, 25(OH)D, vitamin, influenza, risk, respiratory, infections, studies, trials, mechanisms, cytokines while words such as epidemiology, observational, clinical, case fatality, deficiency are less predominant words.

The word cloud for the second most cited article, "*Enhancing immunity in viral infections, with special emphasis on COVID-19: A review*" can be viewed as Figure 11. It indicates that

Covid-19, infections, viral, respiratory, vitamins, minerals, nutrition, nutraceuticals, probiotics are the most predominant words, while micronutrients, interventions, zinc, selenium, evidence are less predominant words.

Figure 12 indicates the word count for the article "*Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel coronavirus disease (COVID-19): Rationale and feasibility of a shared pragmatic protocol*" and indicates the predominant words as Covid-19, patients, China, Wuhan, respiratory, consequences, disease, nutritional, malnutrition and the less predominant words are clinical, anorexia, inflammation, pneumonia, high-calorie, food, nutrition.

Word cloud was not performed for the fourth most cited document, A retrospective cohort study of methylprednisolone therapy in severe patients with COVID-19 pneumonia (Wang et al., 2020), since it was a note. However it is interesting to record that a document such as 'note' can gain about 48 citations.

Two articles were cited in equal numbers (37 citations). Among these, the word cloud of the article, "*Functional role of dietary intervention to improve the outcome of COVID-19: A hypothesis of work*" (Figure 13) indicates terms Covid-19, infection, China, IL-6, TNF-alpha, therapy, dietary outcomes as the most predominant words, while intervention, pneumonia, evidence, drugs, adiponectin were the less predominant words. The word count of the other article, "*Vitamin D and inflammation: Potential implications for severity of Covid-19*" revealed that the most predominant terms are Covid-19, infection, Europe, Norway, Finland, countries, Immune while the less predominant terms are health, Spain, Sweden, biological, innate (Figure 14).

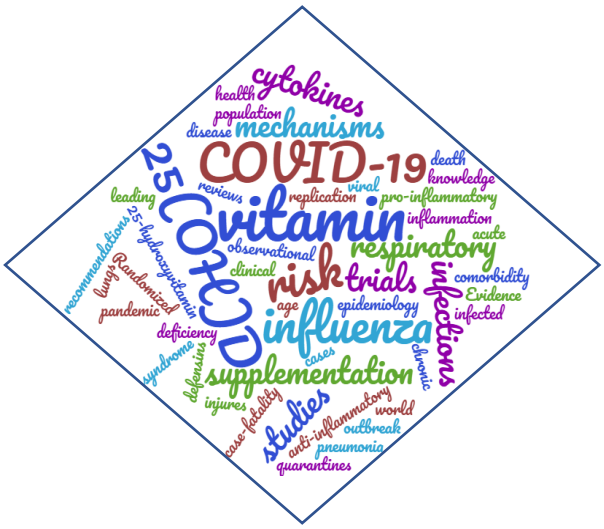

Figure 10: Word cloud for "Evidence that vitamin d supplementation could reduce risk of influenza and covid-19 infections and deaths" article (Grant et al., 2020) (Source: https://www.wordclouds.com)

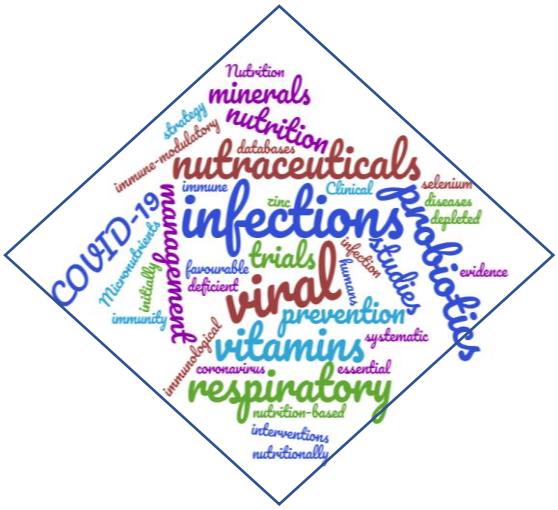

Figure 11: Word cloud for "Enhancing immunity in viral infections, with special emphasis on COVID-19: A review" article (Jayawardena et al., 2020) (Source: https://www.wordclouds.com)

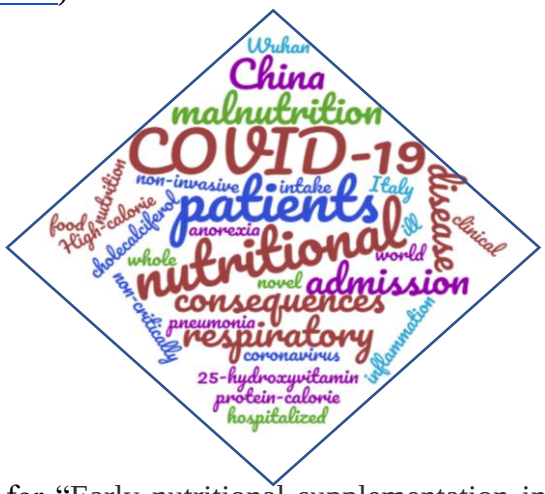

Figure 12: Word count for "Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel coronavirus disease (COVID-19): Rationale and feasibility of a shared pragmatic protocol" article (Caccialanza et al., 2020) (Source: https://www.wordclouds.com)

Figure 13: Word cloud for **"**Functional role of dietary intervention to improve the outcome of COVID-19: A hypothesis of work" article (Messina et al., 2020) (Source: https://www.wordclouds.com)

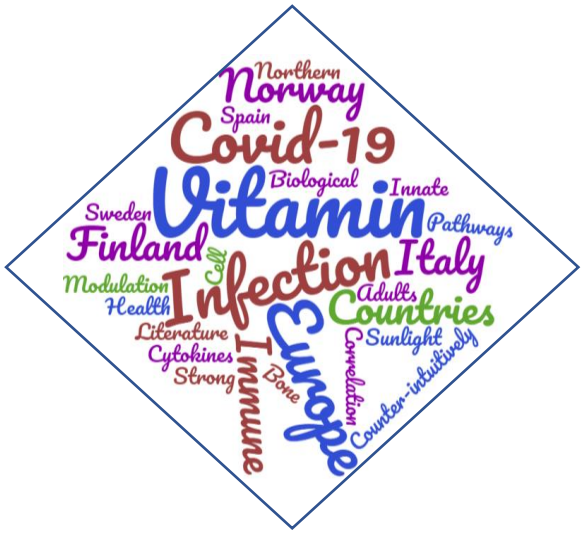

Figure 14: Word cloud for "Vitamin D and inflammation: Potential implications for severity of Covid-19" article (Laird et al., 2020) (Source: https://www.wordclouds.com)

Conclusion

The present paper presents a bibliometric analysis of nutritional therapy's role in COVID-19 management and treatment from 2020 to 2021. According to the publications yielded from Scopus, the documents were critically evaluated and identified that research had been primarily conducted in the areas of nutritional therapy in individuals admitted in ICU where parental and enteral nutrition plays a crucial role, dietary supplements to ensure supply of nutrition and dietary diversity was encouraged to obtain the benefits of a balanced diet. Studies also evaluated the role of nutritional status (malnutrition) in individuals affected with COVID-19 as this may be one of the main detrimental factors which decide the duration of hospital stay. Studies include the role of various micronutrients (vitamins A, B, C, D, E and minerals including copper, iron, magnesium, manganese, sodium, selenium and zinc) and nutraceuticals such as omega-3 fatty acids, probiotics and prebiotics, alpha-lipoic acid, herbal supplements including curcumin, ginger, echinacea, garlic, green tea, cinnamon and ginseng which were studied in multiple and single forms also. Moreover, few studies have also emphasized the post-COVID-19 care with adequate nutrition.

The analysis of countries, types of documents, subject area, authors their affiliations, funding agencies, and journals could reference future research, especially to new researchers who intend to initiate a study in this field. The word cloud analysis obtained from the most cited articles indicated the least predominant words representing the ignored field of research. Some of the most common less predominant terms include '*epidemiology*', '*clinical*', '*observational*', '*case fatality*', '*interventions*', and '*evidence*' indicating the lack of such research methodologies in these areas. Some of the other less predominant words were '*micronutrients*', '*food*', '*nutrition*', '*deficiency*', '*zinc*', '*selenium*', '*high-calorie*', '*adiponectin*', '*anorexia*' specifying the research domains wherein adequate findings are lacking. Future studies may identify the emerging trends and research gaps from the present bibliometric analysis to yield better directionality to their studies.

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