Research Paper
Research Focuses and Trends in Multiple Sclerosis: A Scientometric Analysis

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A B S T R A C T

Introduction: The purpose of this study is to analyze the multiple sclerosis research in Science Citation Index-Expanded from 1992 to 2019 in order to determine the top features, trends, and topics.

Methods: In this scientometric study, research population was all articles related to multiple sclerosis in the Web of Science from 1992 to 2019. These articles were retrieved from the Science Citation Index-Expanded and analyzed based on various indicators and characteristics.

Results: There was a significant increase in the number of articles from 408 in 1992 to 2756 in 2019. A sum of 42,112 articles related to multiple sclerosis has been published in 3,032 journals, which were classified among the 131 Web of Science categories. The top two categories were clinical neurology and neurosciences. Multiple Sclerosis Journal published the most articles. Articles published in the Neurology Journal also had the highest citation per publication. Most of the articles were in English, while 23 other languages were used in the articles. Articles in Japanese and English with 7 and 6.9 authors have a higher average of authors than articles in other languages. English language articles received more citations than articles in other languages. The frequency of used keywords in title, abstract, author keywords, and keywords plus analysis showed that "therapy", "disability", "neurodegeneration", "demyelination" and "MRI" show an increasing trend in the multiple sclerosis articles.

Conclusion: The result of this study can help the policy makers and researchers realize the panorama of multiple sclerosis research and design future research.

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Highlights

• The number of multiple sclerosis (MS) articles shows a growing trend, from 1992 to 2019.

• MS is being studied by researchers worldwide in the articles with 23 different languages.

• Symptoms, diagnosis, the ways to reduce symptoms, models, and epidemiology are main categories of MS articles.

• The main foci and trend in MS articles, is "therapy" of the disease.

Plain Language Summary

In this article we studied the features, trends and topics of MS articles from 1992 to 2019. The 42.112 articles retrieved from the web of Sciences database and analyzed. We found that the number of articles increased from 408 in 1992 to 2756 in 2019. These articles have been published in 3032 journals in 23 languages, shows that this subject is an important subject all around the world. We studied the frequency of used keywords in articles and found that some keywords such as "therapy", "disability", "neurodegeneration", "demyelination" and "MRI" show an increasing trend. Between them, therapy is the most frequent keyword. This shows that this subject is very important for researchers and they are working hard on it. We also studied the main categories of MS articles and found that the research on MS is concentrated around five main categories: symptoms, diagnosis, the ways to reduce the symptoms of the disease such as therapy or rehabilitation, and prevalence of the MS. The results of this study can help the researchers and policy makers realize the panorama of multiple sclerosis research and design future research.

1. Introduction

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system in which the myelin sheaths of nerve cells in the brain and spinal cord are impaired, which can disrupt the nervous system and cause many physical complications (Compston & Coles, 2008). Although the disease's underlying cause is unknown, its main mechanism is the immune system dysfunction that caused myelin damage (Nakahara et al., 2012). According to the Atlas of MS, from 2008 to 2013, the number of people worldwide increased from 2.1 million to 2.3 million (Browne et al., 2014). Controlling MS is a process that begins with the first signs of the disease (National Multiple Scleroris Society, 2023). There is no complete cure for the disease, and existing treatments are available to reduce the disease's activity and improve body function (Compston & Coles, 2008). This disease severely affects patients' quality of life and causes problems in balance, vision, numbness, extreme fatigue, and so on. For this reason, every year, much research is conducted on this disease at great expense around the world, and their reports are published in various ways. However, little effort has been made to collect and systematically analyze data on the disease (Espiritu et al., 2020). Scientometrics is a method of research that can be used to perform these analyses. Previous studies show that scientometrics has been used to analyze data from various fields, including medicine and diseases (Ho et al., 2016; Li et al., 2009a; Mao et al., 2010; Ramos et al., 2008; Wang & Ho, 2016; Wang et al., 2020; Xie et al., 2008; Zhang et al., 2010). However, there is a gap in the analysis of research on MS. Therefore, the present study aimed to conduct a comprehensive evaluation of research in this field and its process using scientometric methods.

2. Materials and Methods

In this scientometric study, the research population consisted of all articles related to MS, retrieved from the SCI-EXPANDED between 1992 and 2019 in Web of Science (WoS) (updated on July 29, 2020). Only those publications were considered which were published from 1992 to 2019 and contained the terms "multiple sclerosis", "multiple cases of sclerosis", "multiple sclerosia", "multiple sclerotic", and "disseminated sclerosis" in the article title, abstract, and author keywords. By using advanced search with TI (title), AB (abstract), and AK (author keywords) as 'front page', 42112 articles, having the search keywords in their 'front page' retrieved as MS research articles. Ho's group012 has suggested the 'front page', including the title, the abstract, and the author keywords as a filter to correct the bias of using the terms of the topic (title, abstract, author keywords, and keywords plus) in the basic search of the SCI-EXPANDED for sci-

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entometric studies (Fu et al., 2012). The reason is that keywords plus searches the records that possibly are unrelated to the studied topic (Fu & Ho, 2015). In these records, keywords searched cannot be found on their 'front page', and can only be suggested to be reading literature for research, but not for scientometric studies. It has been pointed out that utilizing the 'front page' as the filter appeared in a tremendous variety (Ho, 2019a, 2019b).

The retrieved articles were downloaded into spreadsheet software and additional coding was manually made using Microsoft Excel 2016 for analysis (Ho & Fu, 2016; Li & Ho, 2008). Besides, the journal impact factors (IF_{2019}) were acquired by the published 2019 Journal Citation Reports (JCR).

Four citation indicators were applied to examine the citations received by the publications:

C_0: The total number of citations from the Web of Science Core Collection in the publication year (Ho, 2014).

C_{year}: The total number of citations (in a particular year) from the Web of Science Core Collection. C_{2019} means the number of citations in 2019 (Ho, 2012).

TC_{year}: The total quantity of citations from the Web of Science Core Collection from the publication year to the end of the most recent year (Ming et al., 2011). In this study, this is 2019 (TC_{2019}).

CPP_{year}: Citations per publication ($CPP_{2019}=TC_{2019}$/TP) (Ho, 2012).

3. Results

Language

In total, 42112 articles, including 40131 English articles (95% of the 42,112), were retrieved as MS research articles. Table 1 shows the characteristics of MS articles in 23 languages used in MS articles in SCI-EXPANDED. Articles published in English had a much higher CPP_{2019} of 35 than non-English articles with a CPP_{2019} of 3.4. Articles published in Japanese had the highest APP of 7.0, while non-English articles had a lower APP of 4.5. The APP of English articles was 6.9 with the maximal number of 906 authors from the USA, UK, France, Czech Republic, Ireland, Switzerland, Canada, Netherlands, Poland, Australia, Belgium, Denmark, Finland, Germany, Greece, Hungary, New Zealand, Sweden, Turkey, Austria, Israel, Italy, and Spain in an article.

Publication trends and citations

Figure 1 presented the distribution of the annual number of articles (TP) and their citations per publication (CPP_{2019}) by year, which was expressed as TC_{2019}/TP. There has been a significant increase in the number of articles from 408 in 1992 to 2756 in 2019. In 1993 with 431 articles had a CPP_{2019} of 63, which was slightly higher than other years. Figure 1 also shows it takes CPPs about 13 years to reach a plateau.

A total of 28014 MS articles (67% of 42,112 articles) had no citations in the publication year (C_0=0). Moreover, among the best 100 C_0 articles, 27% and 29% were among the main 100 TC_{2019} and C_{2019} articles.

Web of science categories and journals

JCR indexed 9370 journals across 178 Web of Science categories in SCI-EXPANDED in 2019. A sum of 42112 articles related to MS has been published in 3032 journals, which are classified among the 131 Web of Science categories in SCI-EXPANDED. Altogether, 2298 articles were published in 374 journals without IF_{2019}, which were not in SCI-EXPANDED in 2019. The top ten Web of Science categories are shown in Table 2.

The top two categories were clinical neurology with 17578 articles (42% of 42,112 articles) and neurosciences with 15220(36%) articles. The top two productive categories published 24384 MS articles (58% of 42112 articles) in SCI-EXPANDED from 1992 to 2019 with TC_{2019} of 798068 (57% of 1392467 citations). In 2019, 204 and 271 journals were classified into clinical neurology and neurosciences categories, respectively. MS articles had the highest CPP_{2019} of 48 in both categories of "research and experimental medicine" and "general and internal medicine" and the lowest CPP_{2019} of 19 in "pharmacology and pharmacy" to compare with the top 10 categories (Table 2). Articles published in the category of multidisciplinary sciences had the highest APP of 9.0 and the lowest in "pharmacology and pharmacy" with an APP of 5.7. It has been observed that journals could be characterized by at least two classifications in the Web of Science; for instance, the Journal of Neurology Neurosurgery and Psychiatry was classified into clinical neurology, psychiatry, and surgery categories. Hence, the entirety of rates was higher than 100%.

The best ten most productive journals are recorded in Table 3 with journal impact factor (IF_{2019}), number of authors per publication (APP), number of citations per publication (CPP_{2019}), and Web of Science category.

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Seven of the top 10 journals were classified in the category of clinical neurology, three in the category of neurosciences, and two in the category of immunology. Multiple Sclerosis and Multiple Sclerosis Journal had the same International Standard Serial Number (ISSN) of 1352-4585. These two journals were merged as Multiple Sclerosis Journal. It published the most articles (3093 articles; 7.3% of 42112 articles). Comparing the top 10 productive journals in Table 3, articles published in Neurology had the highest APP of 9.2, and Acta Neurologica Scandinavica had the lowest APP of 5.6. Articles published in Neurology also had the highest CPP_{2019} of 74, while Multiple Sclerosis and Related Disorders had only a CPP_{2019} of 4.9.

According to the journal impact factor, the top three journals are in the category of general and internal medicine, such as New England Journal of Medicine with 48 articles (IF_{2019}=74.699), Nature Reviews Drug Discovery with one article (IF_{2019}=64.797), and Lancet with 68 articles (IF_{2019}=60.392).

Figure 2 shows that among the eight high-yield journals in 2019, the two journals, Multiple Sclerosis Journal and Multiple Sclerosis and Related Disorders, are specialized journals in this disease and had the highest growth in terms of the number of articles in the years under review. Other journals with more general titles also show a decrease in the number of articles.

Research focuses and their trends

This study has statistically analyzed all the single words in the title of MS articles. Table 4 shows the 20 most frequently used single words in titles through the past 28 years and four seven-year periods.

The two keywords "patients" and "disease," with a frequency of about 17% and 5.8% of articles, respectively, and ranking third and eighth among all title words, are among the most frequent keywords in the title of articles, which shows the emphasis on this disease and its various aspects. The keyword "clinical," which is one of the most frequently used terms in the title, probably refers to clinical research in this field and has increased slightly during the study.

The keywords "multiple," "sclerosis," "encephalomyelitis," "autoimmune," "lesions," "brain," "expression," and "MS," which are the most frequently used terms in article titles, refer to the disease's name and description. The keywords "treatment" and "therapy", which refer to the disease's treatment, are in the ranks of 20 and 7, re-

spectively. The keywords "MRI" and "imaging," which is one of the most crucial diagnostic methods of this disease, show a slight decrease in the percentage of articles in this area in recent years (compared to previous years), (2.7%. 2.8% in 2013-2019 compared to 4.1 % in 1992 to 98 (MRI) and 3.6% in 1999 to 2005 (imaging). In MS, the keyword "relapsing-remitting" refers to one of the most common types of MS and is ranked the 15th most common keywords, and its share increased from 1.7% in 1992-1998 with a slight increase to 3.6% in 2013-2019.

In general, the percentage of frequency of keywords in articles' titles has a relatively constant trend and has not changed much. Only the words "cell" and "cells" show a growth of about 2%. The term "model" also shows a growth of about 3% in the years under review, related to the models of studying MS. The term "human" also indicates a decrease of about 3% in the years under study. The term "lesions" indicates a reduction of about 2% in the repetition rate.

Table 5 demonstrates the frequency of words in the abstract. There are keywords such as "background" and "conclusions," "significant," "methods," and "significantly" related to the abstract structure and method in this table. The keywords "patients," "disease," and "clinical" are among the most frequent words.

The largest increase in specialized vocabulary is related to the word "treatment," which has increased from 21% in 1992-1998 to 31% in 2013-2019. The term "autoimmune" has increased from 15% to 20%. The word "controls" has also increased from 14% to 19%, and this word was not present in the table related to the most frequent words of article titles (Table 4). The keywords "MRI" and "imaging" are not included in this table.

Table 6 shows that in the authors' keywords, items one to five and item eight are the same as the most frequent title keywords listed in Table 4, and those other keywords are different from the title and abstract high-frequency keywords. However, the authors' keywords are not single words; some of them are compound words that are used to convey the meanings of the article to the readers and are composed of a combination of single words in Tables 4 and 5. These keywords include items such as the name of the disease and its description.

In the authors' keywords, the "EAE" keyword increased from 1.1% in 1992-98 to 2.9% in 2013-2019. "Demyelination" is the hallmark of MS used to describe the disease and has decreased from 5.9% in 1992-1998 to 2.8% in 2013-2019 in the studied years. There is an

Table 1. The scientometrics characteristics of the MS articles in different languages

Language	TP	%	AU	APP	TC_{2019}	CPP_{2019}
English	40,131	95	276,324	6.9	1,385,658	35
German	553	1.3	2,118	3.8	1,644	3.0
French	480	1.1	2,063	4.3	2,326	4.8
Spanish	397	0.94	2,184	5.5	1,911	4.8
Russian	257	0.61	1,268	4.9	397	1.5
Czech	118	0.28	551	4.7	114	1.0
Portuguese	38	0.090	179	4.7	245	6.4
Turkish	35	0.083	146	4.2	34	1.0
Italian	33	0.078	151	4.6	17	0.52
Polish	25	0.059	84	3.4	76	3.0
Hungarian	10	0.024	39	3.9	9	0.90
Chinese	5	0.012	28	5.6	11	2.2
Slovak	5	0.012	28	5.6	1	0.20
Croatian	3	0.0071	11	3.7	0	0
Japanese	3	0.0071	21	7.0	5	1.7
Korean	3	0.0071	4	1.3	3	1.0
Serbian	3	0.0071	12	4.0	7	2.3
Slovene	3	0.0071	10	3.3	2	0.67
Slovenian	3	0.0071	9	3.0	1	0.33
Dutch	2	0.0047	6	3.0	3	1.5
Icelandic	2	0.0047	6	3.0	1	0.50
Persian	2	0.0047	10	5.0	2	1.0
Serbo-Croatian	1	0.0024	3	3.0	0	0

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Abbreviations: TP: Number of publications; AU: Number of authors; APP (AU/TP): Number of authors (AU) per publication (TP); TC_{2019}: Number of citations from Web of Science core collection since publication year to the end of 2019; CPP_{2019}: Citations per publication (TC_{2019}/TP).

increase in the frequency of "inflammation," "fatigue," "disability," "optic neuritis," and "depression" which refer to the disease's complications and the "quality of life" and "rehabilitation." This shows many articles have examined these cases in MS patients. "Cerebrospinal fluid" is one of the ways to diagnose this disease, and its frequency in articles has decreased in recent years.

The frequency of "cytokines" shows a slight decrease (from 2.9 to 1.1 percent). A small percentage (1.8%) of the authors' keywords were dedicated to "epidemiology", which varied from 1.5 to 2.1 in all years. "Neuromyelitis optica" is also one of the most used author keywords in MS articles, and its frequency has increased since 2006 in the reviewed articles.

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Table 2. The top 10 productive web of science categories in MS articles

Web of Science Category	TP (%)	No. J	CPP_{2019}	APP
Clinical neurology	17578(42)	204	34	6.9
Neurosciences	15220(36)	271	35	6.9
Immunology	5696(14)	158	36	7.1
Psychiatry	1995(4.7)	155	25	6.1
Biochemistry and molecular biology	1948(4.6)	297	39	7.2
Radiology, nuclear medicine, and medical imaging	1947(4.6)	133	34	7.1
Multidisciplinary sciences	1870(4.4)	71	45	9.0
Pharmacology and pharmacy	1689(4.0)	270	19	5.7
Research and experimental medicine	1567(3.7)	138	48	6.6
General and internal medicine	1403(3.3)	165	48	6.1

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Abbreviations: TP: Number of publications; No. J: Number of journals in a Web of Science category; APP: Number of authors per publication; CPP_{2019}: Number of citations (TC_{2019}) per publication (TP).

Table 7 shows the high-frequency keywords of keywords plus. keywords including "multiple-sclerosis," "disease," "experimental autoimmune," "encephalomyelitis," "expression," "MS," "brain," "MRI," and "lesions" were repeated in the author, title, or abstract keywords. Nevertheless, the "central nervous system," "disability," "experimental allergic encephalomyelitis," "diagnostic-criteria," "impairment," "double-blind," "T-

Table 3. The top 10 productive journals in MS

Journal	TP (%)	IF_{2019}	APP	CPP_{2019}	Web of Science Category
Multiple Sclerosis Journal	3093(7.3)	5.412	7.6	29	Clinical neurology Neurosciences
Journal of Neuroimmunology	1812(4.3)	3.125	6.7	32	Immunology Neurosciences
Neurology	1176(2.8)	8.770	9.2	74	Clinical neurology
Journal of the Neurological Sciences	1155(2.7)	3.115	6.2	27	Clinical neurology Neurosciences
PLoS One	977(2.3)	2.740	8.7	21	Multidisciplinary sciences
Journal of Neurology	896(2.1)	3.956	7.4	29	Clinical neurology
Multiple Sclerosis and Related Disorders	808(1.9)	2.889	7.3	5	Clinical neurology
Journal of Immunology	684(1.6)	4.886	7.3	68	Immunology
Acta Neurologica Scandinavica	602(1.4)	2.684	5.6	22	Clinical neurology
Journal of Neurology Neurosurgery and Psychiatry	561(1.3)	8.234	7.7	53	Clinical neurology Psychiatry Surgery

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Abbreviations: TP: Number of articles; IF_{2019}: Journal impact factor in 2019; APP: Number of authors per publication; CPP_{2019}: Number of citations(TC_{2019}) per publication(TP).

Table 4. Top 20 most used words in MS article title

Words in Title	TP	R (%)				
		92-19	92-98	99-05	06-12	13-19
Multiple	23,634	1(56)	1(35)	1(60)	1(58)	1(58)
Sclerosis	23,432	2(56)	2(34)	2(60)	2(58)	2(58)
Patients	7,232	3(17)	4(16)	3(16)	3(17)	3(18)
Autoimmune	3,112	4(7.4)	9(5.3)	5(7.3)	4(8.0)	4(7.5)
Encephalomyelitis	2,808	5(6.7)	5(7.9)	4(7.4)	5(6.6)	5(6.1)
Cells	2,541	6(6.0)	14(4.1)	7(6.4)	6(6.4)	6(6.1)
Treatment	2,473	7(5.9)	7(5.9)	6(6.4)	7(5.9)	8(5.6)
Disease	2,462	8(5.8)	10(5.0)	8(6.1)	8(5.8)	7(5.9)
Clinical	2,072	9(4.9)	11(4.5)	9(4.9)	9(4.9)	9(5.1)
Brain	1,763	10(4.2)	12(4.2)	10(4.7)	10(4)	10(4.1)
Cell	1,502	11(3.6)	26(2.5)	13(4.1)	11(3.7)	14(3.5)
MS	1,495	12(3.6)	36(2.1)	17(3.5)	12(3.4)	11(4.0)
Human	1,386	13(3.3)	8(5.4)	11(4.2)	16(3.0)	23(2.6)
Expression	1,384	14(3.3)	16(3.8)	11(4.2)	13(3.2)	17(2.9)
Relapsing-remitting	1,316	15(3.1)	53(1.7)	21(3.1)	17(3.0)	13(3.6)
Imaging	1,274	16(3.0)	25(2.7)	14(3.6)	13(3.2)	18(2.8)
MRI	1,229	17(2.9)	15(4.1)	18(3.5)	21(2.6)	21(2.7)
Model	1,202	18(2.9)	92(1.1)	40(2.0)	18(2.7)	12(3.8)
Lesions	1,190	19(2.8)	13(4.2)	16(3.5)	24(2.5)	27(2.4)
Therapy	1,144	20(2.7)	46(1.9)	25(2.9)	15(3.1)	24(2.6)

TP: Total number of articles; R: Rank.

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cells," and "activation" are among the high-frequency keywords of keywords plus. The "central nervous system," "experimental allergic encephalomyelitis," "experimental autoimmune encephalomyelitis," "lesions," "brain," and "cerebrospinal-fluid" are the keywords that decreased in 2013-2019 compared to 1992-1998. This means that references that use these general keywords in their titles have decreased in recent years. In contrast, "disability," "MS," "diagnostic-criteria," "impairment," "activation," "therapy," and "risk" has had a relatively significant increase in frequency, which shows the trend of recent research toward the "diagnosis," "deficiency," "risk," and "disability" in MS, as well as the "treatment" of disease.

After the analysis of the titles, abstracts, keywords, and keywords plus, some main topics were obtained. As Figures 3 and 4 show, the main foci and trend in MS articles is "therapy" of the disease. After that, "disability," "demyelination," "MRI," and "neurodegeneration" show an increasing number of articles. "Stem cells" shows a relatively stable trend in the years under study; and "rehabilitation" and "immunotherapy" have no increasing trend.

4. Discussion

A total of 42112 articles, having the search keywords in their 'front page' retrieved as MS research articles. The findings showed that there has been a significant increase in the number of articles from 408 in 1992 to 2756

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Table 5. Top 20 most used words in MS article abstract

Words in Abstract	TP	R (%)				
		92-19	92-98	99-05	06-12	13-19
Multiple	38,700	1(94)	1(91)	1(92)	1(94)	1(94)
Sclerosis	38,510	2(93)	2(90)	2(92)	2(94)	2(94)
MS	25,561	3(62)	4(50)	4(59)	3(62)	3(66)
Patients	24,931	4(60)	3(62)	3(59)	4(60)	4(60)
Disease	19,258	5(47)	5(44)	5(47)	5(47)	5(47)
Clinical	14,150	6(34)	6(29)	6(34)	6(34)	7(35)
Methods	12,719	7(31)	68(9.2)	16(18)	7(31)	6(41)
Treatment	11,787	8(28)	10(21)	7(26)	8(29)	8(31)
Cells	9,852	9(24)	7(26)	8(25)	9(23)	12(23)
Significant	9,274	10(22)	12(19)	9(22)	10(22)	11(24)
Significantly	9,221	11(22)	14(19)	11(20)	11(21)	10(25)
System	8,656	12(21)	8(22)	10(21)	12(20)	14(22)
Brain	7,971	13(19)	13(19)	13(19)	14(19)	18(19)
Background	7,968	14(19)	282(3.7)	87(8.8)	16(19)	9(28)
Autoimmune	7,956	15(19)	24(15)	14(18)	13(19)	16(20)
Controls	7,430	16(18)	26(14)	21(17)	20(18)	20(19)
Conclusions	7,388	17(18)	152(5.4)	48(12)	15(19)	13(23)
Central	7,295	18(18)	11(20)	15(18)	23(17)	22(18)
Diseases	7,258	19(18)	15(18)	20(17)	18(18)	26(17)
Role	7,185	20(17)	20(16)	19(18)	19(18)	24(17)

TP: Total number of articles; R: Rank.

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in 2019. Articles published in English had a much higher CPP_{2019} of 35 than non-English articles with a CPP_{2019} of 3.4. The APP of English articles was 6.9 (more than non-English articles with 4.5). In this regard, a relationship among used languages, citations per publication (CPP_{2019}), and the number of authors per publication (APP) has been proposed (Monge-Nájera & Ho, 2017).

A link within the total annual number of articles (TP) and their citations per publication $(CPP_{year}=TC_{year}/TP)$ by the years suggested understanding publications and their impact trends in a research topic (Ho, 2013). Findings indicated that in MS articles, it takes CPPs about 13 years to reach a plateau. While, medical research topics, such as child sexual abuse (Vega-Arce et al., 2019)

2009a and dengue (Ho et al., 2016), took about one decade to reach a plateau. It could be inferred that citations accumulated for at least one decade are required to assess the impact of the papers (Chuang & Ho, 2015).

A total of 28014 MS articles (67% of 42,112 articles) had no citations in the publication year (C_0=0). As Ho and Kahn (2014) indicated, increasing the number of journals in SCI-Expanded will lead to a decrease in the number of publications with no citations in the publication year.

A sum of 42112 articles related to MS has been published in 3032 journals, which are classified among the 131 Web of Science categories in SCI-EXPANDED.

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Table 6. Top 20 most used author keywords in MS articles

Author Keywords	TP	R (%)				
		92-19	92-98	99-05	06-12	13-19
Multiple sclerosis	21,534	1(69)	1(70)	1(71)	1(70)	1(69)
Experimental autoimmune encephalomyelitis	1,235	2(4.0)	10(2.5)	8(3.0)	3(3.7)	2(4.9)
Magnetic resonance imaging	1,197	3(3.9)	2(6.8)	2(5.3)	5(3.0)	4(3.3)
MRI	1,182	4(3.8)	8(3.5)	3(4.3)	2(3.9)	3(3.6)
Demyelination	1,045	5(3.4)	3(5.9)	5(3.8)	4(3.2)	8(2.8)
Inflammation	844	6(2.7)	19(1.5)	7(3.0)	8(2.7)	6(2.9)
Autoimmunity	828	7(2.7)	6(3.7)	4(3.9)	6(2.9)	21(1.8)
EAE	800	8(2.6)	30(1.1)	10(2.1)	7(2.9)	7(2.9)
Cerebrospinal fluid	769	9(2.5)	4(5.1)	9(3.0)	11(2.3)	19(1.9)
Fatigue	760	10(2.4)	31(1.0)	23(1.5)	9(2.5)	5(3.0)
Quality of life	657	11(2.1)	126(0.33)	26(1.4)	12(2.3)	9(2.6)
Disability	639	12(2.1)	20(1.5)	11(2.0)	14(2.1)	16(2.2)
Depression	618	13(2.0)	41(0.74)	13(1.8)	13(2.1)	15(2.2)
Cytokines	573	14(1.8)	9(2.9)	6(3.3)	21(1.7)	31(1.1)
Epidemiology	573	14(1.8)	12(2.1)	24(1.5)	15(2.1)	22(1.8)
Neuromyelitis optica	570	16(1.8)	1162(0.037)	105(0.45)	10(2.4)	13(2.3)
Optic neuritis	565	17(1.8)	11(2.2)	22(1.6)	20(1.8)	19(1.9)
Microglia	557	18(1.8)	14(1.8)	16(1.8)	23(1.5)	18(2.0)
Rehabilitation	548	19(1.8)	126(0.33)	25(1.5)	16(2.0)	17(2.0)
Cognition	545	20(1.8)	126(0.33)	56(0.71)	22(1.7)	10(2.5)

TP: Total number of articles; R: Rank.

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Altogether, 2298 articles were published in 374 journals without IF_{2019}. The top two categories were clinical neurology with 17578 articles (42% of 42,112 articles) and neurosciences with 15220(36%) articles.

Multiple Sclerosis Journal has published the most articles (3093 articles; 7.3% of 42112 articles). Articles published in Neurology had the highest APP of 9.2.

Garfield believed that statistical analysis of title and author keywords can be used to discover the orientation of science. Furthermore, the author's keywords are used to study the trend of science (Garfield, 1990). Authors' keywords are usually what the authors find appropriate to describe the article (Li et al., 2009b; Névéol et al., 2010).

Also, given the dispersion of terms in article titles, abstracts, author keywords, and keywords plus, Ho's group suggested "word cluster analysis" to analyze study main focuses and trends in a study (Mao et al., 2010; Wang & Ho, 2016). So, this study has statistically analyzed all the words in the title, abstract, author's keywords, and keywords plus of MS articles.

Although MS was recognized and described by Robert Carswell in 1838, its treatment dates back to 1990 (Compston & Coles, 2008). Findings show that in total, the two keywords "treatment" and "therapy" constitute about 10% of the keywords of article titles.

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Table 7. Top 20 most used keywords plus in MS articles

KeyWords Plus	TP	R (%)				
		92-19	92-98	99-05	06-12	13-19
Multiple-sclerosis	8,163	1(20)	1(18)	1(19)	1(21)	1(21)
Central-nervous-system	3,844	2(10)	3(11)	2(13)	2(10)	5(7.3)
Disease	3,673	3(9.1)	5(10)	5(9.1)	4(9.2)	3(8.9)
Disability	3,602	4(8.9)	14(3.7)	6(8.9)	3(10)	2(9.4)
Experimental autoimmune encephalo-myelitis	3,265	5(8.1)	6(8.6)	4(10)	5(8.4)	6(7.0)
Expression	3,172	6(7.9)	9(6.9)	7(8.3)	6(8.0)	4(7.8)
Experimental allergic encephalomyelitis	2,573	7(6.4)	2(14)	3(11)	9(6.1)	29(2.8)
Ms	2,517	8(6.2)	28(2.5)	9(7.1)	8(7.4)	7(5.9)
Brain	2,237	9(5.5)	8(7.7)	12(5.9)	12(5.0)	8(5.3)
MRI	2,131	10(5.3)	12(4.6)	10(7.1)	10(5.4)	13(4.6)
Lesions	2,121	11(5.2)	10(6.8)	8(7.7)	11(5.2)	20(3.9)
T-cells	1,878	12(4.6)	17(3.4)	14(5.4)	15(4.7)	14(4.5)
Diagnostic-criteria	1,826	13(4.5)	459(0.23)	32(2.5)	7(7.8)	18(4.1)
Impairment	1,805	14(4.5)	21(2.7)	18(3.3)	13(4.8)	10(5.1)
Cerebrospinal-fluid	1,788	15(4.4)	7(7.9)	13(5.5)	16(4.5)	27(3.1)
Double-blind	1,618	16(4.0)	21(2.7)	15(5.2)	14(4.7)	24(3.3)
Activation	1,570	17(3.9)	26(2.5)	19(3.2)	20(3.6)	12(4.7)
Therapy	1,537	18(3.8)	39(2.0)	21(3.2)	17(4.3)	16(4.1)
Risk	1,533	19(3.8)	63(1.5)	83(1.3)	19(4.0)	9(5.2)
Cells	1,511	20(3.7)	13(4.2)	16(3.7)	24(3.3)	19(3.9)

TP: Total number of articles; R: Rank.

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The keywords "MRI" and "imaging", which is one of the most crucial diagnostic methods of this disease, show a slight decrease in the percentage of articles in this area in recent years. As noted by Compston and Coles (2008), in most cases, MS can be diagnosed clinically, but MRI is used to diagnose when the diagnosis is unclear.

In general, the percentage of frequency of keywords in articles' titles has a relatively constant trend and has not changed much. Only the words "cell" and "cells" show a growth of about 2%. This work may be about Nerve cells, T cells, B cells, or stem cells. Nerve cells are demyelinated in MS and T cells and B cells play a key role in causing MS, but cell therapy is known as one of the

new methods of treating MS and has created great hope in MS patients (Rice et al., 2013).

In the authors' keywords, the "EAE" keyword is one of the animal models for studying the inflammatory and behavioral indicators of MS (Gijbels, et al. 2000), which increased from 1.1% in 1992-98 to 2.9% in 2013-2019. It is found that efforts to study these indicators have increased.

"Cytokines" play an important role in MS, and restoring the balance between them through drug or adjuvant interventions can help improve and control the disease (Wagner et al., 2020). However, the frequency of it in the authors' keywords, shows a slight decrease (from 2.9 to 1.1 percent).

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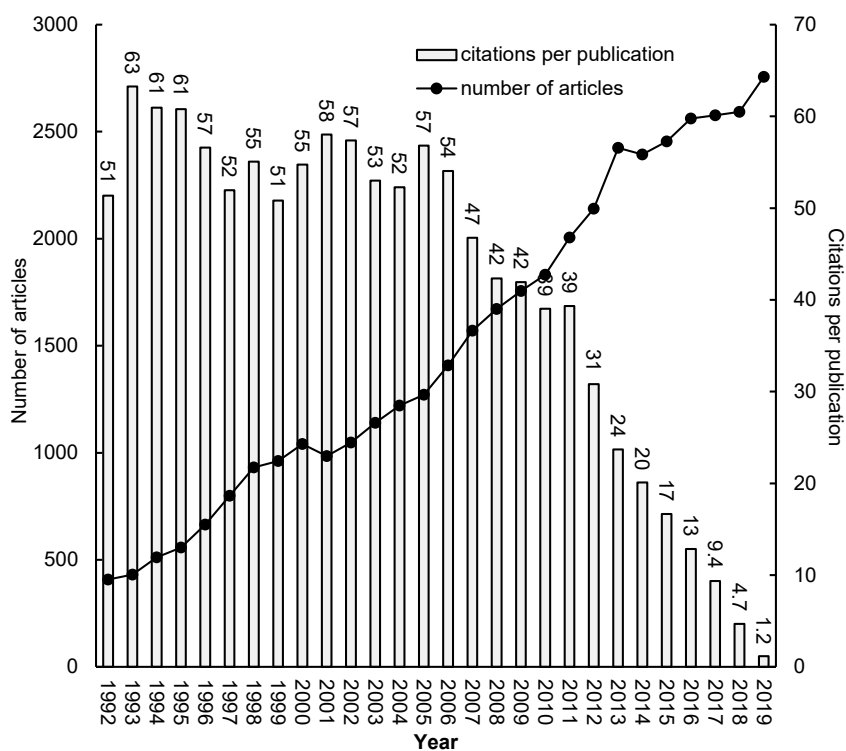
Figure 1. Number of multiple sclerosis articles and citations per publication by year
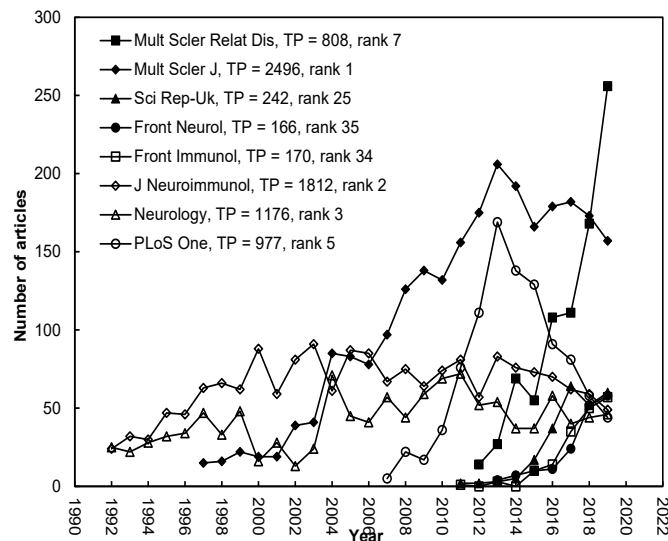
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"Neuromyelitis Optica" or NMO is an autoimmune inflammatory disease of the optic nerve and spinal cord whose symptoms are very similar to MS and may be confused with MS. It is one of the most used author keywords in MS articles, which can be due to knowing more about this disease and differentiating it from MS.

KeyWords Plus is generated by a machine algorithm and contains words and phrases that appear in the article's title of cited references. According to Garfield, these keywords can show the article's content with more depth and variety (Garfield, 1990). Therefore, keywords plus has been used in scientometric studies to indicate the articles' themes (Fu et al., 2013; Li et al., 2009a, 2009b; Mao et al., 2010).

Besides, due to the greater number of keywords plus terms and their wide range of meanings, the use of keywords plus in the scientometric analysis is recommended (Zhang et al., 2016). In the present article, the high-frequency keywords of keywords plus are general keywords and are not repeated in the top keywords of other sections. This suggests that, as Névéol et al. (2010) have argued for indexers' keywords in PubMed; keywords plus considers articles in a larger scope of the resources. For this reason, the keywords of the authors and the index words of keywords plus are probably somewhat different and less specific than the words of the title.

In general, the frequency of words in different sections of articles shows that the authors' keywords are relatively more specific than the keywords of title, abstract, and keywords plus and some of them show the concepts related to the symptoms of the disease and the quality of life of patients. This study revealed that the research on MS is concentrated around five main categories:

1. The symptoms of the disease: This category includes the terms such as "fatigue", "disability", and "depression". All these words are frequently used author keywords.

2. Diagnosis of the disease: This category includes the words such as "diagnostic-criteria", "optic neuritis", "MRI" or "magnetic resonance imaging", and "cerebrospinal fluid". "Diagnostic-criteria" are among the 20 most frequently used keywords plus. Also, "optic neuritis" and "cerebrospinal fluid" are the frequently used author keywords. "MRI" and "imaging" are among the most frequent words in article titles.

3. Treatment of the disease which is related to the keywords such as "therapy", "treatment", "cells", "activation", and "rehabilitation". As there is no complete cure for the disease, different treatments are used to reduce the symptoms of the disease and the frequency and intensity of the relapses and slow down the progression

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Figure 2. Comparison of the growth trends of the top eight productive MS journals in 2019

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of the disease. Every year, a lot of research is done on the treatment of MS all over the world. The terms "treatment" or "therapy" are among the 20 most cited words in the article title, abstract, and keywords plus. Cell therapy is a new method to treat MS and the keywords "cell" and "cells" are mostly used in articles' titles, abstracts, and keywords plus, which may be related to cell therapy (it may be also related to other subjects such as T-cells and nerve cells). "Activation" is one of the top 20 most used keywords plus and may be a part of the microglia activation and T-cell activation that the reduction of them is considered in the treatment of MS. "Microglia"

is among the most frequently used author keywords and "T-cells" is also a most used keywords plus. "Rehabilitation" such as occupational therapy and physical therapy, help the patients to improve their functional abilities and decreases the MS symptoms such as disabilities, impairments, and handicaps. "Rehabilitation" is the most frequent term in author keywords.

4. The models such as EAE are also one focus of MS researchers. "Model" is a keyword in the 20 most-used article titles. It is relevant to the animal models of MS that is very crucial in MS research. "EAE" or "experi-
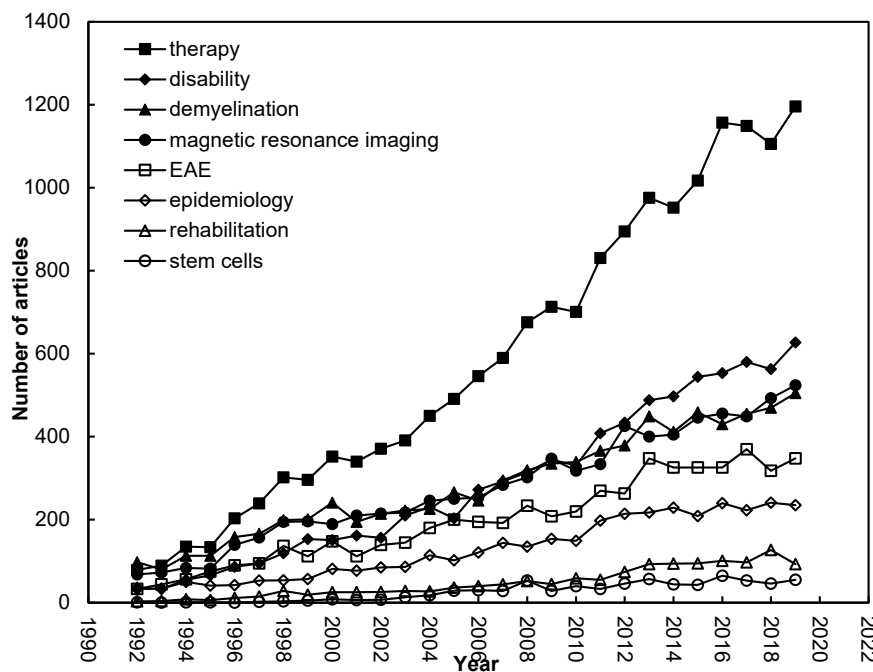
Figure 3. Developments of the main research foci of multiple sclerosis (a)

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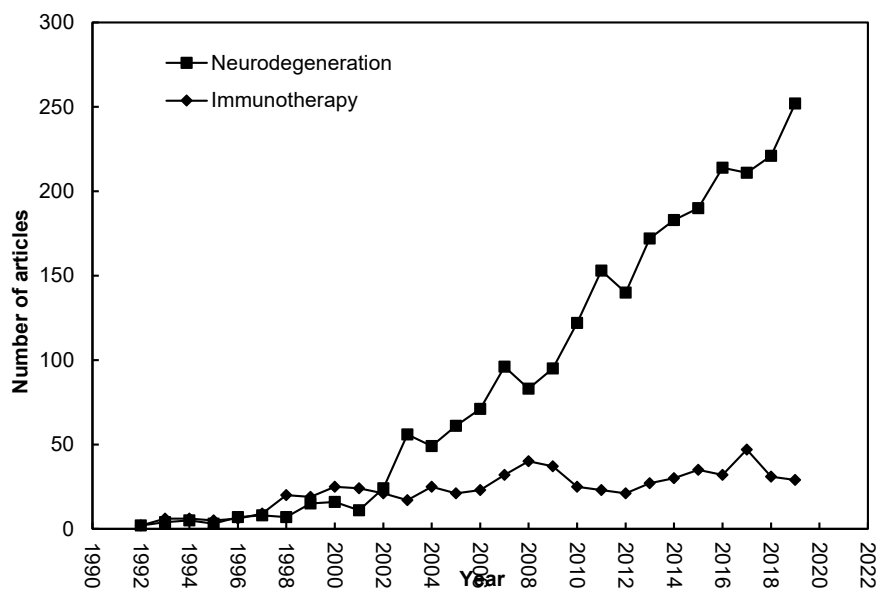
Figure 4. Developments of the main research foci of multiple sclerosis (b)

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mental autoimmune encephalomyelitis" or "experimental allergic encephalomyelitis' is also one of the animal models for studying the inflammatory and behavioral indicators of MS. "Experimental autoimmune encephalomyelitis" and "EAE" respectively are the second and ninth most used author keywords. "Experimental autoimmune encephalomyelitis" and "experimental allergic encephalomyelitis' respectively are the fifth and the eighth most frequently used keywords plus.

5- Epidemiology: Epidemiology studies the distribution and determinants of diseases in various countries and regions. "Prevalence" and "incidence" are supporting words for epidemiology. It is also a main category in MS and is one of the most used keywords plus.

The main foci and trend in MS articles is "therapy" of the disease. As mentioned before, there's no cure for MS up to now and medications can help to manage the symptoms. The trend of articles related to the treatment of MS shows a great increase in the studied years. After that, "disability" shows an increasing number of articles. Disability is an important subject in MS. For someone working in the field of MS, the most important thing is this disability. The disability must get more and more attention. Because there is no cure for the disability yet, and in other words, it is the Achilles tendon of MS. Despite the importance of "stem cells" and "immunotherapy" in the treatment of MS, published articles in this field show a relatively stable trend in the years under study.

The "neurodegeneration" trend shows a significant increase in the number of articles after 2000. Increased attention to neurodegeneration is due to the progressive nature of MS. Although most cases of recurrent MS are curable, in the natural course of the disease, 85% of them enter the progressive phase. This is due to neurodegeneration and axonal damage that maybe occurs from the onset of the disease (Fitzner & Simons, 2010).

5. Conclusion

In this study, 42112 articles related to MS from 1992 to 2019 around the world were analyzed. Most of the articles (95%) were in English, while 22 other languages were used in the articles, indicating that MS is being studied by researchers worldwide. Articles in Japanese and English with 7 and 6.9 authors have a higher average of authors than articles in other languages with an average of 4.5 authors. However, English language articles received more citations than articles in other languages, which shows that English has more visibility and effectiveness than other languages.

The number of MS articles shows a growing trend, from 408 articles in 1992 to 2756 articles in 2019. Articles related to 1993 have the highest citation averages in 2019. In recent years, articles have received more citations in the first publication year (C_0) than in previous years, so 27% of the articles that are among the 100 most cited articles in the first year of publication, are among the 100 most cited articles in 2019 and all the years under review. This shows that the visibility of articles has

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increased in recent years compared to the past. This may be due to easier access to articles and their faster sharing on social media.

Most articles on MS have been published in journals in the categories of clinical neurology and neuroscience, which seems reasonable given the nature of MS, which falls into the category of diseases of the central nervous system. Other subject categories also publish articles in this field. Articles published in journals in the multidisciplinary sciences category have an average number of authors (APP) more than articles published in other categories. The average citation of articles in this category is more than other categories after research and experimental medicine, and general and internal medicine.

Among the ten most popular journals in this field, there are two journals with the special title of multiple sclerosis, which shows this field's specialization. These journals are among the journals in which the process of publishing an article on MS is much higher than other journals. Journals with more APPs also received more citations.

The research on MS is concentrated around five main categories: 1. The symptoms of the disease such as "fatigue" and "disability". 2. Diagnosis of the disease such as "diagnostic-criteria," "optic neuritis," "MRI," and "cerebrospinal fluid". 3. The ways to reduce the symptoms of the disease such as therapy or treatment of disease, rehabilitation, and activation of the cells. 4. Models such as animal models and EAE. 5. Epidemiology.

"Therapy," "disability," "neurodegeneration," "demyelination," and "MRI" show an increasing trend in the MS articles.

The result of this study can help policymakers and researchers realize the panorama of MS research and design future research.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Conflict of interest

The authors declared no conflict of interest.

References

Browne, P., Chandraratna, D., Angood, C., Tremlett, H., Baker, C., & Taylor, B. V., et al. (2014). Atlas of multiple sclerosis 2013: A growing global problem with widespread inequity. *Neurology, 83*(11), 1022–1024. [DOI:10.1212/WNL.0000000000000768] [PMID] [PMCID]

Chuang, K. Y., & Ho, Y. S. (2015). An evaluation based on highly cited publications in Taiwan. *Current Science Association, 108*(5), 933. [Link]

Compston, A., & Coles, A. (2008). Multiple sclerosis. *Lancet, 372*(9648), 1502–1517. [DOI:10.1016/S0140-6736(08)61620-7] [PMID]

Espiritu, A. I., Leochico, C. F. D., Separa, K. J. N. J., & Jamora, R. D. G. (2020). Scientific impact of multiple sclerosis and neuromyelitis optica spectrum disorder research from Southeast Asia: A bibliometric analysis. *Multiple Sclerosis and Related Disorders, 38*, 101862. [DOI:10.1016/j.msard.2019.101862] [PMID]

Fitzner, D., & Simons, M. (2010). Chronic progressive multiple sclerosis - pathogenesis of neurodegeneration and therapeutic strategies. *Current Neuropharmacology, 8*(3), 305–315. [DOI: 10.2174/157015910792246218] [PMID] [PMCID]

Fu, H. Z., & Ho Y. S. (2015). Top cited articles in thermodynamic research. *Journal of Engineering Thermophysics, 24*(1), 68-85. [DOI:10.1134/S1810232815010075]

Fu, H. Z., Wang, M. H., & Ho, Y. S. (2012). The most frequently cited adsorption research articles in the science citation index (Expanded). *Journal of Colloid and Interface Science, 379*(1), 148–156. [DOI:10.1016/j.jcis.2012.04.051] [PMID]

Fu, H. Z., Wang, M. H., & Ho, Y. S. (2013). Mapping of drinking water research: A bibliometric analysis of research output during 1992-2011. *The Science of the Total Environment, 443*, 757–765. [DOI:10.1016/j.scitotenv.2012.11.061] [PMID]

Garfield, E. (1990). Keywords plus-ISI's breakthrough retrieval method. 1. Expanding your searching power on current-contents on the diskette. *Current Contents, 32*, 3-7. [Link]

Gijbels, K., Engelborghs, S., & De Deyn, P. P. (2000). Experimental autoimmune encephalomyelitis: An animal model for multiple sclerosis. *Neuroscience Research Communications, 26*(3), 193-206. [DOI:10.1002/1520-6769(200005/06)26:33.0.CO;2-5]

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Ho., et al. (2023). Research Focuses and Trends in Multiple Sclerosis. *BCN, 14*(2), 273-288

Ho, Y. S. (2012). Top-cited articles in chemical engineering in science citation index expanded: A bibliometric analysis. *Chinese Journal of Chemical Engineering, 20*(3), 478-488. [DOI:10.1016/S1004-9541(11)60209-7]

Ho, Y. S. (2013). The top-cited research works in the science citation index expanded. *Scientometrics, 94*(3), 1297-1312. [DOI:10.1007/s11192-012-0837-z]

Ho, Y. S. (2014). A bibliometric analysis of highly cited articles in materials science. *Current Science, 107*(9), 1565-1572. [Link]

Ho, Y. S. (2019). Rebuttal to: Su et al. "The neurotoxicity of nanoparticles: A bibliometric analysis," Vol. 34, pp. 922-929. *Toxicology and Industrial Health, 35*(6), 399–402. [DOI:10.1177/0748233719850657] [PMID]

Ho, Y. S. (2019). Some comments on: Mao et al. (2018) "Bibliometric analysis of insights into soil remediation. *Journal of Soils and Sediments, 18*(7), 2520-2534. [DOI:10.1007/s11368-019-02322-6]

Ho, Y. S., & Fu, H. Z. (2016). Mapping of metal-organic frameworks publications: A bibliometric analysis. *Inorganic Chemistry Communications, 73*, 174-182. [DOI:10.1016/j.inoche.2016.10.023]

Ho, Y. S., & Kahn, M. (2014). A bibliometric study of highly cited reviews in the S cience C itation I ndex expande. *Journal of the Association for Information Science and Technology, 65*(2), 372-385. [DOI:10.1002/asi.22974]

Ho, Y. S., Siu, E., & Chuang, K. Y. (2016). A bibliometric analysis of dengue-related publications in the Science Citation Index Expanded. *Future Virology, 11*(9), 631-648. [DOI:10.2217/fvl-2016-0057]

Li, L. L., Ding, G., Feng, N., Wang, M. H., & Ho, Y. S. (2009). Global stem cell research trend: Bibliometric analysis as a tool for mapping of trends from 1991 to 2006. *Scientometrics*, *80*(1), 39-58. [DOI:10.1007/s11192-008-1939-5]

Li, J., Zhang, Y., Wang, X., & Ho, Y. S. (2009). Bibliometric analysis of atmospheric simulation trends in meteorology and atmospheric science journals. *Croatica Chemica Acta, 82*(3), 695-705. [Link]

Li, Z., & Ho, Y. S. (2008). Use of citation per publication as an indicator to evaluate contingent valuation research. *Scientometrics*, *75*(1), 97-110. [DOI:10.1007/s11192-007-1838-1]

Mao, N., Wang, M. H., & Ho, Y. S. (2010). A bibliometric study of the trend in articles related to risk assessment published in the science citation index. *Human and Ecological Risk Assessment, 16*(4), 801-824. [DOI:10.1080/10807039.2010.501248]

Ming, H. W., Hui, Z. F., & Yuh, S. H. (2011). Comparison of universities' scientific performance using bibliometric indicators. *Malaysian Journal of Library & Information Science, 16*(2), 1-19. [Link]

Monge-Nájera, J., & Ho, Y. S. (2017). El salvador publications in the science citation index expanded: Subjects, authorship, collaboration and citation patterns. *Revista de Biología Tropical, 65*(4), 1428-1436. [DOI:10.15517/rbt.v65i4.28397]

Nakahara, J., Maeda, M., Aiso, S., & Suzuki, N. (2012). Current concepts in multiple sclerosis: Autoimmunity versus oligodendrogliopathy. *Clinical Reviews in Allergy & Immunology, 42*(1), 26–34. [DOI:10.1007/s12016-011-8287-6] [PMID]

Névéol, A., Doğan, R. I., & Lu, Z. (2010). Author keywords in biomedical journal articles. *AMIA Annual Symposium Proceedings, 2010*, 537–541. [PMID] [PMCID]

Ramos, J. M., Padilla, S., Masiá, M., & Gutiérrez, F. (2008). A bibliometric analysis of tuberculosis research indexed in PubMed, 1997-2006. *The International Journal of Tuberculosis and Lung Disease, 12*(12), 1461–1468. [PMID]

Rice, C. M., Kemp, K., Wilkins, A., & Scolding, N. J. (2013). Cell therapy for multiple sclerosis: An evolving concept with implications for other neurodegenerative diseases. *Lancet, 382*(9899), 1204–1213. [DOI:10.1016/S0140-6736(13)61810-3] [PMID]

National Multiple Sclerosis Society (MS). (2023). Treating MS. Retrieved from: [Link]

Vega-Arce, M., Salas, G., Núñez-Ulloa, G., Pinto-Cortez, C., Fernandez, I. T., & Ho, Y. S. (2019). Research performance and trends in child sexual abuse research: A science citation index expanded-based analysis. *Scientometrics*, *121*(3), 1505-1525. [DOI:10.1007/s11192-019-03267-w]

Wagner, C. A., Roqué, P. J., & Goverman, J. M. (2020). Pathogenic T cell cytokines in multiple sclerosis. *The Journal of Experimental Medicine, 217*(1), e20190460. [DOI:10.1084/jem.20190460] [PMID] [PMCID]

Wang, C. C., & Ho, Y. S. (2016). Research trend of metal-organic frameworks: A bibliometric analysis. *Scientometrics*, *109*(1), 481-513. [DOI:10.1007/s11192-016-1986-2]

Wang, Y. Q., Chen, Y. B., Xu, D., & Cui, Y. L. (2020). Bibliometrics and visualization of the mechanisms of parkinson's diseases based on animal models. *Endocrine, Metabolic & Immune Disorders Drug Targets, 20*(10), 1560–1568. [DOI:10.2174/1871530320666200421103429] [PMID]

Xie, S., Zhang, J., & Ho, Y. S. (2008). Assessment of world aerosol research trends by bibliometric analysis. *Scientometrics, 77*(1), 113-130. [DOI:10.1007/s11192-007-1928-0]

Zhang, G., Xie, S., & Ho, Y. S. (2010). A bibliometric analysis of world volatile organic compounds research trends. *Scientometrics, 83*(2), 477-492. [DOI:10.1007/s11192-009-0065-3]

Zhang, J., Yu, Q., Zheng, F., Long, C., Lu, Z., & Duan, Z. (2016). Comparing keywords plus of WOS and author keywords: A case study of patient adherence research. *Journal of the Association for Information Science and Technology, 67*(4), 967-972. [DOI:10.1002/asi.23437]

Ho., et al. (2023). Research Focuses and Trends in Multiple Sclerosis. *BCN, 14*(2), 273-288

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