



COLLNET Journal of Scientometrics and Information Management

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/tsim20>

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To cite this article: Amadou W. Jallow, Ming-Huang Wang & Yuh-Shan Ho (2020) Global research trends and publications of insomnia: A bibliometric analysis, COLLNET Journal of Scientometrics and Information Management, 14:2, 349-367, DOI: [10.1080/09737766.2021.1906184](https://doi.org/10.1080/09737766.2021.1906184)

To link to this article: <https://doi.org/10.1080/09737766.2021.1906184>



Published online: 04 Jun 2021.



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Global research trends and publications of insomnia : A bibliometric analysis

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This study aimed to evaluate the tendency of insomnia articles in SCI-EXPANDED database. Data was obtained from the online version of Science Citation Index Expanded (SCI-EXPANDED) database in the Web of Science Core Collection of Clarivate Analytics within the publication year from 1991 to 2018. The publications were assessed regarding their document types, languages, and journals. We used three citation indicators such as C_{2018} , TC_{2018} , and CPP_{2018} to determine the citation received by publications. We used the Y-index method formulated by Ho. The study found 16,478 insomnia documents within 15 document types indexed in the Web of Science, and articles type was used most constituting 66% (10,801) of the documents. Ninety-five percent of the articles were published in English. The journal of *Sleep* published most of the insomnia article then followed by *Sleep Medicine*. The 30% of 10,801 articles were published in the top category of clinical neurology. The G7 countries published most of the insomnia articles. The most productive country and institution was United States and Harvard University respectively. The article entitled “A new method for measuring daytime sleepiness: The Epworth sleepiness scale” published by Johns in 1991 was the most cited article with TC_{2018} of 7,191 and C_{2018} of 661 citations. The most industrious and had more potential to published insomnia articles was M.M. Ohayon. Moreover, the study showed that most of the insomnia articles were related to depression, anxiety, cancer, and schizophrenia. Insomnia is a serious problem with synergistic effects for normal body health. Bibliometric method can help researchers to have comprehensive knowledge on insomnia and initiate an orientation for further research so as to solve a problem. Furthermore, it may also help researchers to determine the impact of insomnia publications as well as to identify relevant research groups in the field of insomnia.

Keywords: *Bibliometric, Citation Analysis, Implant, Web of Science Core Collection, Y-index.*

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1. Introduction

Generally, every adult experiences either one or more symptoms of insomnia in their lifetime. Insomnia is a sleeping disorder characterised by difficulty initiating sleep, difficulty maintaining sleep, waking up too early and sometimes nonrestorative or poor quality of sleep [1]. In United State, an estimation of 30 to 107 billion dollars is spent on insomnia each year [2]. The prevalence of insomnia is higher in women and the case increases as you get older [3-5]. Insomnia as a sleep disturbance, could lead to poor quality of life, impaired work performance and impedes social functioning [3]. Hyperarousal disorder is believed to be the major causative factor for insomnia and was well described in the cognitive and physiological models of insomnia [6, 7].

The consequences of insomnia and its health problems have been elaborated in several studies. Patient with chronic insomnia experiences more impaired functions than patient with congestive heart failure (CHF) in terms of pain reports, emotional effects, and mental health effects [8]. The comorbidity between insomnia and psychiatric disorders such as depression and anxiety has been found in a several publications [9, 10]. Due to the comorbidity, insomnia could also be an example of mental disorder [11]. Moreover, the risk of insomnia has also been determined in cancer, heart diseases, sleep apnea and lack of exercise [12]. Daytime sleepiness experienced by patient is a major issued in insomnia. Those adult patients who experiences daytime sleepiness are affected with conditions such as obstructive sleep apnea syndrome (OSAS), idiopathic hypersomnia, periodic limb movement disorder (PLMD), narcolepsy, and other disorders [13]. Therefore, patients need proper assessment and monitoring for daytime sleepiness.

A cohort study in determining sleep duration and it association with telomere length categorised sleep duration on individuals as short (less than six hours), average (six to eight hours), and long (more than eight hours) sleepers [6]. Insufficient sleep is not a life threaten condition but could be an addition risk for accidents, tiredness, falls and sometimes impairs your daily functions [12]. Minimizing such risks associated with insomnia could be achieved if does sleep disturbances are eradicated. Actually there is no standardised guidelines for managing insomnia. In this case, recommending sleeping pills and applying clinical judgement could be substantial. In the case where insomnia coincided with other conditions may need proper approaches and interdisciplinary collaboration to manage [14].

Bibliometric method can be applied to determine the impact of publications and research groups in their research field. It is also an ideal way to quantify the quality of published work for organizations, authors, and countries [15]. Today, it is essential to determine the countries and institutions research performances using Science Citation Index Expanded or Social Science Citation Index to evaluate their research performances in various aspects [16]. Analysis of research performance and trends of the main search focuses were presented in medical related topics [17, 18]).

This current study will show the research trend of Insomnia extracted from SCI-EXPANDED. Description and analysis of insomnia articles in terms of document types,

publication language, publication outputs, citation impact and comparison of performances among countries, institutions, and author applying six indicators. We also applied the *Y*-index parameter introduced by Ho [15] [19] to distinguish researchers' characteristics and who had higher potential in publishing more articles. Data were clearly drafted and represented in tables and figures for clear evidence and explanation.

2. Methodology

It was noted that is inappropriate to apply all databases which are not in the same level in Web of Science Core Collection for bibliometric studies [20]. Bibliometric information of research reports was extracted from the online version of Science Citation Index Expanded (SCI-EXPANDED) database in the Web of Science Core Collection of Clarivate Analytics (formerly as Institute for Scientific Information and the Intellectual Property of Thomson Reuters) (updated on September 24, 2019). We conducted pre-study to obtain keywords "insomnia", "insomniac", "insomniacs", and "insomnias". The keywords were used to search documents in terms of topic (including title, abstract, author keywords, and *KeyWords Plus*) within the publication year from 1991 to 2018. *KeyWords Plus* is an application for citation indexing using terms extracted from the titles of publications cited by authors in the ISI (now Clarivate Analytics) to be focus on [21]. For the initial search, 20,469 documents related to insomnia publications were found. Applying only *KeyWords Plus* criteria to search documents is likely to obtain unrelated publications for the bibliometric study topic [22]. Due to the bias of using Web of Science Core Collection for bibliometric studies, Ho's group were the first to propose the 'front page' as a filter [23] [24] [25]. This covers only documents with searching keywords in their 'front page' including only the title, abstract, and author keywords. Filtering might avoid introducing unrelated publications for analysis [23]. After the filtering, we founded 16,478 documents (81% of 20,469 documents) which were well defined as insomnia research publications. The full record of SCI-EXPANDED and the number of citations in each year for each document were downloaded to Microsoft Excel 2016 and checked. Additional coding was manually performed [25] [26]. The journal impact factors (IF_{2018}) were taken from the Journal Citation Reports (JCR) published in 2018.

The corresponding-author is designated as the 'reprint author' in the SCI-EXPANDED database. Therefore, we will be using the term 'corresponding-author' in this study [27]. In a situation where authorship is unspecified in a single-author paper, the author is both the first- and corresponding-author [15]. Similarly, as in a single institutional paper, the institution is regarded as the first- and corresponding-author institution [28]. In cases like multiple corresponding-authors, only the last corresponding-author and their affiliation were considered [29]. Also in single-author articles, only the first affiliation and first country were considered. Furthermore, country affiliations such as England, Scotland, Northern Ireland, and Wales were considered to be part of United Kingdom (UK) [30]. Affiliations in Hong Kong prior to 1997 were included under the heading of China [31]. Affiliations in Zaire were regarded to be part of Dem Rep Congo (the Democratic Republic of the Congo).

Affiliations in USSR (the Union of Soviet Socialist Republics) were also checked and reclassified to be in Russia [32].

Three Ho's citation indicators were being applied to determine the citations received by each publication. The indicators were denoted as: C_{year} (number of citations within a particular year in Web of Science Core Collection) and C_{2018} means the number of citations in 2018 [15], TC_{year} (total number of citations from the year published to the most recent year in Web of Science Core Collection) and TC_{2018} (2018) is the recent year used in this study [33, 34] and the third indicator is CPP_{year} : citations per publication ($CPP_{year} = TC_{year}/TP$) where TP is total number of publications [15].

We determined publication performance of authors and their potentials in the field of insomnia. The Y-index method formulated by Ho was applied to compare publication potentials of different authors and their contribution characteristic in single index within the same research field [15, 19]. The Y-index is related to the number of first-author publications (FP) and corresponding-author publications (RP). The Y-index combines the two parameters j and h , denoted as (j, h) [15, 19].

The Y-index (j, h) is defined as:

$$j = FP + RP$$

$$h = \tan^{-1}\left(\frac{RP}{FP}\right)$$

where FP is the number of first-author articles; RP is number of corresponding-author articles; j is the publication potential which is a constant related to publication quantity, and h is publication characteristics which can describe the proportion of RP to FP . The greater the value of j , the more the contribution of the first-author and corresponding-author articles. Different values of h represent different proportions of corresponding-author articles from first-author articles. $h > 0.7854$ indicates more corresponding-author articles; $h = 0.7854$ indicates the same number of first-author and corresponding-author articles; and $h < 0.7854$ indicates more first-author articles. When $h = 0$, j is the number of first-author articles, and $h = \pi/2$, j is the number of corresponding-author articles.

3. Results and Discussion

3.1 Document type and language of publication

Analysis of document types and their citations per publication has been reported earlier [35]. We found 16,478 insomnia documents within 15 document types indexed in the SCI-EXPANDED. Among the document types, article was used most (66% of 16,478 documents) followed by meeting abstracts (18%) and reviews (11%) (Table 1). Articles and reviews had similar citations per publication ($CPP_{2018} = TC_{2018}/TP$) with 30 and 41 respectively. A total of 1,421 meeting abstracts (47% of 3,048 meeting abstracts) were mainly published in *Sleep*, followed by *Journal of Sleep Research* with 472 (15%) meeting abstracts.

Table 1
Characteristics of document types

Document type	<i>TP</i>	%	<i>TP</i> *	<i>AU</i>	<i>APP</i>	<i>TC</i> ₂₀₁₈	<i>CPP</i> ₂₀₁₈
Article	10,801	66	10,785	60,228	5.6	321,868	30
Meeting abstract	3,048	18	3,046	15,265	5.0	2,638	0.87
Review	1,829	11	1,829	6,690	3.7	74,736	41
Proceedings paper	489	3.0	487	1,915	3.9	22,360	46
Editorial material	417	2.5	409	886	2.2	2,650	6.4
Letter	221	1.3	221	696	3.1	1,046	4.7
News item	46	0.28	30	30	1.0	69	1.5
Correction	43	0.26	43	180	4.2	80	1.9
Note	37	0.22	37	130	3.5	777	21
Book chapter	32	0.19	32	75	2.3	1,874	59
Book review	22	0.13	22	22	1.0	1	0.045
Reprint	7	0.042	7	19	2.7	68	10
Addition correction	5	0.030	5	20	4.0	5	1.0
Bibliography	1	0.0061	1	1	1.0	2	2.0
Item about an individual	1	0.0061	1	1	1.0	0	0

TP: number of publications; *TP**: number of publications with author information in SCI-EXPANDED; *AU*: number of authors; *APP*: number of authors per publication; *TC*₂₀₁₈: the total number of citations from Web of Science Core Collection since publication to the end of 2018; *CPP*₂₀₁₈: number of citations (*TC*₂₀₁₈) per publication (*TP*).

Only article under document type was used for subsequent analysis because it included complete research ideas and results [36]. Nineteen languages were used in insomnia articles. Ninety-five percent of the articles were published in English. Other languages were French (161 articles; 1.5% of 10,801 articles), German (103; 1.0%), Spanish (92; 0.85%), Russian (40; 0.37%), Polish (23; 0.21%), Turkish (23; 0.21%), Portuguese (18; 0.17%), and Japanese (10; 0.093%). Some other languages that were less used on were Korean (9 articles), Czech (6), Hungarian (6), Italian (4), Serbian (3), Chinese (2), Croatian (2), Dutch (2), and one in each of Icelandic and Slovak respectively. In addition, one article was found published in a bi-lingual (English and Spanish) journal *Actas Espanolas De Psiquiatria*. Two non-English highly cited articles were published in French such as "Assessment of insomnia: validation of three questionnaires" [37] and "Prion diseases" [38] with *TC*₂₀₁₈ of 118 and 108 respectively.

3.2 Characteristics of publication outputs and citation impact

A relationship among number of articles in a year (TP), their citations per publication ($CPP_{year} = TC_{year}/TP$), and year as a figure has been proposed in medical related topics such as dengue [32], Ebola [39], and child sexual abuse (Vega-Arce et al., 2019). The distribution of the 10,801 insomnia articles from 1991 to 2018 and their CPP_{2018} are shown in Fig. 1. The number publications for insomnia articles continue increasing from 1991 to 2018 with great reduction in citations. The highest value of CPP_{2018} was in 1991 which can be attributed to the most frequently cited article entitled “A new method for measuring daytime sleepiness: The Epworth sleepiness scale” [13] by Johns with TC_{2018} of 7,191. Based on Fig. 1, it takes $CPPs$ about a decade to reach a plateau. Similarly, research on dengue took about one decade to reach a plateau, could also be found [32]. It might be concluded that to evaluate impact of papers, citations accumulated at least one decade is needed [40].

3.3. Journals and Web of Science categories

According to Journal Citation Reports (JCR), it indexes 9,258 journals with citation references across 178 Web of Science categories in the SCI-EXPANDED in 2018. In this context, we found 10,801 highly cited insomnia articles published in 1,909 journals across 136 Web of Science categories in SCI-EXPANDED. Bradford’s Law of Scattering [41] was applied. Bradford’s law was used to estimate the exponentially diminishing returns of extending a search for references in science journals. One formulation of Bradford’s Law is that if journals in a field are sorted by number of articles into three zones, each with about

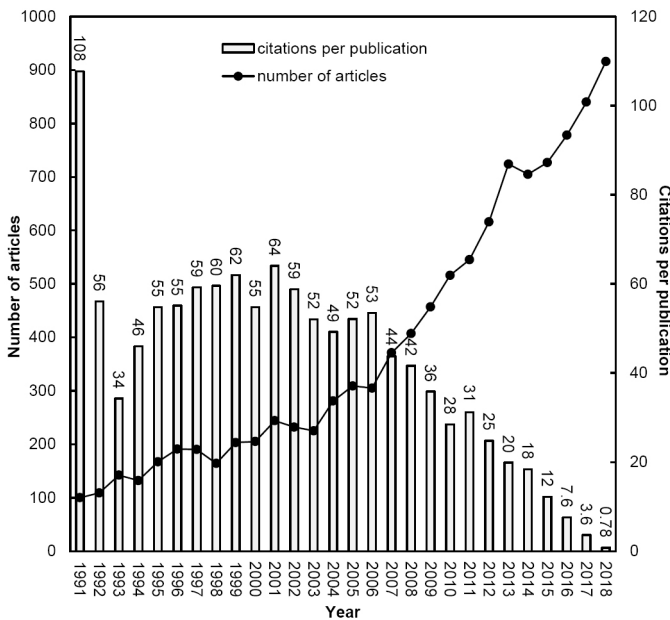


Figure 1
Number of highly cited articles and citations per publication by year.

one-third of all articles, then the number of journals in each zone will be proportional to $1 : n : n^2$. The journals of zone 1 could be recognized as the core journals obviously. The journals in descending order in terms of their published articles, and the journals were divided into three “zones”. Zone 1, representing the most productive third of the total articles, contained 36 journals or 1.9% of 1,909 journals. Zone 2, representing the next most productive third of total articles, contained 236 journals or 12% of 1,909 journals. Zone 3, representing the least productive third of total articles, contained 1,637 journals or 86% of 1,909 journals. The number of journals of three zones approximately followed the Bradford’s law. To reiterate, the number of journals was approximate $1 : n : n^2$ ($1.0 : 6.6 : 45$). Table 2 showed the top ten productive journals with the respective IF_{2018} , Web of Science category of the journal, number of relevant articles, the percentage of total articles, TC_{2018} , and CPP_{2018} . *Sleep* ($IF_{2018} = 4.571$) ranked first with 590 articles (5.5% of 10,801 articles). Insomnia articles published in *Sleep* also had the highest CPP_{2018} of 77. In addition, as regards to the impact factor for all journals, *New England Journal of Medicine* won the first place with the highest impact factor (70.670) with 22 articles, followed by *Lancet* ($IF_{2018} = 59.102$) with 15 articles and *JAMA-Journal of the American Medical Association* ($IF_{2018} = 51.273$) with 22 articles. Highly cited articles were also published in journals with lower impact factor, for

Table 2
Top 10 most productive journals.

Journal	TP (%)	IF_{2018}	Web of Science category	TC_{2018}	CPP_{2018}
Sleep	590 (5.5)	4.571	clinical neurology neurosciences	45,280	77
Sleep Medicine	449 (4.2)	3.36	clinical neurology	1,4128	31
Journal of Clinical Sleep Medicine	234 (2.2)	3.456	clinical neurology	4,468	19
Journal of Clinical Psychiatry	208 (1.9)	4.023	clinical psychology psychiatry	10,838	52
Journal of Sleep Research	205 (1.9)	3.432	clinical neurology neurosciences	6,938	34
PLoS One	143 (1.3)	2.776	multidisciplinary sciences	1,952	14
Journal of Psychosomatic Research	122 (1.1)	2.722	Psychiatry	6,264	51
Journal of Affective Disorders	105 (1.0)	4.084	clinical neurology psychiatry	3,438	33
Behavioral Sleep Medicine	97 (0.90)	3.171	clinical neurology psychiatry	1,252	13
Psychiatry Research	88 (0.81)	2.208	psychiatry	1,599	18

TP (%): rank and the percentage of number of articles; IF_{2018} : journal impact factor in 2018.

example *Journal of Neurological Sciences-Turkish* ($IF_{2018} = 0.0750$) and *Bulletin de l'Academie Nationale de Medecine* ($IF_{2018} = 0.0830$).

In total, 6,293 articles (58% of 10,801 articles) were published in the top four categories such as clinical neurology (3,234 articles; 30% of 10,801 articles), psychiatry (2,561; 24%), neurosciences (2,048; 19%), and pharmacology and pharmacy (1,409; 13%). Other categories with 300 articles or more were general and internal medicine (910; 8.4%), oncology (432; 4.0%), public, environmental and occupational health (409; 3.8%), geriatrics and gerontology (376; 3.5%), psychology (366; 3.4%), health care sciences and services (328; 3.0%), and research and experimental medicine (318; 2.9%). It should be noted that journals can be classified in two or more categories in Web of Science. For example, *Sleep* was classified in two different categories such as clinical neurology and neurosciences, therefore the cumulative percentage can be higher than 100%.

3.4 Publication Performances: Countries, Institutions, Authors

This result shows comparison of countries, institutions, and authors publication performances using Ho's group six publication indicators such as total number of publications (*TP*), independent publications (*IP*), collaborative publications (*CP*), first-author publications (*FP*), corresponding-author publications (*RP*), and single-author publications (*SP*) [30, 36, 42]. First-author and corresponding-author are the two most contributed authors in an article [43]. The achievement of corresponding-author institution might be a home base of the study or origin of the paper at the institutional level [15].

There were 63 articles (0.58% of the 10,801 articles) without affiliations in SCI-EXPANDED. Of 10,738 articles with author affiliations from 116 countries, 8,635 (80% of the 10,738 articles) were single country articles from 82 countries and 2,103 (20%) were internationally collaborative articles from 108 countries. Table 3 shows a comparison of the top 20 productive countries with the six publication indicators and citation indicator CPP_{2018} . The top 20 productive countries published 9,764 insomnia articles (91% of the 10,738 articles) and the greatest contributions arose from the seven major industrialized countries (G7) such as USA, UK, Japan, Canada, Germany, France, and Italy. This great achievement and result was also reported in previous medical studies [44]. United State is the most productive country in all five of the six publication indicators used (*TP*: 41%, *IP*: 37%, *CP*: 56%, *FP*: 35% and *RP*: 49%) as well as a CPP_{2018} of 40 (Table 3). Similarly, these present results were also obtained in the study of Ebola [39] and neurosciences [45]. Our study showed huge differences in terms of publication performances between United States (USA) and other countries as evidenced in Table 3. Therefore, this study may say that United States is most industrious for insomnia research. The question arises what makes difference in publication performances among countries. Inadequacy or lack of research fund or incentives could be the attributing factor for variation in publication performances within the same field.

Institutions published articles either by individually or collaboration. We found 3,207 (30% of 10,738 articles) single institution articles and 7,531 (70%) inter-institutionally collaborative articles including 5,428 (72% of 7,531 inter-institutionally collaborative articles)

Table 3
Top 20 most productive countries

Country	TP	TPR (%)	IPR (%)	CPR (%)	FPR (%)	RPR (%)	SPR (%)	CPP ₂₀₁₈
USA	4,385	1 (41)	1 (37)	1 (56)	1 (35)	1 (35)	1 (49)	40
UK	787	2 (7.3)	6 (3.8)	2 (22)	4 (4.4)	4 (4.5)	2 (7.3)	35
China	696	3 (6.5)	3 (6.0)	8 (8.6)	2 (5.8)	2 (5.9)	21 (0.81)	13
Canada	660	4 (6.1)	5 (3.9)	3 (16)	6 (4.2)	5 (4.2)	5 (3.8)	51
Germany	644	5 (6)	4 (4.0)	4 (14)	5 (4.2)	6 (4.2)	3 (4.9)	36
Japan	610	6 (5.7)	2 (6.1)	16 (4)	3 (5.3)	3 (5.3)	6 (2.7)	17
France	542	7 (5.0)	8 (3.1)	5 (13)	8 (3.4)	8 (3.3)	4 (4.7)	38
Italy	523	8 (4.9)	7 (3.5)	6 (11)	7 (3.8)	7 (3.6)	20 (0.95)	42
Australia	428	9 (4.0)	11 (2.4)	6 (11)	10 (2.6)	10 (2.7)	10 (1.5)	44
South Korea	341	10 (3.2)	9 (2.9)	14 (4.4)	9 (2.8)	9 (2.9)	16 (1.1)	15
Spain	334	11 (3.1)	12 (2.2)	12 (6.7)	12 (2.2)	12 (2.2)	7 (2.4)	29
Netherlands	318	12 (3.0)	14 (1.8)	9 (7.8)	14 (2.0)	14 (1.9)	14 (1.2)	36
Taiwan	304	13 (2.8)	10 (2.8)	21 (3.1)	11 (2.6)	11 (2.6)	16 (1.1)	21
Sweden	281	14 (2.6)	16 (1.6)	11 (6.9)	15 (1.6)	15 (1.7)	23 (0.54)	33
Brazil	265	15 (2.5)	12 (2.2)	20 (3.4)	13 (2.2)	13 (2.1)	16 (1.1)	18
Switzerland	255	16 (2.4)	19 (1.1)	10 (7.5)	17 (1.5)	17 (1.5)	9 (1.9)	42
Norway	207	17 (1.9)	17 (1.3)	14 (4.4)	16 (1.6)	16 (1.6)	27 (0.27)	33
Finland	177	18 (1.6)	20 (1.1)	18 (3.9)	19 (1.2)	19 (1.2)	32 (0.14)	36
Belgium	163	19 (1.5)	24 (0.63)	13 (5.2)	24 (0.77)	23 (0.82)	10 (1.5)	34
Turkey	162	20 (1.5)	15 (1.8)	43 (0.48)	18 (1.5)	18 (1.5)	8 (2.2)	10

TP: total number of articles; TPR (%): rank and the percentage of total number of articles; IPR (%), rank and the percentage of single country articles; CPR (%), rank and the percentage of internationally collaborative articles; FPR (%), rank and the percentage of first-author articles; RPR (%), rank and the percentage of corresponding-authored articles; SPR (%), rank and the percentage of single-author articles; CPP₂₀₁₈: number of citations (TC₂₀₁₈) per publication (TP).

nationally collaborative articles and 2,103. (28%) internationally collaborative articles. In Table 4, University of Toronto (Canada) and University of Bergen (Norway) were the only institutions among the top 20 without a single-author publication. Majority of the institutions were from United State (USA). Harvard University is the most industrious and productive institution for insomnia publications with 261 articles (2.4% of the 10,738 articles) and 235 inter-institutionally collaborative articles (3.1% of 7,531 inter-institutionally collaborative articles). Stanford University (USA) published the most first-author articles with 104 (1.0% of 10,738 first-author articles), corresponding-author articles with 104 (1.0%

Table 4
Top 20 most productive institutions

Institute	<i>TP</i>	<i>TPR</i> (%)	<i>IPR</i> (%)	<i>CPR</i> (%)	<i>FPR</i> (%)	<i>RPR</i> (%)	<i>SPR</i> (%)
Harvard University, USA	261	1 (2.4)	6 (0.81)	1 (3.1)	4 (0.77)	3 (0.81)	12 (0.54)
Stanford University, USA	227	2 (2.1)	4 (1.1)	2 (2.6)	1 (1.0)	1 (1.0)	1 (2.0)
University of Pittsburgh, USA	217	3 (2.0)	1 (1.6)	5 (2.2)	3 (0.93)	3 (0.81)	1 (2.0)
Duke University, USA	205	4 (1.9)	24 (0.41)	3 (2.5)	11 (0.49)	10 (0.46)	5 (0.95)
University of Pennsylvania, USA	190	5 (1.8)	29 (0.37)	4 (2.4)	8 (0.52)	10 (0.46)	103 (0.14)
Henry Ford Hospital, USA	173	6 (1.6)	3 (1.1)	6 (1.8)	4 (0.77)	5 (0.77)	3 (1.5)
University California San Diego, USA	156	7 (1.5)	11 (0.69)	7 (1.8)	10 (0.51)	9 (0.49)	3 (1.5)
University of Laval, Canada	155	8 (1.4)	2 (1.3)	10 (1.5)	2 (1.0)	2 (1.0)	22 (0.41)
University of Washington, USA	143	9 (1.3)	8 (0.72)	9 (1.6)	8 (0.52)	8 (0.51)	8 (0.68)
University of Toronto, Canada	137	10 (1.3)	29 (0.37)	8 (1.7)	26 (0.34)	26 (0.29)	N/A
University of Michigan, USA	132	11 (1.2)	5 (0.90)	14 (1.4)	6 (0.60)	7 (0.52)	6 (0.81)
University of California Los Angeles, USA	121	12 (1.1)	17 (0.50)	13 (1.4)	20 (0.35)	16 (0.38)	12 (0.54)
Massachusetts General Hospital, USA	120	13 (1.1)	46 (0.28)	11 (1.5)	7 (0.56)	6 (0.56)	22 (0.41)
Johns Hopkins University, USA	119	14 (1.1)	24 (0.41)	12 (1.4)	33 (0.26)	31 (0.27)	44 (0.27)
Case Western Reserve University, USA	108	15 (1.0)	29 (0.37)	16 (1.3)	13 (0.41)	24 (0.33)	22 (0.41)
Karolinska Institutet, Sweden	108	15 (1.0)	46 (0.28)	15 (1.3)	31 (0.27)	27 (0.29)	103 (0.14)
University of Bergen, Norway	100	17 (0.93)	95 (0.16)	17 (1.3)	23 (0.34)	19 (0.35)	N/A
University of Helsinki, Finland	98	18 (0.91)	39 (0.31)	19 (1.2)	29 (0.28)	28 (0.28)	103 (0.14)
University California San Francisco, USA	97	19 (0.90)	95 (0.16)	18 (1.2)	33 (0.26)	31 (0.27)	103 (0.14)
Yale University, USA	89	20 (0.83)	17 (0.50)	23 (1.0)	20 (0.35)	19 (0.35)	22 (0.41)

TP: total number of articles; *TPR* (%): total number of articles and the percentage of total number of articles; *IPR* (%): rank and percentage of the single institute articles; *CPR* (%): rank and the percentage of institutionally collaborative articles; *FPR* (%): rank and the percentage of first-author articles; *RPR* (%): rank and the percentage of corresponding-authored articles; *SPR* (%): rank and the single-author articles; N/A: not available.

of 10,515 corresponding-author articles), and single-author articles with 15 (2.0% of 738 single-author articles) respectively while University of Pittsburgh (USA) ranked top on single institute articles with 51 (1.6% of 3,207 single institute articles) and single-author articles with 15 (2.0% of 738 single-author articles) respectively. The institute of Henry Ford and Massachusetts in United State were the only hospitals among the top 20 institutions.

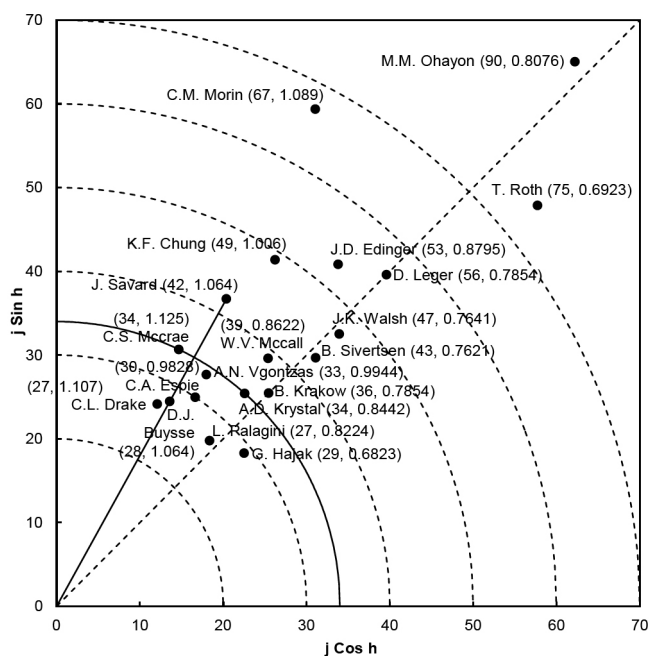


Figure 2

Y-index of the top 19 authors with $j \geq 27$.

In total, 10,446 articles (97% of the 10,801 articles) with both first- and corresponding-author information in the SCI-EXPANDED were used to calculate Y-index for authors. A total of 10,446 articles were contributed by 35,682 authors. Figure 2 displays the distribution of the Y-index (j, h) for the top 19 authors with $j \geq 27$. In this recent study, we found that the author M.M. Ohayon was the most industrious and potential to published insomnia articles with $j = 90$ then followed by T. Roth with $j = 75$. The advantage of the Y-index is that, when j of authors are the same, publication characteristics of authors can be indicated by h [15, 19]. It indicated that the top productive authors contributing to insomnia were more likely to be designated as the corresponding-authors. The j of C.S. Mccrae and A.D. Krystal were the same of 34 and located on the same curve in Fig. 2. However h of Mccrae was 1.125 and Krystal was 0.8442. Mccrae had the greatest proportion of corresponding-author articles to first-author articles, then Krystal. The h of J. Savard and D.J. Buysse were the same of 1.064 and located on the same straight line in Fig. 2. However j of Savard was 42 and Buysse was 28. Savard had the higher publication potential then Buysse. Similarly, the authors who had the same publication characteristics were D. Leger with Y-index (56, 0.7854) and B. Krakaw with Y-index (36, 0.7854). They published the same numbers of first- and corresponding-author articles respectively with the same value of h . Leger with j of 56 had high publication potential than Krakaw with j of 36. Thirteen authors had h greater than 0.7854, it means authors had more contribution as the corresponding-author.

The author who had the greatest proportion of corresponding-authors was C.S. McCrae ($h = 1.125$). The author J.K. Walsh (47, 0.7641), B. Sivertsen (43, 0.7621), T. Roth (75, 0.6923), and G. Hajak (29, 0.6823) were the only authors with $h < 0.7854$. These four authors had a greater proportion of first- than corresponding-authors articles, suggesting that they performed more research and writing on their publications.

3.5. Highly cited articles and citations per publication by year

Highly cited articles provide an interesting and useful insight into which authors and topics are influencing a research discipline over time [40, 46]. Top articles with high TC_{year} were investigated in a research field and topic [15, 17]. Number of total citations from Web of Science Core Collection was updated weekly and applied widely in most studies. The citation indicator TC_{2018} was applied to evaluate the top cited articles. The advantage of TC_{2018} compared to the usual measure of total citations in the Web of Science Core Collection lies in its invariance and it is not updated over time [48]. The top 10 highly cited articles with TC_{2018} of 880 or more were listed in Table 5. Six of the 10 articles had TC_{2018} of 1,000 citations or more. Article entitled "A new method for measuring daytime

Table 5
Top 10 most frequently cited articles with $TC_{2018} \geq 880$

Rank (TC_{2018})	Rank (C_{2018})	Article title	Reference
1 (7,191)	1 (661)	A new method for measuring daytime sleepiness: The Epworth sleepiness scale	Johns [13]
2 (1,754)	2 (308)	Validation of the Insomnia Severity Index as an outcome measure for insomnia research	Bastien et al. [61]
3 (1,322)	27 (52)	Cross-national epidemiology of major depression and bipolar disorder	Weissman et al.[62]
4 (1,316)	3 (230)	The size and burden of mental disorders and other disorders of the brain in Europe 2010	Wittchen et al. [11]
5 (1,030)	4 (180)	Ledipasvir and sofosbuvir for untreated HCV genotype 1 infection	Afdhal et al. [49]
6 (1,021)	552 (11)	A controlled trial of sustained-release bupropion, a nicotine patch, or both for smoking cessation	Jorenby et al. [63]
7 (995)	20 (62)	Sleep disturbance and psychiatric disorders: A longitudinal epidemiological study of young adults	Breslau et al. [64]
8 (907)	44 (41)	Varenicli, an $\alpha 4\beta 2$ nicotinic acetylcholine receptor partial agonist, vs sustained-release bupropion and placebo for smoking cessation: A randomized controlled trial	Gonzales et al. [65]
9 (903)	50 (38)	Mortality associated with sleep duration and insomnia	Kripke et al. [12]
10 (880)	22 (57)	Sleep complaints among elderly persons: An epidemiologic study of three communities	Foley et al. [66]

TC_{2018} : the total number of citations from Web of Science Core Collection since publication to the end of 2018;
 C_{2018} : the total number of citations in 2018 only.

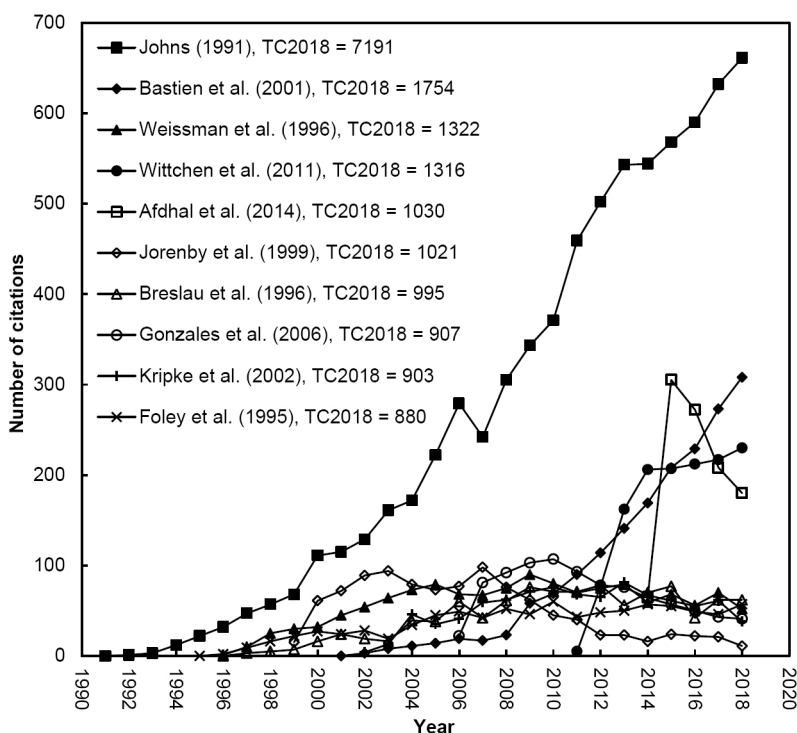


Figure 3

The citation histories of the 10 most frequently cited articles with $TC_{2018} \geq 880$.

sleepiness: The Epworth sleepiness scale" published by Johns in 1991 was the most cited article with TC_{2018} of 7,191 and C_{2018} of 661 citations. This article published, established and described a scale called Epworth sleepiness scale (ESS) to measure daytime sleepiness with new questionnaires in an easy and standardized manner [13]. As a result, it was cited most among the top 10 highly cited articles. The most recent insomnia article with TC_{2018} of more than 1,000 citations was published by Afdhal et al [49], in 2014 with TC_{2018} of 1,030 and C_{2018} of 180 (Table 5).

Figure 3 shows the citation historical trends of the top 10 most frequently cited articles ($TC_{2018} \geq 880$) respectively. Researchers were advised to pay more attention to top articles with the citation indicator of C_{year} (high impact articles in the most recent year) rather than TC_{year} (highly cited articles) [50]). This because some of the articles with high impact in the most recent year had not accumulated enough citations to be the highly cited articles [51]. In recent years, the citation life cycles of the top cited articles in a research field were presented [15, 47]). It was generally accepted that the earlier publications would tend to be accumulated more citations when compared the same level impact publications. Ho and Kahn [42] noted that a review published by [52] had 738 citations in the year of publication

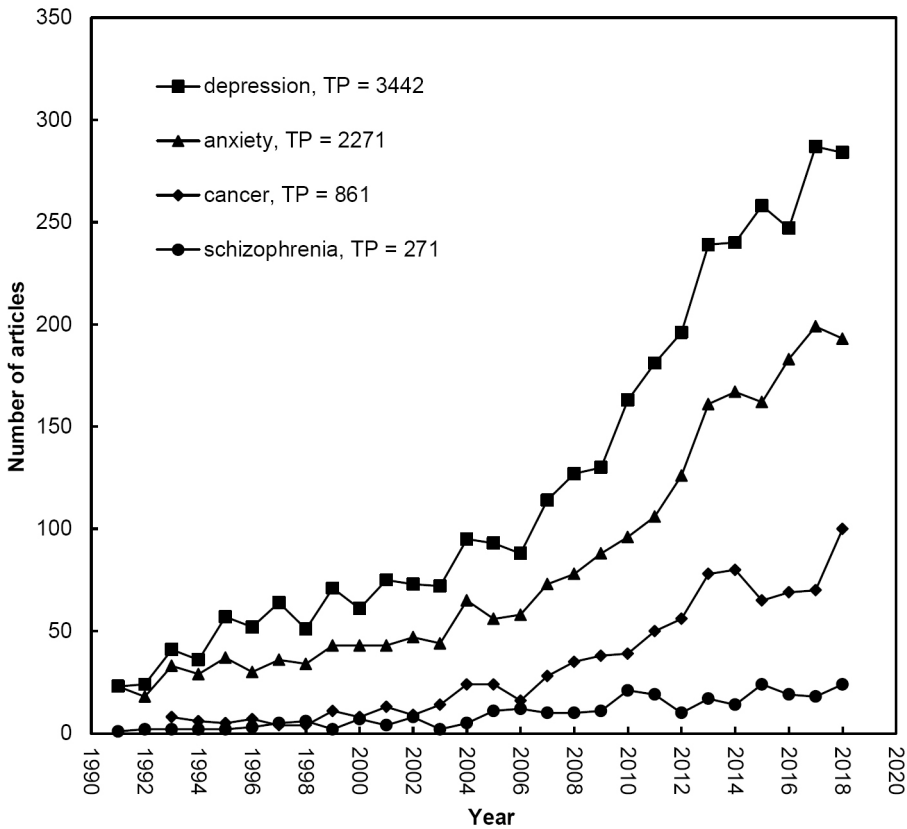


Figure 4
Insomnia articles with associated condition

that might be the highest citation recorded. The article by Johns entitled “A new method for measuring daytime sleepiness: The Epworth sleepiness scale” [13] was the most cited and its citation trend kept increasing drastically until it reached a high plateau with 661 citations in 2018. Five years later after the publication of article of Johns, increase in insomnia publications and citations began to fluctuate within the same trend for twelve years then suddenly reached a peak. Surprisingly, the citation trend for insomnia articles seems to be going down as publication increases.

3.6 Research Tendencies and Hotspots

The distribution of words in article titles, abstracts, author keywords, and *KeyWords Plus* can be informative when evaluating trends in research topics [53, 54]. The results of our keyword analyses provide information about the main and possible research foci as each word cluster comprised several supporting words. In this current study, we found out that insomnia articles were highly associated with depression then followed by anxiety,

cancer and schizophrenia. Our evidence was based on the recorded insomnia articles with other conditions as in Fig. 4. Apart from our study, other studies also reported that insomnia was significantly associated with depression [55-57], and schizophrenia [58]. Base on this finding, we may draw our conclusion that insomnia is substantially comorbid with mental disorder particularly depression. Except for mental disorders, insomnia is more associated with cancer disease, as indicated in Fig. 4. Previous study showed that insomnia is associated with cancer and breast cancer was more recommended [59, 60].

4. Conclusion

In this present study, we found 16,478 insomnia publications within 15 document types indexed in the Web of Science. Article types were mostly used and had similar citations per publication with review type. The highest value of CPP_{2018} was recorded in 1991 and was ascribed to the article entitled "A new method for measuring daytime sleepiness: The Epworth sleepiness scale" [13] by Johns. English was the dominant language. The study obtained 10,801 articles published in 1,909 journals within 136 Web of Science categories in SCI-EXPANDED. The most productive journal was *Sleep* while *New England Journal of Medicine* had the highest journal impact factor. A growing number of the insomnia articles were published by the G7 countries (USA, UK, Japan, Canada, Germany, France, and Italy) and the most productive country was USA. The majority of the institutions contributed to insomnia publications were located in United State and Harvard University ranked first in terms of insomnia research. M.M Ohayon had the highest potential to publish insomnia article and C.S. McCrae had the greatest proportion of corresponding-author articles. The article published by Johns in 1991 recorded the highest citations in Web of Science Core Collection from the year of publication to the end of 2018. Furthermore, the study also found that insomnia was highly associated with depression then followed by anxiety, cancer and schizophrenia. The research foci in insomnia were associated with depression and anxiety the most.

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