

Research Article

Internationalization of Research Devoted to the Contemporary Diagnosis of Obstructive Sleep Apnea

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Abstract

Background: The purpose of this scientometric investigation was to analyze some features of the international scientific communications in the field of the diagnosis of obstructive sleep apnea.

Methods: The publication output on this interdisciplinary topic that had been reflected in three data-bases (*Web of Science*, *MEDLINE* and *Scopus*) for the period from 2009 till 2013 was analyzed. The following scientometric parameters were comparatively followed-up: number of abstracted publications; names and countries of authors; languages and types of primary documents; titles of journals, and citation counts.

Results: In *MEDLINE*, there were 5120 items, in *WoS* - 5856 by authors from 72 countries and in *Scopus* - 1963 ones by authors from 65 countries from all over the world. In *WoS*, most papers were primarily published in 2012 (1396) and in 2009 (1138), while in *MEDLINE* and in *Scopus* - in 2013 (1168 and 481) and in 2012 (1088 and 419), respectively. Original articles prevailed followed by reviews. In *WoS*, primary publications were in 24 languages while in *Scopus* and in *MEDLINE* - in 25 ones each. English language significantly dominated followed by Chinese, German, Spanish, French, etc. First came the authors from the USA followed by those from Australia, Canada, Germany, Japan, etc. There were 86 papers by A. Malhotra abstracted in *WoS*, 64 ones by D. Gozal abstracted in *MEDLINE* and 20 ones by S. Tufik abstracted in *Scopus*. In *WoS*, the journals *Sleep* and *Sleep & Breathing* dominated, in *MEDLINE* - *Sleep & Breathing* and *Sleep*, and in *Scopus* - *Sleep & Breathing* and *Sleep Medicine* did. In *WoS*, the papers received 28232 citations, of which 21293 - without self-citations by 13734 citing articles, of which 11661 - without self-citations. The average citations per item were 4,82 and the average citations per year were 4033.14. The value of h-index was relatively high - of 53.

Conclusion: The files with abstracts could contribute to further improvement of international collaboration between the scientists from leading and smaller countries.

Keywords: Obstructive sleep apnea; Diagnosis; *Web of Science*; *MEDLINE*; *Scopus*; Scientometrics; Publication activity

Abbreviations

cIMT: Carotid Intima-Media Thickness; h-index: Hirsch index; OSA: Obstructive Sleep Apnea; OSAS: Obstructive Sleep Apnea Syndrome; PSG: Polysomnography; *WoK*: *Web of Knowledge*; *WoS*: *Web of Science*

Introduction

Obstructive sleep apnea (OSA) affects about 4% of middle-aged males and 2% of middle-aged females in the developed countries. OSA is characterized by recurrent episodes of upper airway collapses during sleep and subsequent disruption of normal ventilation and sleep patterns. These events are, usually, accompanied by oxyhemoglobin desaturation and terminated by brief arousals [1]. OSA is the result of a dynamic interplay between chemo- and mechanosensory reflexes, neuromodulation, behavioural state and the differential activation of the central respiratory network and its motor outputs [2]. There is rising evidence that OSA severity is linked

with increased death risk.

OSA has a substantial economic impact on contemporary healthcare systems as it is associated with increased cardiovascular disease morbidity and medical costs [3]. The following subsequent cardiovascular pathology is implied in association with OSA: systemic and pulmonary hypertension, heart failure, arrhythmias, sudden cardiac death, myocardial infarction, renal disease, and stroke as well. The conduit vessel endothelial function may be impaired in OSA and this impairment may be related to endothelial cell apoptosis [4]. In OSA patients, endothelial function is evaluated by flow-mediated vasodilation technique [5]. OSA syndrome (OSAS) could damage endothelial function and worsen cardiovascular risk profile since childhood [6]. There exists an intimate association of OSAS and early systemic atherosclerosis [7,8]. OSAS duration and severity are statistically significantly important factors related with higher carotid intima-media thickness (cIMT) values and with a higher risk of atherosclerosis [9].

Recently, the interest in the diagnosis of OSA dramatically increases worldwide. Our recent publications dealing with the international scientific communications in pediatric OSA [10] as well as with OSA in Bulgarian adults [11,12] prove the socio-medical importance of this pathology.

A systematic review and meta-analysis of 18 studies demonstrate that level 3 portable devices shows good diagnostic performance compared with level 1 in-laboratory polysomnography (PSG) in adult patients with a high pretest probability of moderate to severe OSA and no unstable comorbidities [13] while according to another systematic review and meta-analysis of 14 studies, peripheral arterial tonometry represents a viable alternative to PSG for confirmation of clinically suspected OSA [14]. According to that of 51 other studies, OSA patients present with higher levels of several systemic inflammatory markers than the control subjects [1]. In such patients, there are higher levels of some inflammatory markers such as high-sensitive C-reactive protein CRP, interleukin-6, tumor necrosis factor- α and pentraxin-3 which correlate to cIMT [15].

Some potential underpinnings of the phenotypic variability in pediatric sleep disordered breathing are profoundly examined and a conceptual framework for facilitating the process of advancing knowledge in this disorder is proposed [16].

Problem-oriented scientometric investigations of the internationalization, institutionalization, and interdisciplinarity of science contribute to enhancement of the quality and effectiveness of science forefront [17,18].

Internationalization of science includes not only direct research interaction between single scientists from different countries and their teams organized through official contracts or within informal collectives but also a series of the following components [17]:

i) continuous creation of new international scientific societies and international associations of national societies, of new international scientific journals and international publishers or publishing houses; ii) publishing of scientific papers, reviews and book reviews in foreign journals and periodicals; iii) translation and publishing of monographs by foreign authors; iv) organization of international scientific forums and participation in them of authors from numerous foreign countries; v) enrichment of the forms of immediate exchange of scientists from other countries; vi) unlimited dissemination of new scientific information through modern information-communication technologies; vii) modernization and automatization of scientific libraries; viii) introduction of electronic journals and monographs, and ix) overcoming of the traditional barriers for interpersonal communication between scientists from different countries.

The main objective of this article is to comparatively study some essential peculiarities of dynamic advances in the field of OSA diagnosis by using a complex scientometric method for evaluation of the world publication output and mutually linked aspects of stratification and internationalization of this interdisciplinary research field and thus to contribute to further improvement of the scientific communications in smaller countries.

Materials and Methods

In July, 2014, a retrospective problem-oriented search was

Web of Science, Scopus, MEDLIN



Figure 1: Flow chart of information retrieval and scientometric data processing.

performed in three data-bases, i.e. *Web of Science (WoS)* and *MEDLINE* of *Web of Knowledge (WoK)* (USA) as well as *Scopus* (The Netherlands). The relevant scientific papers primarily published during the period from January 1, 2009 till December 31, 2013 was examined. The following scientometric parameters were analyzed: number of abstracted publications; names and countries of authors; languages and types of primary documents, and titles of journals. The main citation parameters of the publications abstracted in *WoS* such as sum of total citations with and without self-citations; citing articles with and without self-citations; average citations per item and per year as well as h-index [19] were automatically generated by this information portal.

The process of retrieval of relevant publications in these three data-bases and the subsequent scientometric processing of their bibliographic citations is illustrated on Figure 1.

Results and Discussion

Some of the results are summarized in four tables and two figures.

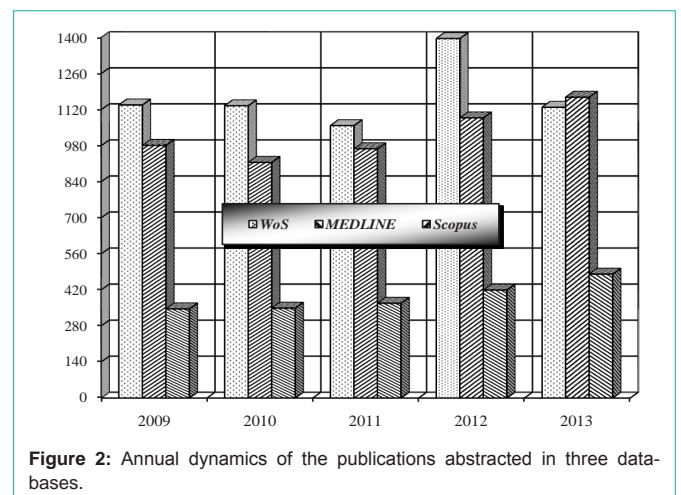


Figure 2: Annual dynamics of the publications abstracted in three data-bases.

Table 1: Distributions of document types of publications abstracted in three data-bases.

Document types	WoS	MEDLINE	Scopus
article	5234	4835	1404
review	494	714	341
meeting abstract	1798	-	-
case report	216	354	-
letter-to-the-editor	177	170	31
clinical trial	167	132	-
editorial	72	99	20
randomized controlled trial	-	293	-
conference paper	-	-	100
book/book chapter	67	-	23
evaluation study	-	114	-
multicenter study	-	113	-
meta-analysis	-	48	-
validation studies	-	101	-

The number of abstracted relevant publications differs in these three data-bases in single years and during the whole 5-year period. The annual dynamics of these publications is illustrated on Figure 2.

In MEDLINE, there are 5120 items, in WoS - 5856 by authors from 72 countries and in Scopus - 1963 ones by authors from 65 countries from all over the world. In WoS, most papers have primarily been published in 2012 (1396) and in 2009 (1138), while in MEDLINE and in Scopus - in 2013 (1168 and 481) and in 2012 (1088 and 419), respectively. The original articles prevail followed by reviews, letters-to-the-editor, case reports, etc. (Table 1). As a whole, there are 34 different languages of publications. Some of them are demonstrated on Table 2. It should be added that the percentage of the English-language papers differs between the three data-bases, too - from 92.86% in WoS, 91.27% in MEDLINE to 83.70% in Scopus.

The scientists from the USA dominate similarly to any scientometric distributions in the medical sciences. They have authored 1643 publications in WoS (28.06% of the publications in this data-base) and 620 ones in Scopus (31.58% of the publication in this data-base) during this period. Science stratification concerning the involvement of the other 14 leading countries through their authors is demonstrated on Figure 3. Next come several countries like Israel,

Table 2: Languages of publications.

Languages	WoS	MEDLINE	Scopus
English	5438	4673	1643
Chinese	71	95	44
German	68	71	57
Spanish	51	47	35
French	43	55	35
Portuguese	51	45	30
Italian	14	14	23
Japanese	14	22	11
Russian	27	26	14
Polish	16	18	11
Turkish	11	9	19
Romanian	12	14	4
Czech	5	2	14
Hungarian	4	5	1
Korean	4	1	4
Other	9 (16 papers)	10 (23 papers)	10 (18 papers)

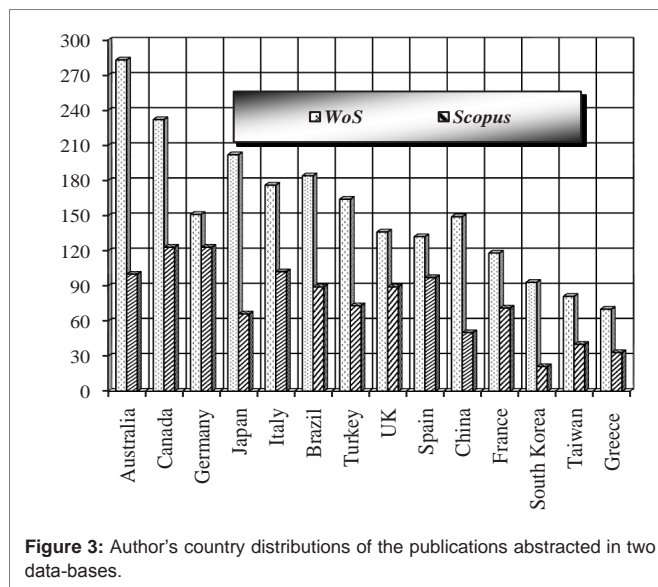


Figure 3: Author's country distributions of the publications abstracted in two data-bases.

Sweden, Poland, the Netherlands, etc. Some countries participate with a single publication by their authors, mainly as a result from effective international collaboration, e.g. 11 countries in WoS, etc. For instance, one of the five publications by Bulgarian authors abstracted in WoS is co-authored by researchers who are members of a CDBE2010 Study Group and currently work in 46 other institutions from 14 other countries in Europe and North America. It has been published in the journal *Eur Neuropsychopharmacol* in 2011 and has already received 148 citations in WoS.

The most significant ('core') scientific journals are listed on Table 3. Five of them contain the term of 'sleep' in their titles that argues of an advanced institutionalization of science in this very narrow research topic. Next come some eminent journals such as *Eur Respir J*, *Am J Respir Crit Care Med*, *Eur Heart J*, *Laryngoscope*, etc. which belong to these closely related clinical disciplines and testify to the intensive interdisciplinary collaboration taking regularly place in the specific field of OSA.

The names and affiliations of the scientists with the greatest number of publications abstracted in these three data-bases are demonstrated on Table 4. Four of them have been identified in our previous paper [3] devoted to the internationalization of research on OSA in children and infants.

In WoS, the papers have already received 28232 citations by 13734 citing articles. Some 21293 of these citations are without self-

Table 3: 'Core' journals in OSA diagnosis.

No	Journals	Countries	WoS	MEDLINE	Scopus
1.	<i>Sleep</i>	USA	1165	208	51
2.	<i>Sleep Breathing</i>	Germany	324	417	116
3.	<i>J Clin Sleep Med</i>	USA	115	214	67
4.	<i>Sleep Med</i>	the Netherlands	130	196	62
5.	<i>J Sleep Res</i>	UK	257	66	21
6.	<i>Chest</i>	USA	117	128	46
7.	<i>Int J Pediatr Otorhinolaryngol</i>	Ireland	52	65	26
	total - n	5	2160	1294	389
	total - %	-	36.89	25.27	19.82

Table 4: Most productive authors in OSA diagnosis.

No	Names	Affiliations	WoS	MEDLINE	Scopus
1.	Atul Malhotra	Brigham and Women's Hospital, Boston, MA, USA	86	61	19
2.	David Gozal	University of Chicago, Chicago, IL, USA	76	64	16
3.	Sergio Tufik	Universidade Federal de São Paulo (UNIFESP), São Paulo, Brazil	83	51	20
4.	Susan Redline	Case Western Reserve University, Cleveland, OH, USA	83	31	7
5.	Leila Kheirandish-Gozal	University of Chicago, Chicago, IL, USA	43	42	6
6.	Geraldo Lorenzi-Filho	University of São Paulo Medical School, São Paulo, Brazil	37	37	11
7.	Christian Guilleminault	Stanford Center for Sleep Sciences and Medicine, Stanford, CA, USA	32	24	7
8.	Carole L. Marcus	University of Pennsylvania School of Medicine, Philadelphia, PA, USA	20	26	8
9.	Rakesh Bhattacharjee	University of Louisville, Louisville, KY, USA	21	24	5
10.	Luciano F. Drager	University of São Paulo Medical School, São Paulo, Brazil	11	30	8

citations and 11661 citing articles are without self-citations. The average citations per item are 4.82 and the average citations per year are 4033.14. The value of h-index is relatively high - of 53. The paper by S. Redline *et al.* (*Am J Respir Crit Care Med.*, 2010; 182: 269-277) has already received 184 citations in WoS. These authors work in 12 institutions from 9 American universities.

The comprehensive study of the constellations of several publication output and citation activity patterns sheds light on various aspects of the continuous fruitful exchange of ideas, methods, results and suggestions in the increasingly internationalized topic of modern OSA diagnosis. It convincingly demonstrates the rapid science advancement in such a socially significant interdisciplinary field. The complex analysis of the internationalization by means of these scientometric parameters reveals the dynamic stratification of the forefront of this narrow topic, on the one hand, and the diversification of scientific communication channels worldwide, on the other hand. Nowadays science expansion stresses, indeed. The comparative assessment of WoS, MEDLINE and Scopus illustrates not only certain attractive advantages but also some disadvantages and pitfalls of these information-retrieval and information-storage systems for end users. There exist dramatic differences between the counts of single parameters between these widely used data-bases. The coverage scope of the primary scientific literature should further be enlarged, the processing capacities should be enriched and the indexing algorithms should be refined.

There is a permanent interest in research internationalization [20-22]. Some probable indicators of research internationalization to serve policy-makers, research funders and research-performing organizations were suggested [23]. Recently, numerous scientometric indicators of science internationalization were elaborated [24]. The analysis of the international research profiles of Europe's top 10 largest multinational pharmaceutical companies based on publication counts and author address information shows that international research activity of European industry is significantly more oriented towards the US science base than vice versa [25].

International collaboration is closely related to the visibility of science in some countries on the international scientific market [26], e.g. as examined by means of an international publication ratio [27]. It continuously attracts the attention of the scientometric community worldwide [28-37]. The interuniversity, interregional and international collaboration networks generated by Spanish universities were studied by means of social network visualization techniques [38]. It was demonstrated that the international

collaboration was implemented mainly with authors from European Union, North and Latin America. In the Netherlands, in 1988-2004, there is a high share of international research collaborations as collaborating within national research systems helps academia, firms and governmental organizations to overcome differences in norms, values and incentives [39]. The successful creation of international joint laboratories by the French *Centre National de la Recherche Scientifique* and the German *Max-Planck-Gesellschaft* is an example of the institutionalization of the dynamics of previously self-organized international collaborations [40]. Such modern models should be widely popularized among scientists themselves, science managers and policy makers in OSA theoretical and applied research, too.

Conclusion

Our results convincingly demonstrate the permanent expansion of research within and from highly developed countries to peripheral more or less specialized institutions in peripheral countries from all over the world. The substantial increase of the international collaboration promotes the improved visibility of the scientists from the smaller countries as well. This problem-oriented scientometric study creates comprehensive data-set containing systematized files with the researchers' names, addresses and publications designed mainly for the scientists from smaller countries. Its effective usage could contribute to the further improvement of their scientific communications and international collaboration with eminent colleagues from all over the world.

Authors Contributions

M. Milkov performed the searches in the data-bases, wrote the text and prepared the references of the manuscript, L. Matev processed the scientometric data, P. Nedev prepared the tables and figures and Z. Tonchev copy-edited the whole manuscript. All the authors approved the final version of the manuscript.

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