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SLEEP APNEA THROUGH JOURNAL ARTICLES INCLUDED IN THE WEB OF SCIENCE IN THE FIRST DECADE OF THE 21st CENTURY

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Abstract

Sleep Apnea is characterized by cessation (apnea) or semi-cessation of breathing (hipopnea) while asleep. The most important effect of Sleep Apnea is the daily somnolence which is one of the most important causes of traffic accidents. Thus, it is crucial to conduct research on the topic to analyze different parameters, such as where it is conducted, who are the most productive scientists, in which journals it is published, and whether the number of studies on the subject is rising. The purpose of the current study was to analyze these parameters on the Web of Science in the first decade of the 21st Century. It was found that the number of studies on the topic is increasing; the countries with the highest number of studies were the USA, Germany and Canada. The most productive authors were David Gozal (USA), T. Douglas Bradley (Canada) y Patrick Levy (France). The journals with the highest number of articles were Sleep, Chest and American Journal of Respiratory and Critical Care Medicine.

Keywords: descriptive study; sleep apnea; Web of Science; articles; indicators.

Resumen

La apnea del sueño se caracteriza por el cese (apnea) o semi-cese de la respiración (hipopnea) durante el sueño. El efecto más importante de la apnea del sueño es la somnolencia diurna, que a su vez es una de las causas más importantes de los accidentes de tráfico. Por lo tanto, es crucial llevar a cabo investigaciones sobre el tema y analizar diferentes parámetros, por ejemplo, dónde se produce, cuáles son los científicos más productivos, en qué revistas se publica, y si el número de estudios sobre el tema está aumentando. El propósito del presente estudio consistió en analizar estos parámetros en la *Web of Science* en la primera década del siglo XXI. Se encontró que el número de estudios sobre el tema es cada vez mayor; los países con el mayor número de estudios fueron EE.UU., Alemania y Canadá. Los autores más productivos fueron David Gozal (EE.UU.), T. Douglas Bradley (Canadá) y Patrick Levy (Francia). Las revistas con mayor número de artículos fueron *Sleep*, *Chest* y *American Journal of Respiratory and Critical Care Medicine*.

Palabras clave: estudio descriptivo; apnea del sueño; *Web of Science*; artículos; indicadores.

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Introduction

Intrinsic sleep disorders are caused by anomalies within the body and produce secondary effects such as insomnia or excessive sleepiness (American Academy of Sleep Medicine, 2001). One of the intrinsic sleep disorders is Obstructive Sleep Apnea (OSA) Syndrome. Persons who suffer from the syndrome stop breathing (apnea) or have periods of shallow or low breathing (hypoapnea) while asleep due to complete or partial upper airway obstruction (Sánchez, Martínez, Miró, Bardwell, & Buela-Casal, 2009). As a consequence, blood oxygen saturation decreases. Another disorder, Central Sleep Apnea (CSA) consists of breathing cessation when the brain's respiratory control centers do not work properly. Thus, persons with CSA show apneas and hypoapneas due to failures in signals from Central Nervous System (White, 2005). If both conditions are present, patients are diagnosed with mixed apnea. In any case, Sleep Apnea (SA) leads to sleep fragmentation making occurrence of normal sleep stages impossible in persons with the disorder.

Although most of the individuals with SA show symptoms during the day, not all are conscious of their disease. This may have important and dangerous consequences. Research has shown that SA patients rate high in depression (Sánchez & Buela-Casal, 2007) and anxiety (Macey, Woo, Kumar, Cross, & Harper, 2010), have increased risk of heart failure (Kasai & Bradley, 2011), risk behavior (Di Stasi, Díaz-Piedra, Catena, & Buela-Casal, 2012) and cerebrovascular accidents such as strokes (Ramar & Surani, 2010). Moreover, sleep apnea is also an important risk factor for the whole industrial society as about 20% of car accidents are due to sleepiness or being tired (Connor et al., 2002; Philip et al., 2010). Academic performance is also influenced by sleep variables (Quevedo-Blasco & Quevedo-Blasco, 2011). Thus, SA is an important risk factor for accidents and development of mental and physical disorders.

The number of studies on the syndrome is increasing. Nevertheless, given the importance of the subject, further research on the topic should be conducted. Crucial questions on prevention and treatment should still be answered. At the same time, it is important to analyze what research is being conducted, who are the most important scientists in the field and in what parts of the world they work. This can be done by an analysis of scientific publications on the subject.

The development of the new ways of scientific communication, together with modern information and communication technology enabled free flow of information

between researchers from different parts of the world. Nearly everything can be published, in journals or on the Internet, and the access to the information is extremely easy just by turning on a computer with Internet connection. But how can we distinguish high quality information from publications based on opinions or research with no guarantees? Scientists from all over the world and different fields of knowledge are trying to answer these questions. Thus, different ways of measuring quality of scientific publications have been developed. One of the most popular is the Impact Factor which is based on the number of citations received by journals (Buela-Casal & Zych, 2012; Garfield, 2003). It is understood that the best documents are those which receive the highest number of citations. Moreover, it was also shown that the best quality articles according to experts are also more cited than the rest (Buela-Casal & Zych, 2010).

The growing concern related to the quality of investigation has led to the development of measures to evaluate scientific publications (see Purnell & Quevedo-Blasco, 2013). Different studies analyzed the internationality of the scientific publications (e.g., Olivas-Ávila, Musi-Lechuga, Quevedo-Blasco, & Luna-Hernández, 2012) or the productivity of institutions (Jiménez-Torres, Guerrero-Ramos, & López-Sánchez, 2013), researchers (Buela-Casal, Olivas-Avila, Musi-Lechuga, & Zych, 2011) and journals (Quevedo-Blasco, 2013). Bibliometric studies were conducted to analyze Web of Science publications in Psychology (Navarrete-Cortes, Fernández-López, López-Baena, Quevedo-Blasco, & Buela-Casal, 2010; Navarrete-Cortés, Quevedo-Blasco, Chaichio-Moreno, Ríos, & Buela-Casal, 2009) or Legal Psychology (Quevedo-Blasco, Ariza, & Raya-Muñoz, 2012) among other topics (e.g., Martín-Banderas, Durán-Lobato, Holgado, Álvarez-Fuentes, & Fernández-Arévalo, 2013). The objective of the current study is to analyze parameters related to the research on "sleep apnea" in the first decade of the 21st Century, such as where it is conducted, who are the most productive scientists, in which journals it is published, and whether the number of studies on the subject is on the rise.

Method

The unit of the analysis

The authors of the current study analyzed all the articles and reviews about "sleep apnea" included in the WoS in the first decade of the 21st Century. Only the countries with more than 60 documents were included in the analyses.

Materials

- Web of Science (WoS): a database provided by Thomson Reuters with more than 11,000 journals.
- Information related to the number of inhabitants and Gross Domestic Products (GDP) of each country found at the website of the World Bank Group (2009).

Design and procedure

The current work is a descriptive study through document analysis, edited according to the Hartley's recommendations (2012). The search was conducted from the January 24th to the February 2nd 2011. Two independent researchers searched for the documents on the WoS. Only the documents classified in the WoS as "articles" and "reviews" were taken into account. Finally, the results found by the two researchers were compared. If any differences were found, analyses were reviewed until agreements were achieved in all the criteria. The percentage of agreements in all the indexes was greater than 97%.

The authors of the current study analyzed documents on Sleep Apnea included in the Web of Science from 2000 to 2009 (ten years). The words "apnea" and "sleep*" were entered in "general search" and the documents (articles and reviews) which included the word in their "title" OR "topic" were analyzed. Then selected documents whose object of study is the "Sleep Apnea" and not another meaning of apnea. Although most of the documents are classified as "Science", the analyzed databases were: Science Citation Index Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts and Humanities Citation Index. All these databases were included to assure the inclusion of all the documents on the topic.

Quality indicators utilized in this study are included in Table 1. The productivity of each country was calculated taking into account the country of origin of each author (not just the first author) as many documents were signed by authors from different countries. This was done in case of the number of documents (Ndoc) and researchers (Nres).

Analyses were also performed taking into account numbers of inhabitants and Gross Domestic Products of each country in 2009. This information was found at the website of the World Bank Group (2009).

All the results were introduced in a database designed for the current study and analyzed in Microsoft Excel 2007.

Table 1. Bibliometric Indicators Utilized in the Study.

Indicator	Meaning
Ndoc (Number of documents): Number of articles (original and reviews) per country.	The number of articles from each country in the first decade of the 21st Century (ten years). Documents signed by authors from different countries account for all the countries.
Nres (Number of researchers/authors): The total number of researchers per country.	The number of researchers per country is calculated by assigning each author to their country of origin. The country of origin of the article is not taken into account in this indicator.
Prod (Productivity): Number of articles per author from each country.	The productivity is calculated dividing the number of articles from each country between the number of researchers / authors from each country. This makes possible the comparison among countries with different human resources.
IAVR (Interannual Average Variation Rate): average increase (%) in research on a given subject in productivity and number of authors per country.	Interannual Variation Rate (IVR) shows variations in percentage of the productivity and the number of authors from each country during the previous year. The indicator was calculated for each year included in the study. Interannual Average Variation Rate (IAVR) is the average for the ten years for the number of articles (IAVR/Ndoc) and for the number of researchers/authors (IAVR/Nres).
Top 10 most productive researchers	A ranking of the ten researchers with the highest number of documents on "sleep apnea" in the first decade of the 21st Century.
Top10 journals (Ndoc)	The ten journals with the highest number of articles on "sleep apnea" in the first decade of the 21st Century.

Results

The authors of the current study found a total number of 9,533 documents with the word "apnea" AND "sleep*" in the title OR in the topic. The documents analyzed in the study were articles (n = 8,367; 87.77%) and reviews (n = 1,166; 12.23%) with the word "apnea" AND "sleep*" in the title or in the topic, included in the Web of Science (WoS). Publication languages of the analyzed documents are shown in Table 2.

Table 2. Publication Languages of the Analyzed Articles.

Language	No. of documents (%)
English	8,912 (93.49)
German	222 (2.33)
French	165 (1.73)
Spanish	155 (1.63)
Russian	29 (.3)
Portuguese	17 (.18)

Note. The table shows publication languages where the number of documents was higher than 10.

9,533 documents were included in the analyses, excluding the countries with less than 60 publications, for example Singapore (58), Russia (53) or India (51). It should be emphasized that, among Ibero-American countries, only Spain and Brazil had more than 60 articles. In case of Spain, 349 articles were found. For Brazil, the number of documents was 230. The analyzed indicators for each country are shown in Table 3.

Table 3. Results for Each Indicator for Each Country.

Country	Ndoc	Nres	Prod (Ndoc/Nres)	IAVR (Ndoc)	IAVR (Nres)
Total*	9,533	26,030	.304	29.022	37.791
Distribution by country					
1. United States	3,851	10,320	.373	39.889	170.111
2. Germany	694	2238	.310	.333	53.167
3. Canada	684	1921	.356	4.889	43.167
4. Japan	568	2027	.280	7	78.222
5. France	555	1886	.294	3.889	43.500
6. Australia	490	1448	.338	4.111	39.500
7. England	395	1480	.267	2.222	29.333
8. Italy	362	1567	.231	4.556	55.167
9. Spain	349	1258	.277	4	29.222
10. Sweden	233	588	.396	-.111	9.611
11. Brazil	230	908	.253	6.444	37.778
12. Israel	213	620	.344	.889	13.222
13. Republic of China	208	761	.273	5.222	26.611
14. Turkey	207	792	.261	4.889	35.611
15. Switzerland	178	610	.292	1.333	13.389
16. Belgium	173	564	.307	-.778	10.833
17. Finland	138	450	.307	2	7.611
18. Taiwan	130	394	.330	2.444	14.056
19. Greece	128	468	.274	2.444	21.222
20. Holland	119	516	.231	.889	6.389
21. South Korea	100	341	.293	3	12.667
22. Scotland	98	290	.338	0	5.889
23. Austria	78	249	.313	-1	-.444
24. New Zealand	73	233	.313	.333	5.833
25. Poland	71	252	.282	1.111	8.333
26. Ireland	61	160	.381	.111	4.222

Note. Ndoc= number of articles; Nres= number of researchers; Prod= number of articles per author; IAVR= Interannual Average Variation Rate.

* Total is not the sum of values in all the countries as some indicators score for more than one country at the same time (see Table 2).

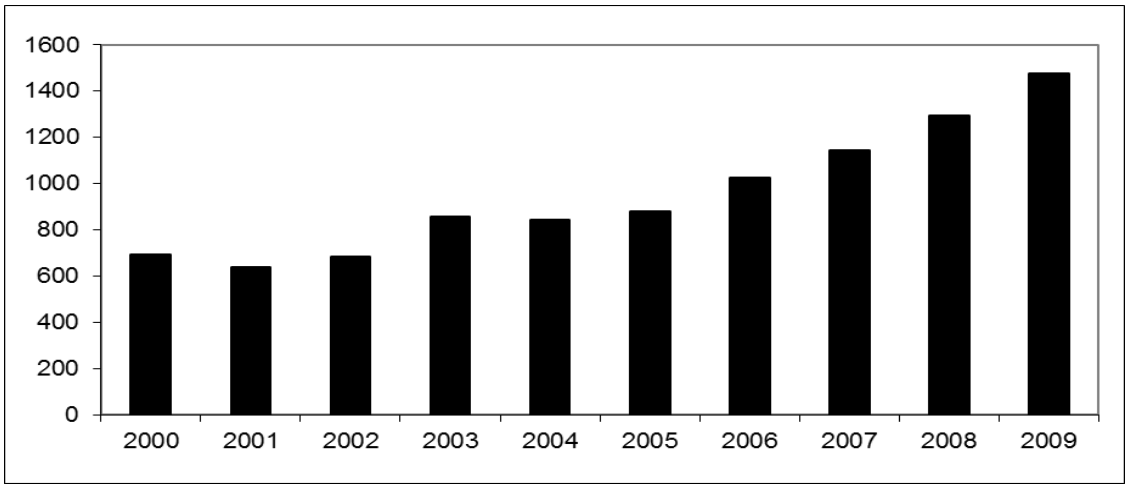
As can be seen in Table 3, the country with the highest number of documents, number of researchers, productivity and Interannual Average Variation Rate is the United States. Thus, it is not surprising that the most productive Sleep Apnea researcher, David Gozal, is also from the USA (see Table 4).

Table 4. The Ten most Productive Authors on "Sleep Apnea" in the First Decade of the 21st Century.

Researcher	Country of origin	No. of documents
1. Gozal, David	United States	132
2. Bradley, T. Douglas	Canada	54
3. Levy, Patrick	France	49
4. Tufik, Sergio	Brazil	45
5. Douglas, Neil J.	Scotland	44
6. Grunstein, Ronald R.	Australia	40
7. Montserrat, Josep M.	Spain	37
8. Lavie, Peretz	Israel	33
8. Maurer, Joachim T.	Germany	33
10. Kahn, Andre	Belgium	32

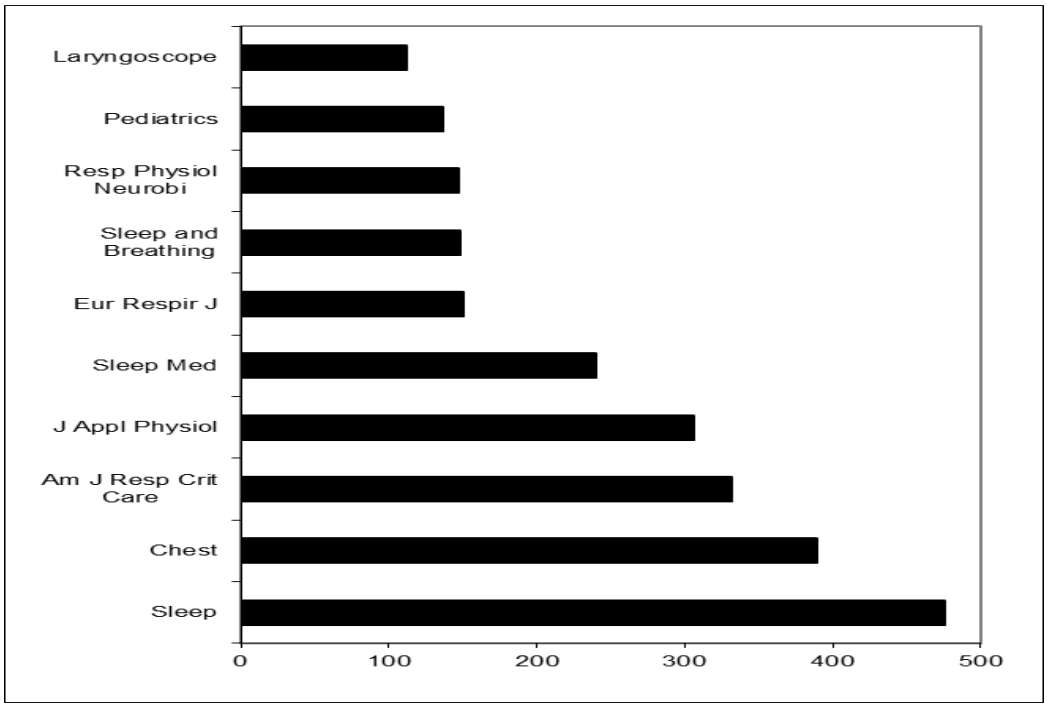
Figure 1 shows the number of articles on “sleep apnea” throughout the analyzed years. This distribution reflects the growing interest in the subject as the number of documents is rapidly increasing. 691 documents were published in 2000 and in 2009 the number of articles on the topic was more than two times higher.

Figure 1. The Number of Articles on “Sleep Apnea” throughout the Ten Analyzed Years.



Sleep is the journal with the highest number of articles about "sleep apnea". The journal published almost 500 documents on the subject. *Chest* and *American Journal of Respiratory and Critical Care Medicine* are the second and the third journals respectively (see Figure 2).

Figure 2. Top Ten Journals Publishing Articles on "Sleep Apnea" in the First Decade of the 21st Century.



Note. Include 25.55% of the total sample.

The geographic zone where the highest number of articles was published is North America, followed by Europe. These two continents are where more than 80% of all the articles on the topic were published (see Table 5).

Table 5. The Number of Articles about "Sleep Apnea" of Each Geographic Zone in the First Decade of the 21st Century.

Geographic Zone	No. of articles (%)
North America*	4,535(43.66)
Europe*	3,839 (36.96)
Asia	1,219 (11.74)
Australia and Oceania	563 (5.42)
South America and Caribbean islands	230 (2.21)
Africa	0 (0)

* *Note.* Europe and North America is where 80.63% of the documents on "sleep apnea" were published.

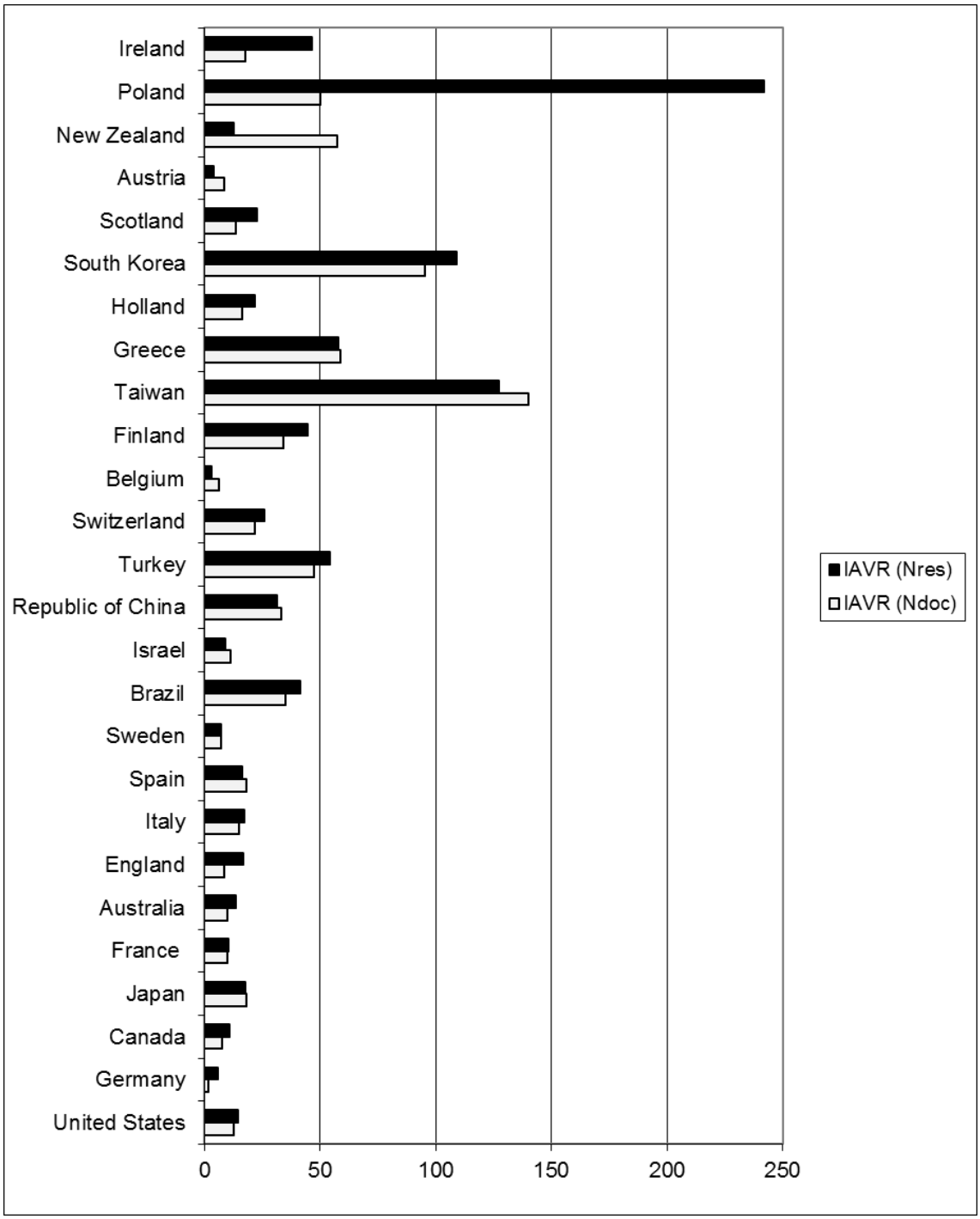
Although the United States is the leading country in publications about "sleep apnea", the situation changes if the number of articles is divided by one million of inhabitants (per capita). If this is done, Israel is the country with the highest proportion of documents per inhabitant. On the other hand, Sweden is the country with the highest productivity calculated as number of documents per researcher. If Gross Domestic Product is taken into account, the number one country in publications about "sleep apnea" is China. These results are presented in Table 6.

Table 6. Top Fifteen Countries in Number of Articles (Ndoc) per One Million of Inhabitants, Number of Articles per Author (Prod) and Number of Articles (Ndoc) per One Million Dollars (Gross Domestic Product).

Country	Ndoc/one million of inhabitants	Country	Prod	Country	Ndoc/ GDP
1. Israel	28.622	1. Sweden	.396	1. Republic of China	2.78017
2. Finland	25.850	2. Ireland	.381	2. Greece	1.00345
3. Sweden	25.048	3. United States	.373	3. Israel	.00109
4. Switzerland	23.024	4. Canada	.356	4. Finland	.00058
5. Australia	22.400	5. Israel	.344	5. New Zealand	.00058
6. Canada	20.273	6. Australia	.338	6. Sweden	.00057
7. New Zealand	16.915	7. Scotland	.338	7. Australia	.00053
8. Belgium	16.035	8. Taiwan	.330	8. Canada	.00051
9. Ireland	13.706	9. New Zealand	.313	9. Belgium	.00037
10. United States	12.544	10. Austria	.313	10. Switzerland	.00036
11. Greece	11.344	11. Germany	.310	11. Turkey	.00034
12. Austria	9.326	12. Belgium	.307	12. United States	.00027
13. France	8.863	13. Finland	.307	13. Ireland	.00027
14. Germany	8.476	14. France	.294	14. Spain	.00024
15. Spain	7.594	15. South Korea	.293	15. France	.00021

Interannual Average Variation Rate (IAVR) is the ten year average for the number of articles (IAVR/Ndoc) and for the number of researchers/authors (IAVR/Nres). The results in this indicator show that both numbers are increasing (see Figure 3).

Figure 3. Comparison of the Interannual Average Variation Rates (IAVR) of the articles (Ndoc) and researchers (Nres) among the Analyzed Countries.



Tables 7 and 8 show the Web of Science categories with the highest number of documents about "sleep apnea" in general and in psychology. As can be seen in the tables, these categories are *Respiratory system* and *Psychology*, respectively.

Table 7. Ten Categories with the Highest Number Of Documents (Ndoc) about "Sleep Apnea" in the Web of Science.

Categories	Ndoc
Respiratory system	1,819
Clinical neurology	1,811
Neurosciences	1,228
Pediatrics	970
Physiology	819
Otorhinolaryngology	783
Medicine, general & internal	655
Cardiac & cardiovascular systems	512
Surgery	472
Critical care medicine	448

Table 8. Psychology Categories with the Highest Number of Documents (Ndoc) about "Sleep Apnea" in the Web of Science.

Categories	Ndoc
Psychology	45
Psychology, Clinical	40
Psychology, Developmental	26
Psychology, Experimental	18
Psychology, Multidisciplinary	15
Psychology, Biological	7

Discussion

The current study is the first analysis of different parameters to evaluate the research in "sleep apnea" in the first decade of the 21st Century. As described in the introduction, the syndrome has serious implications for the health of the patients, such as increased risk of depression, anxiety, heart attacks or strokes. Moreover, excessive daily sleepiness caused by "sleep apnea" also leads to dangerous consequences such as the likelihood of car accidents. Thus, it is crucial to analyze and strengthen the research on the syndrome. This study is an important contribution to that purpose.

The results of the study have shown that the United States is the leading country in most of the parameters of "sleep apnea" research. This is the country with the highest number of articles and researchers who investigate in the subject. Also the most productive researcher, David Gozal, is from the USA. Nevertheless, it should be taken into account that investigation on the syndrome is conducted in many different countries all over the world, with high number of documents and authors from Germany, Canada,

Japan, France, Australia, England, Italy and Spain. Moreover, if the results are calculated taking into account the number of inhabitants of each country, the number of articles per author or per one million dollars of the GDP, the leading countries are Israel, Sweden and Republic of China, respectively. This situation was similar in previous studies which analyzed global psychology throughout documents included in the Web of Science (Navarrete-Cortes et al., 2010; Navarrete-Cortés et al., 2009).

The journals which published the highest number of documents on "sleep apnea" are *Sleep*, *Chest* and *American Journal of Respiratory and Critical Care Medicine*. Web of Science categories with the highest number of documents on "sleep apnea" are *Respiratory System*, *Clinical Neurology* and *Neurosciences*. The results of the current study show that more than 150 articles on the syndrome were published in psychology journals. Moreover, it was found that the number of documents on the topic is increasing.

As mentioned in the introduction, it is crucial to evaluate the quality of the scientific publications (Buela-Casal, 2003). This is the only way to know what research is being conducted and where, who are the most important scientists or the most important journals in the field and whether the number of studies is increasing or decreasing. The current study answered these questions for "sleep apnea" research and can be utilized to strengthen future investigation of the syndrome.

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