

Original Research

Sleeping Beauties in Anatomy Literature

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Abstract

The study aimed to identify the most critical sleeping beauty papers in anatomy and calculate their awake intensity and year. The data score was defined with a Scopus query using advanced search. Since at least 10 years of sleep is necessary for a paper to be regarded, only papers published between 1970-2010 were included. The bibliographic and Citation Report features were exported in the CSV format. The B-score of the remaining documents was then calculated. The top 10 sleeping beauty documents had an awake year after 2010 in Anatomy. Based on the B-Score of the top 10 papers, the number of studies that cite sleeping beauties is increasing. Identifying the citation patterns of sleeping beauties can help analyze researchers' scientific behavior, examine the evolution of a particular discipline, and understand the delay in recognizing innovative processes.

Keywords: Sleeping Beauties, Anatomy, Citations, B-score, Scientometrics.

Introduction

Bibliographic citations in scientific papers have gained momentum since the 1950s. Citation data in bibliometrics are essential to examining and discovering the relationships between scientific evidence, the evolution of scientific disciplines, the patterns in scientific collaboration networks, and citation-based scientific impacts. Citations are also widely used to evaluate researchers' career paths and performance in scientific institutes. Citations can be viewed as tools by which the scientific community is recognized through its scientific output (Song, Situ, Zhu & Lei, 2018).

The ISI indicators impact factor, immediacy index, and cited half-life are three standardized measurements associated with citations. (Yu, Guo & Li, 2006) Citations to articles published

in a given year increase drastically for the first two to six years after publication and then decline exponentially. The three indicators can be used to determine how a journal's articles are cited over time. (Amin & Mabe, 2004) However, many scientific documents do not receive citations immediately following publication. (Zong, Liu & Fang, 2018) Early studies referred to this phenomenon as "resisted discoveries" (Barber, 1961), "scientific prematurity" (Stent, 1972), and the "Mendel syndrome" (Costas, Van Leeuwen & Van Raan, 2011; Garfield, 1979), which relates to delayed recognition papers.

Recently, the term "sleeping beauty" was coined to characterize this phenomenon of delayed recognition, in which the importance of a significant article is not recognized until a long time after its publication. (Min, Sun, Pei & Ding, 2016) This term was first used by Van Raan (2004) to refer to documents recognized late but suddenly received citations. Sleeping beauties frequently "wake up" gradually, making softer impressions instead of startling citation blasts that command immediate attention. (Li & Shi, 2016) Every sleeping beauty has its prince. A Prince is a paper that cites a sleeping beauty for the first time, thereby creating a high citation that leads to the recognition of the sleeping beauty (Miura, Asatani & Sakata, 2021). Figure 1 depicts the identification of a sleeping beauty by a prince. Each node denotes a paper, and each edge represents a citation. In Figure 1, the blue node that represents the sleeping beauty has few citations and is unrecognized; however, when the prince recognizes the importance of the sleeping beauty and cites it, it forms a citation network and introduces that paper to the scientific community.

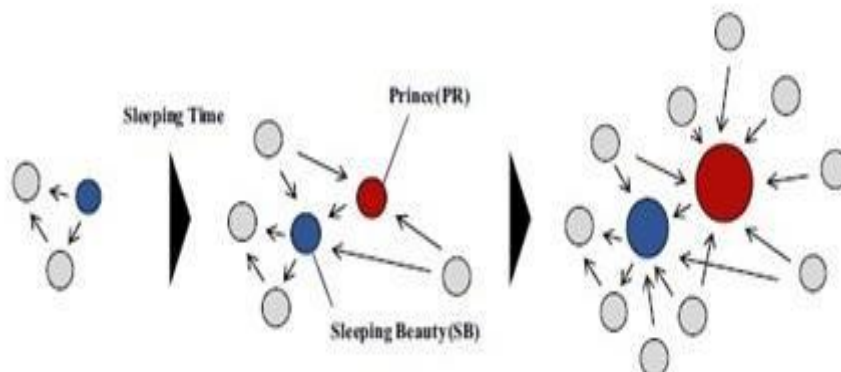


Figure 1: A sleeping beauty and its identification by a prince

Identifying sleeping beauties is a special type of citation analysis and, in turn, a bibliometric method through which the works cited in published studies are evaluated to determine the patterns of scientific collaboration and evaluate scientific documents in a particular field. Identifying the citation patterns of sleeping beauties can help analyze researchers' scientific behavior, examine the evolution of a particular discipline, understand the delay in recognizing innovative processes, and early detection of innovative ideas (Kokol, Vošner & Vermeulen, 2017). A review of the literature suggests that there are different methods for determining sleeping beauty (Bornmann, Ye & Ye, 2018; Costas, van Leeuwen & van Raan, 2010; Du & Wu, 2018; Ke, Ferrara, Radicchi & Flammini, 2015; Sun, Min & Li, 2016; Teixeira, Vieira & Abreu, 2017; Ye & Bornmann, 2018). In general, there are three quantitative criteria for examining these papers: average-based, quartile-based, and parameter-free criteria (Costas et al., 2010). According to Van Raan's 2004 research, there are three types of variables for average-

based criteria: 1) depth of sleep (cs), which refers to the average of citations received during the sleeping period since the publication of the paper, which is divided into two types of deep sleep. ($sc \leq 1$) and shallow sleep ($1 < cs \leq 2$); 2) length of sleep (ns), indicating the length of the sleeping period that often lasts five to 10 years; and 3) awake intensity (cw) (e.g., 20 citations per annum over a four-year period) (Van Raan, 2004). Costas et al. (2010) identified sleeping beauties based on quartile-based criteria and Year 50%, i.e., when the paper first received at least 50% of its citations. Accordingly, Sleeping Beauties are papers that have not received 50% of their citations, while 75% of other documents in their field have already received 50% of their citations (Costas et al., 2010). The third quantitative criterion is the parameter-free criterion proposed in 2015, called the beauty coefficient or B score. Based on the citation curve and considering the year of publication of the paper and the year of maximum citations, the B score helps identify sleeping beauties (Ke et al., 2015). Over time, the accuracy of methods for detecting sleeping beauties has increased (Hou & Yang, 2019). Criteria such as the Gs index (Teixeira et al., 2017), k value indicator (Teixeira et al., 2017), dynamic citation angle (Ye & Bornmann, 2018), dynamically normalized citation impact scores (Bornmann et al., 2018), and beauty coefficient percentage or PCP index (Du & Wu, 2018) are all examples of this.

Identification of the sleeping beauty phenomenon is familiar and has been studied in different decades and in various fields (Fazeli-Varzaneh et al., 2021; Song et al., 2018). A field that has recently received research attention in multiple subjects and studies is the COVID-19 pandemic. On this, Haghani and Varamini (2021) explored temporal evolution, the most influential studies, and sleeping beauties in scientific texts related to the coronavirus. In their 2020 study, Fazeli-Varzaneh et al. examined and identified sleeping beauties in coronavirus research (Fazeli-Varzaneh et al., 2021). Another notable case observed in other studies is the identification of sleeping beauty patents (Hou & Yang, 2019; van Raan & Winnink, 2019). The phenomenon of sleeping beauty has also been studied in nursing (Kokol et al., 2017), social media (Hou & Yang, 2020), chemistry (El Aichouchi & Gorry, 2018), and head and neck surgery (Coelho, Kirk, Miller, Hasan & Fenton, 2020), among other fields.

Anatomy, one of the oldest known medical sciences, is the foundation of medical education and an integral element of the medical curriculum. (Çetkin, Turhan, Bahşi & Kervancıoğlu, 2016) It is believed that the first studies in anatomy trace back to the 19th century B.C. (Persaud, 1999) Because countless scientists contributed to the development of anatomy over such a lengthy period, today's medical literature contains anatomical knowledge in great detail. (Çetkin et al., 2016; Wing & Massoud, 2015) For this reason, each study in the field of anatomy is significant in terms of its contribution to the discipline. (Bahşi, Adanır, Kervancıog, Orhan & Govsa, 2021) Knowledge of the structure of the human body, from the organs to the molecular level, is critical to understanding its function in health and illness (McCuskey, Carmichael & Kirch, 2005). Following the growing significance of anatomy in modern medicine, the rise in the number of papers, and the fact that papers often cite fated anatomical studies, the current study aimed to identify the most important sleeping beauty papers in this field and calculate their awake intensity and year.

Materials and Methods

The score of the data was defined with a query of Scopus that was performed on October 5, 2021, using advanced search with the following keywords: *Anatomy*, *Anatomical variations*,

Anthropology, Anthropological index, Morphology, and Morphological measurements. Since at least 10 years of sleep is necessary for a paper to be considered a sleeping beauty, papers published in or after 2011 were excluded, and only papers published from 1970 to 2010 were included. A sleeping beauty has to be sleeping for at least 10 years; thus, in the current study, the paper had to be published before 2010. The *bibliographic* and *Citation Report* features were individually exported in the CSV format, and the two files were merged.

As noted before, there are three main variables for sleeping beauty according to Van Raan (2017): (1) the depth of sleep in terms of a maximum citation rate during the sleeping period (an average annual citation < 1 in the sleeping period), (2) 10 years of sleeping period after publication (We considered publications up to 2010 because the collection of sleeping beauties must have experienced at least 10 years of sleep); and (3) the awake intensity in terms of a minimum citation rate during the awake period (We included papers that possess a maximum citation of at least five during the awake period).

After completing the citation collection, data cleaning, enrichment, and curation processes were applied. The beauty score (B-score) (Ke et al., 2015) of the remaining documents was then calculated as follows:

$$B = \sum_{t=0}^{t_m} \frac{\frac{c_{t_m} - c_0}{t_m} \times t + c_0 - c_t}{\max\{1, c_t\}}$$

where t denotes the (discrete integer) year number (referring to the first year of publication (t_0) as 0, the next year 1, etc., up to t_m), c_{t_m} represents the paper's number of citations in the last year of interest t_m (here, e.g., 2020); thus, c_0 denotes the paper's number of citations in the publication year t_0 , and c_t shows the paper's number of citations in the year t . The B-score determines whether a given paper represents the SB citation pattern. As such, papers that received moderate primary attention followed by more outstanding citations in subsequent years usually receive a relatively high B-score. Herein, the paper must have experienced a 10-year sleep period to be regarded as a sleeping beauty; based on this constraint, we also retrieved the number of citations during the first 10 years after the paper's publication. In this way, we only retained papers with an average annual citation of < 1 in the first 10 years after publication.

Results

After extracting the data from Scopus, we arranged them in chronological order to examine the volume of documents and citations per annum. The first anatomical documents date back to 1863 (three documents); since then, this value has exhibited considerable annual fluctuation. Most documents in this domain belong to 2015 ($n = 22787$). Figure 2 displays the trend of publication from 1970 to 2021 by year.

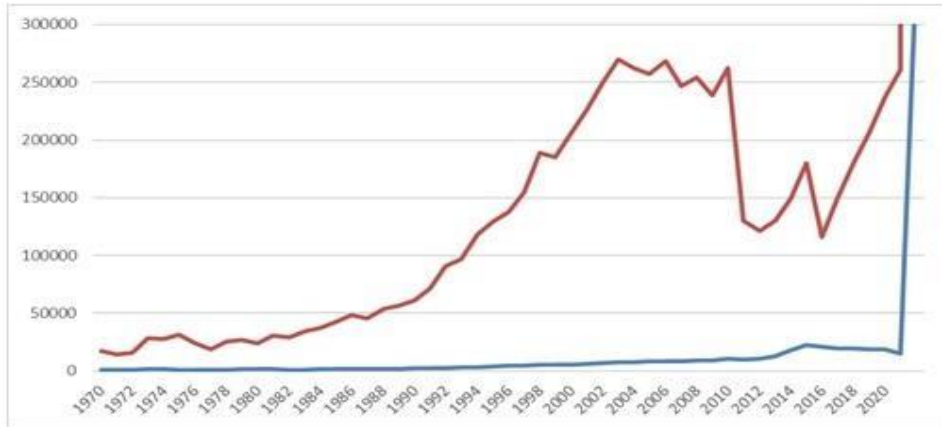


Figure 2: Number of documents and citations of anatomy documents from 2010 to 2021

In contrast, the red line shows the number of citations to these documents. The total number of citations to documents in this period is 5923641, most of which are in 2003 ($n = 269536$). The citation trend has been uniform and continuous from 1970 to 1993, but suddenly, since 1994, the number of citations was doubled compared to previous years. The citation trend has grown steadily over these years; however, between 2011 and 2016, there has been some fluctuation in citations, which rose again in subsequent years.

Out of 150726 papers on anatomy (published between 1970 and 2010), 927 sleeping beauties were extracted, of which 18 papers had a B score of ≥ 50 , five papers had a B score of ≥ 100 , and five papers had a B score of ≥ 110 . As shown in Figure 3, 49.8% of all sleeping beauties in anatomy have a B-Score of ≤ 10 , and only 1.07% of the papers have a B-Score of ≥ 100 .

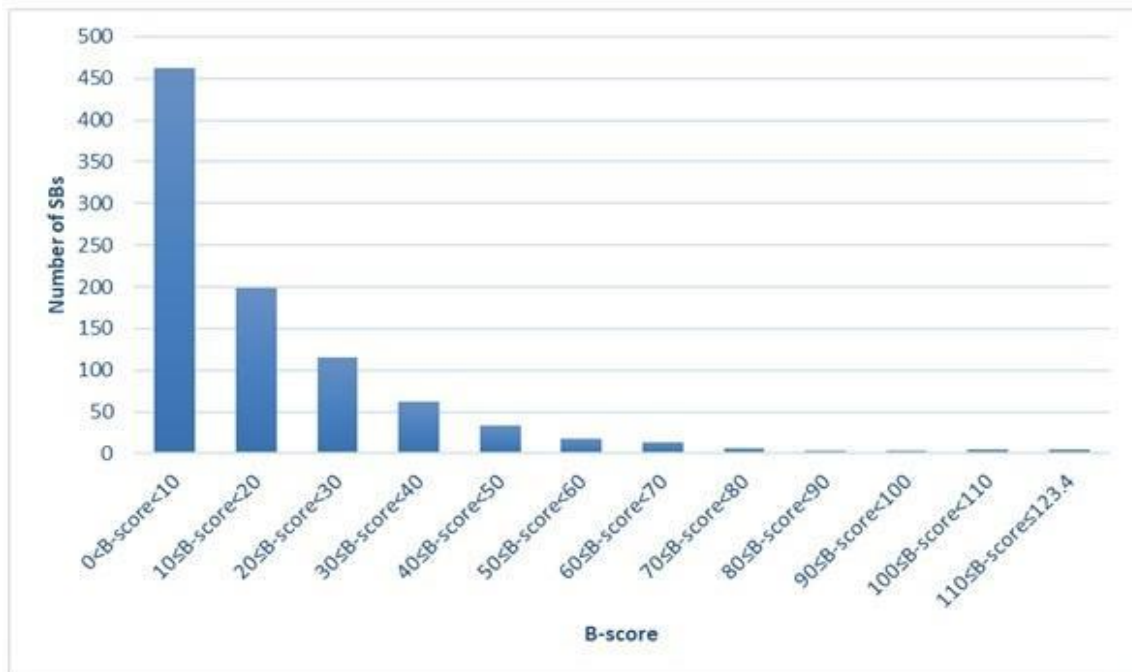


Figure 3: Distribution of all sleeping beauties based on beauty score (>0 and <200)

To examine the sleeping beauties in more detail, their annual presence is shown in Figure 4.

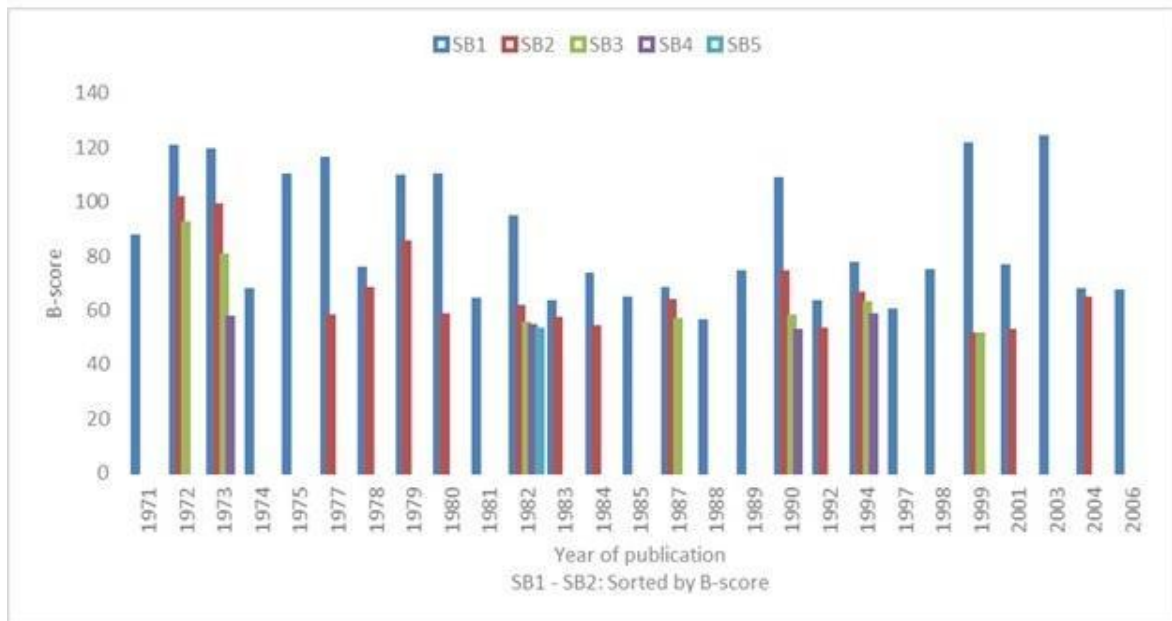


Figure 4: Number of documents with sleeping beauties ≥ 50

There are 55 papers with a B-score of ≥ 50 . The highest sleeping beauty index belongs to 2003, 1999, and 1972.

Based on Table 1, the highest B-Score (123.4) belongs to a paper entitled *Functional and Aesthetic Rhinoplasty*, published in *Aesthetic Plastic Surgery*. This paper was published in 2003 and awakened in 2021. It received a total of 31 citations as of November 2021. Top 10 sleeping beauty papers with the maximum B-Score were published between 1972 and 2003, of which the maximum number of citations received belonged to two papers, respectively entitled *A road map to the internal carotid artery in expanded endoscopic endonasal approaches to the ventral cranial base* (2018) and *the anatomy of the arterial supply of the human thalamus and its use for the interpretation of the thalamic vascular pathology* (2011), while the rest of papers belonged to 2021. Most of these studies were conducted by authors from the United States ($n = 3$), the United Kingdom ($n = 2$), and France ($n = 2$). Note that the papers in Table 1 are ranked in descending order according to their B-Score. Furthermore, nine out of 10 journals had an impact factor of > 2 .

Table 1

Top 10 sleeping beauties on Anatomy with the highest Beauty Score

Paper ID	Title	Authors	Journal	JIF	Collaborator Countries	Funded YES/NO	Year of Publication	Year of Maximum Citations	Total citations	Annual citation (for the first 10 years for publications)	B-score
A1	Functional and Esthetic Rhinoplasty	Gola, R.	Aesthetic Plastic	2.326	France	NO	2003	2021	31	0.5	123.4
A2	Treatment of the nasal hump with preservation of the cartilaginous framework	Ishida, et all	Plastic and Reconstructi	4.730	Brazil	NO	1999	2021	58	0.6	120.7 136
A3	The anatomy of the arterial supply of the human thalamus and its use for the interpretation of the thalamic vascular pathology	Percheron, G.	Zeitschrift für Neurologie	-	France	NO	1973	2011	183	0.3	118.8 983
A4	A ""second"" radial artery for monitoring the perioperative pediatric cardiac patient	Amato, et all.	Journal of Pediatric	2.545	United States	NO	1977	2021	17	0.1	115.5 091
A5	Anatomy and physiology of the fallopian tube	Eddy et all.	Clinical Obstetrics	2.190	United States	No	1980	2021	70	0	109.5 614
A6	The braincase of Typhlops and Leptotyphlops (Reptilia: Serpentes)	Rippel O.	Zoological Journal of the Linnean Society	3.286	Switzerland	Yes	1979	2021	35	0.3	108.9 325
A7	Functional anatomy of the choroidal circulation: Methyl methacrylate casting of human choroid	Olver, J.M.	Eye (Basingst	3.775	United Kingdom	Yes	1990	2021	105	0.9	108.1 368

Paper ID	Title	Authors	Journal	JIF	Collaborator Countries	Funded YES/NO	Year of Publication	Year of Maximum Citations	Total citations	Annual citation (for the first 10 years for publications)	B-score
A8	Comparative anatomy and histology of the cervix uteri in non-human primates	Hafez et al.	Primates	2.163	United States; Poland	No	1972	2021	39	0.2	101.1837
A9	The comparative leaf anatomy of Agave, Beschorneria, Doryanthes and Furcraea species (Agavaceae: Agaveae)	Blunden et al.	Botanical Journal of the Linnean Society	2.911	Hampshire; United Kingdom	Yes	1973	2021	20	0.2	98.56944
A10	A road map to the internal carotid artery in expanded endoscopic endonasal approaches to the ventral cranial base	Labib et al.	Neurosurgery	4.654	Canada	Yes	1982	2018	57	0	94.15819

Figures 5 illustrate the citation process for the top 10 papers in Table 1 each year.

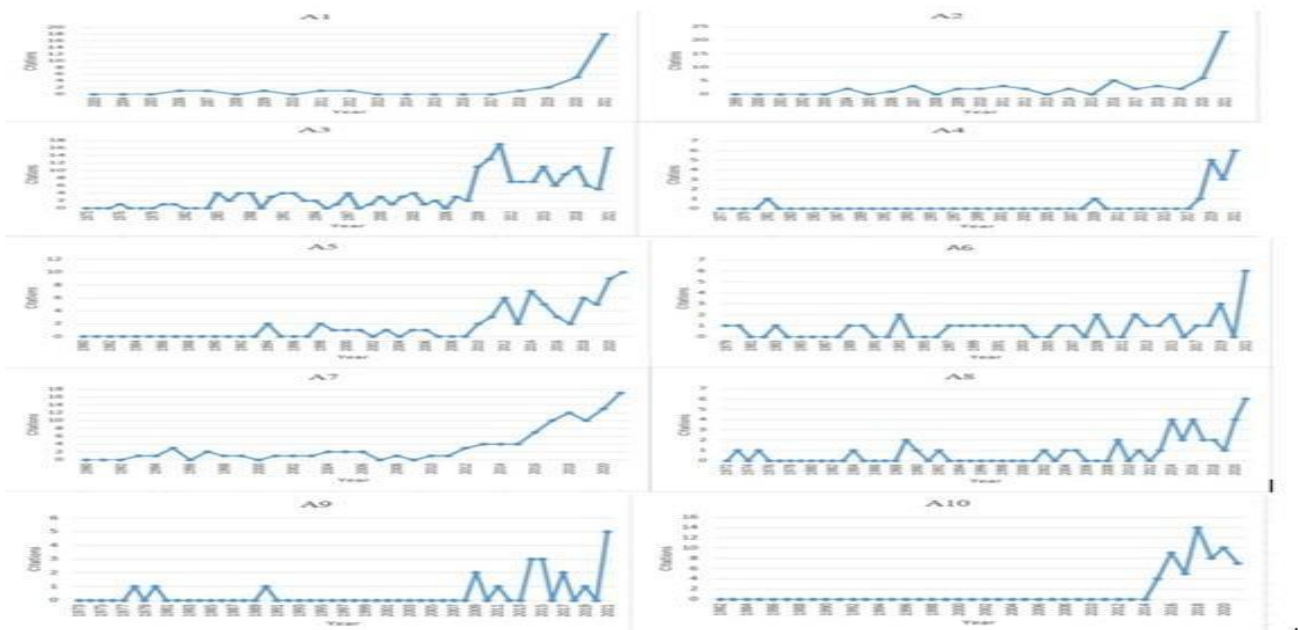


Figure 5: Number of citations to help ten documents with higher sleeping beauty

Overall, these papers received 31-105 citations from the beginning of publication to the year of awakening (i.e., 2021, 2018, and 2011). Papers A5 and A10 received the lowest citations in the first 10 years after publication. No citations were made to these two papers during this period. In contrast, most citations were made to the A7 paper in the first 10 years after its publication (i.e., 0.9 citations per annum). Paper A1 received only 13 citations between 2003 and 2020 and, therefore, has the highest sleeping beauty score.

Discussion

Identifying sleeping beauties is a special type of citation analysis and, in turn, a bibliometric method through which the works cited in published studies are evaluated to determine the patterns of scientific collaboration and evaluate scientific documents in a particular field (Kokol et al., 2017).

A review of the number of anatomical studies suggested that, for the studies published during 11 years (1970 to 2021), the number of citations suddenly rose in 1994, decreased in 2011 and 2012, and then increased once more. As with similar studies on medical sciences (Coelho et al., 2020), a review of the top 10 sleeping beauties showed that most of them had US affiliations. In line with other studies (Kokol et al., 2017; van Raan & Winnink, 2019), most of the journals publishing the top sleeping beauties had a high credibility and impact factor; out of 10 journals, three are in the top 10% (*Zoological Journal of the Linnean Society*, *Eye*, *Neurosurgery*) and one in the top 5% (*Plastic and Reconstructive Surgery*) based on their SNIP index, while nine journals have an impact factor > 2.

Furthermore, the top 10 sleeping beauties had an awake year after 2010, as noted in other studies (Coelho et al., 2020; van Raan & Winnink, 2019). This phenomenon is due to online databases and, consequently, easier search and retrieval of information resources than before, which has awakened sleeping beauties. One reason for the dormancy of papers in the past was the absence of online systems and databases, the paper nature of these papers, and the lack of centralized access to them.

Based on the B-Score of the top 10 papers, the number of studies that cite Sleeping Beauties is increasing over time, thus indicating the great popularity of the content of Sleeping Beauties, which is consistent with previous research (Coelho et al., 2020; Fazeli-Varzaneh et al., 2021; Kokol et al., 2017). Still, the level of popularity is lower in medical sciences than in other disciplines, and few studies have been conducted on this field in clinical sciences; the only example is the study by Coelho et al. (2020) to examine the trend of citations to sleeping beauties in ENT.

Conclusion

The present study investigated the number of documents and citations of papers in the field of anatomy and then identified the most critical sleeping beauties in this field, as well as their awake year and intensity. Like other methods of citation analysis and bibliometrics, identifying the citation patterns of sleeping beauties can help analyze researchers' scientific behavior and performance in scientific and research institutes, evaluate their career path, examine the evolution of the field, accelerate the recognition and detection of innovative processes; and identify innovative ideas. Due to the multitude of sleeping beauties in various disciplines, it is necessary to locate them in different scientific fields, especially medical sciences. In addition, since the findings of most sleeping beauties are beyond the scientific level and understanding

of their time, they should be used in scientific studies and research institutes to improve research and executive performance.

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