Where Does Stem Cell Research Stand in the 21st Century: Observation from the Standpoint of a Bibliometric Analysis

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Abstract: In this bibliometric study through the meticulous analysis of year and language wise distribution of publications, document type wise distribution of contributions, year wise citation analysis and country wise productivity in the field of stem cell research, an effort has been made to delineate a vibrant image of the present condition of stem cell research. Data have been collected from Scopus database for the purpose of the study. The study reflects that among the total 137937 publications on stem cell, the highest number of publications i.e. 11653 were published in 2016 and lowest number of publications i.e.1910 were published in 2001. In case of only India, 2017 was the highest productive year and 2001 was the lowest. Among the published documents mostly were in English language (124,745) and it is followed by Chinese language. Journal articles (99468) were the highest in number among different types of publications as nascent information on a subject mainly get reflected in journal articles. Researchers from USA top the list with 42,211 publications on stem cell in the whole world. The year 2008 has received maximum number of citations i.e. 333,921. Finally there is a significant negative correlation between time and growth of citation. From 2014 to 2018 the number of citations has been reduced in comparison to previous years. It also reflects that as it is a growing subject domain the new ideas are emerging everyday and the old ideas are slightly losing ways to give place to the new ones.

Keywords: Stem cell, Bibliometric analysis, Publication types, Geographical distribution, Pearson's correlation

Introduction

With the onward march of time biological science has achieved admirable height in the realm of research. A giant leap in cell biology and cell engineering research has been orchestrated through the transplantation of damaged cells in living bodies through stem cells. Now the obvious questions which torment our thoughts are what is a stem cell? What for stem cells are used and so on. The answer is very simple. A stem cell is a cell with the unique ability to develop into specialised cell types in the body. In the future they may be used to replace cells and tissues that have been damaged or lost due to disease. In the field of research stem cells are used to help people understand the basic biology of how living things work and what happens in different types of cell during disease. When it comes to the question of therapy, stem cells are used to replace lost or damaged cells which are either permanently damaged or lost by disease, injury and genetic conditions that our bodies can't replace naturally. (What is a stem cell, n.d.) In fighting with the most fatal disease of this present century i.e. cancer, stem cell therapy also has its impact. In 1949 scientist J. Hammond's experiment with mouse had broaden the path of stem cell research. . In developing therapies for hematological, cardiovascular, neurodegenerative and genetic diseases as well as cancer stem cell research has played a great role. (Cantos-Mateos, Vargas-Quesada, Chinchilla-Rodríguez & García, 2012)

To know the state of the art condition of a research domain bibliometric evaluation of that subject is the ultimate solution. Bibliometric analysis is a method for analyzing scientific production and is a tool for evaluating the quality of scientific production. (Ahmadi, Habibi, Sedghi, & Hosseini, 2014).

Bibliometrics are a range of quantitative measures that assess the impact of research outputs and complement qualitative indicators of research impact mainly to assess the quality and impact of research (University of Leeds, n.d.).

Massive growth in the field of stem cell research gets its flagrant reflection in the original outputs of the journals in this field. A specific subject area nowhere gets amore nascent information than a suitable journal in that specific field. Journals are always the primary sources of information and are the torchbearers of the growth of literature in different areas of knowledge (Pal & Sarkar, 2018). Along with journal articles, reviews, book chapters, conference papers, letters etc. also carry new ideas in a specific field.

In this bibliometric study through the panoramic analysis of year and language wise distribution of publications, document type wise distribution of contributions, year wise citation analysis and country wise productivity in the said field of research, a vibrant image of the present condition of stem cell research has been portrayed.

Literature Review

Cantos-Mateos, Vargas-Quesada, Chinchilla-Rodríguez & García (2012) in their bibliometric analysis of main research areas on stem cell through KeyWords Plus focused on a dual analysis of Spain´s scientific output in this field during the period 1997-2007. Their output is mainly concentrated in Cataluña and Madrid, and hospitals are the most productive centres which are followed by health institutes, where the main authors are affiliated. Main categories are Hematology, Oncology and Biophysics.

Ahmadi, Habibi, Sedghi, & Hosseini (2014) in their bibliometric analysis of stem cell publications in Iran tried to examine qualitative and quantitative states of stem cell research in Iran in order to extract information production patterns. The study showed that total number of Iranian stem cell articles and proceedings indexed in Web of Science until 2012 was 709. The highest frequency belonged to the multiple institution category. The highest citations per publication rate i.e. 29.7 belonged to the international articles written by the authors from other countries with Iranian co-authors.

Lin & Ho (2015) in their bibliometric analysis of publications on Pluripotent stem cell research had analyzed the publication trend, citation trends of top articles and distributions of journals. Five bibliometric indicators including total articles, independent articles, collaborative articles, first author articles, and corresponding author articles were applied to compare publications between countries and institutions. The impact of top articles changed from year to year. Top cited articles in previous publication years were not the same as recent years.

Objectives

The objectives of this study are to:

i. To represent the year-wise distribution of publications on stem cell worldwide as well as in India.
ii. To trace the language wise distribution of publications on stem cell.
iii. To show the document wise distribution of publications in this research domain.
iv. To delineate the country wise distribution of publications on the basis of author affiliations.
v. To reflect the chronological distribution of citations as well to represent the correlation between year and number of citations.

Scope and Limitation

  The study is restricted within a particular database, i.e. Scopus.com (Scopus, 2019). In this study the documents published on stem cell within 2001 to 2018 have been collected. Data have been collected between, April 1 to 5, 2019.

Methodology

To find out the objectives of this study a general bibliometric process has been used. As a registered user of Scopus database by using a search string **TITLE (stem cell) AND PUBYEAR > 2000 AND PUBYEAR < 2019** (Noruzi, 2017). Also by using another search string **TITLE (stem cell) AND PUBYEAR > 2000 AND (LIMITTO (AFFILCOUNTRY , "India"))** for affiliated country India, data have been retrieved on that specific domain. After retrieval, data have been collected and consolidated and then analysed keeping in view the objectives of the study. GunnMap (http://gunnmap.herokuapp.com/) tool has been used to delineate the country wise distribution of publications. Pearson's correlation formula has been used to represent the relationship between year and number of citations through R statistical software.

Data Analysis and Findings

        In the following few paragraphs retrieved data are presented and analysed through some tables and figures.

➢ *Year-wise distribution of publication*

 Year wise distribution of publications helps us to identify the research trends regarding the topic stem cell.
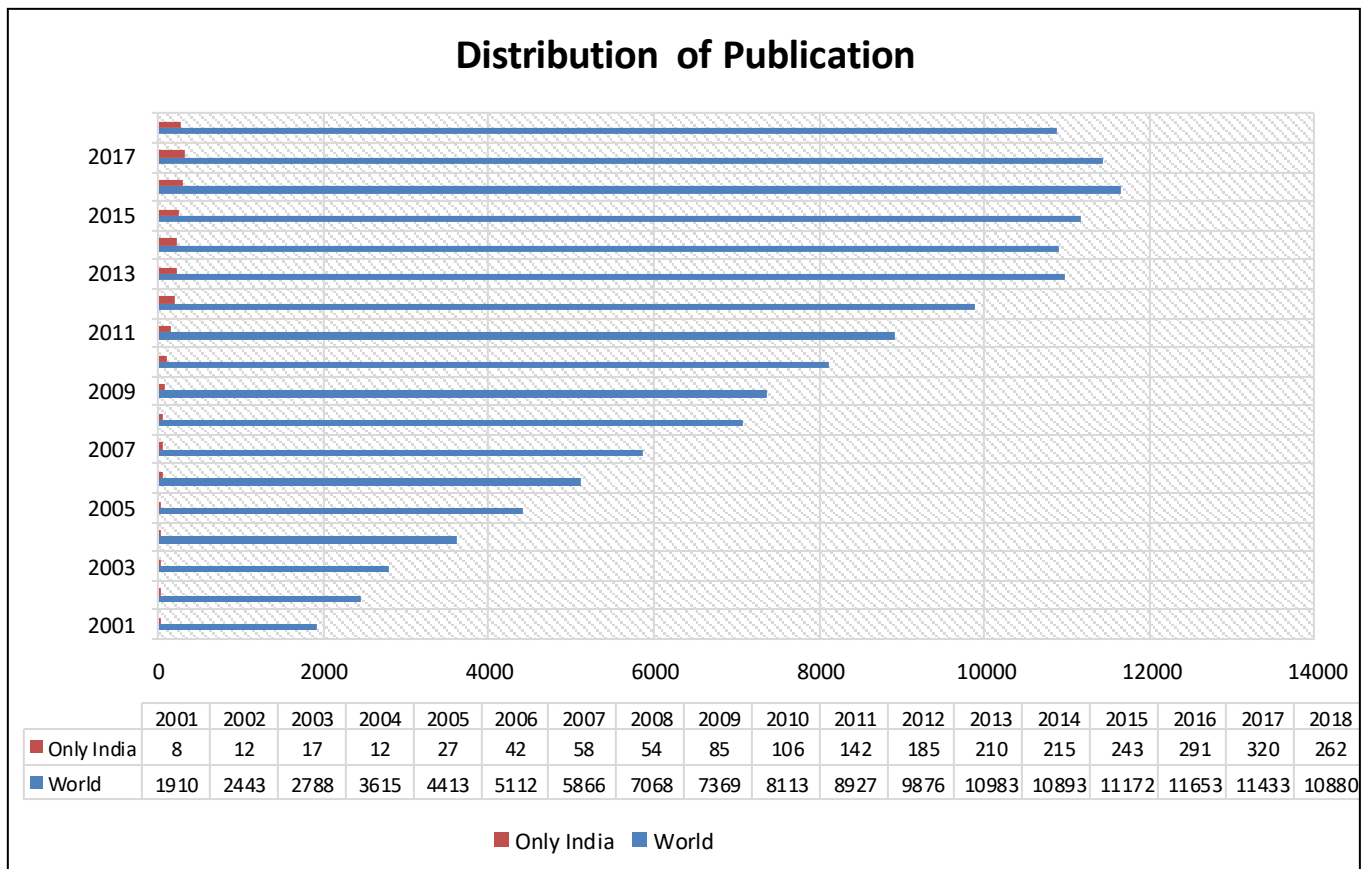
Distribution of Publication

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
■ Only India	8	12	17	12	27	42	58	54	85	106	142	185	210	215	243	291	320	262
■ World	1910	2443	2788	3615	4413	5112	5866	7068	7369	8113	8927	9876	10983	10893	11172	11653	11433	10880

■ Only India ■ World

Figure 1: Year-wise distribution of publication

As per this figure, total 137937 number of publications were identified in Scopus within the studied time period. Among the total 137937, the highest number of publications i.e. 11653 were published in 2016 and lowest number of publications i.e.1910 were published in 2001. In case of only India, total 2384 number of publications was identified and out of 2384 highest amount was in 2017 and the lowest in 2001.

> ➤ *Language wise distribution of publication*

Following Table-1 reveals the number of top ten languages of published documents on stem cell.

Table-1: Language (top ten) wise distribution of published documents

Language	Number	Language	Number
English	124,745	Russian	526
Chinese	9,113	Spanish	432
Japanese	927	Polish	271
French	732	Portuguese	224
German	727	Persian	144

From the above table it can be concluded that, among the published documents mostly were in English (124,745) and then it is followed by Chinese, Japanese, French, German, Russian, Spanish, Polish, Portuguese and Persian.

> *Document-type wise distribution of publication*

Following table (Table-2) shows the differences in document types on stem cell.

Table 2: Document type wise distribution of publications

Type of Document	Number	Type of Document	Number
Article	99468	Short survey	1805
Review	18274	Erratum	1776
Book chapter	4453	Article in Press	536
Conference paper	3696	Book	202
Letter	2921	Retracted	21
Note	2820	Conference review	3
Editorial	1962	**TOTAL**	**137937**

The table reflects that articles are maximum in number (99468). It is followed by reviews (18274) and book chapters (4453). Conference reviews are only 3 in number.

> *Country wise distribution of publication*

Following figure-2 portrays the distribution of 35 countries (on the basis of the authors' affiliations) those have more than 500 plus number of publications. Researchers from USA top

the list with 42,211 publications on stem cell in their works while China holds the 2nd position with 27,751 and Japan holds the 3rd rank with10,303 publications. Among the African countries only Egypt has some publications on this subject domain.
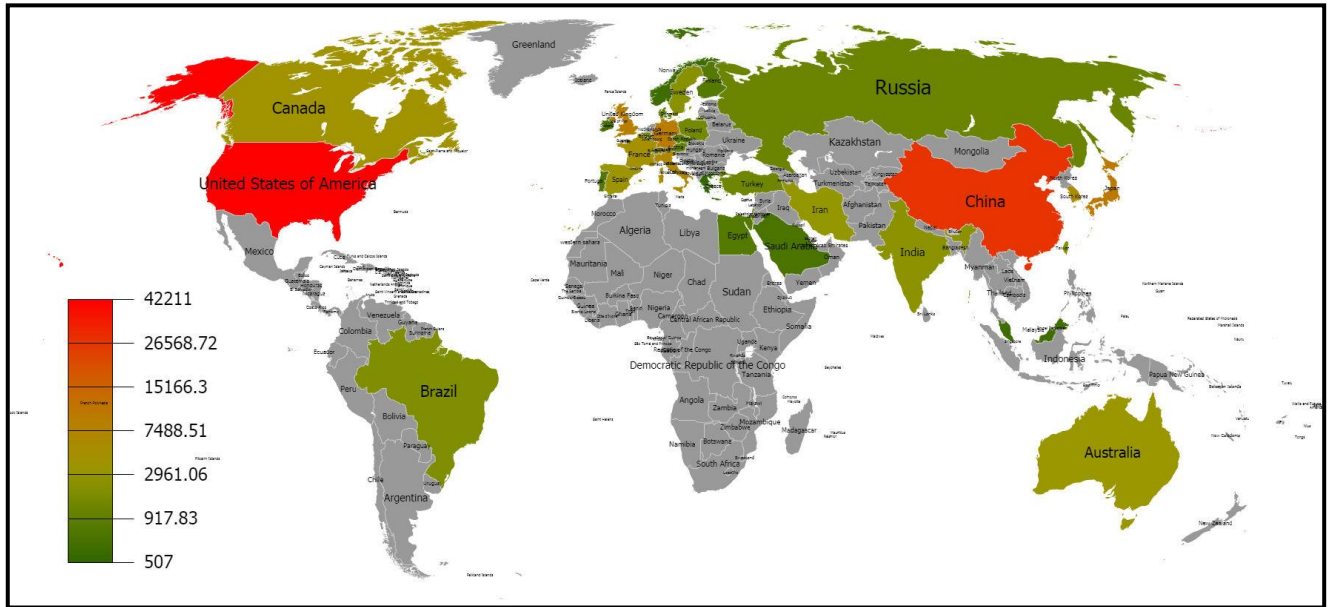

Figure-2: Heat map of countries with active research

(Grey: countries with less than 500 publications and/or no publications; Red: upper limit of publication and Olive Green: lower limit of publication on stem cell). *Tool*: GunnMap (http://gunnmap.herokuapp.com/)

➤ *Year wise distribution of citations*

Table-3: Chronological distribution of citations

Year	Number of Citation	Year	Number of Citation
2018	17511	2009	321896
2017	61090	2008	333921
2016	104724	2007	319853
2015	150829	2006	297677
2014	199671	2005	247878
2013	239124	2004	223492
2012	265699	2003	186160
2011	289463	2002	150806
2010	309929	2001	118097

The above table demonstrates that year 2008 has received maximum number of citations i.e. 333,921. Using Pearson correlation formula the relationship between year and number of citations can be tested. Pearson correlation is a test used to know the correlation (degree of association) between two variables. In this study correlation has been observed between time (year) and growth of citation (number of citation).

Pearson correlation as per R-Statistical Software:

> Year<- c (2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

> Citation<- c (118097, 150806, 186160, 223492, 247878, 297677, 319853, 333921, 321896, 309929, 289463, 265699, 239124, 199671, 150829, 104724, 61090, 17511)

>cor (Year, Citation, method="pearson")

[1] -0.3553382

There is a significant negative relationship between time and growth of citation. In this case Pearson's **r = -0.3553382**. Following figure also shows the negative correlation between two variables.
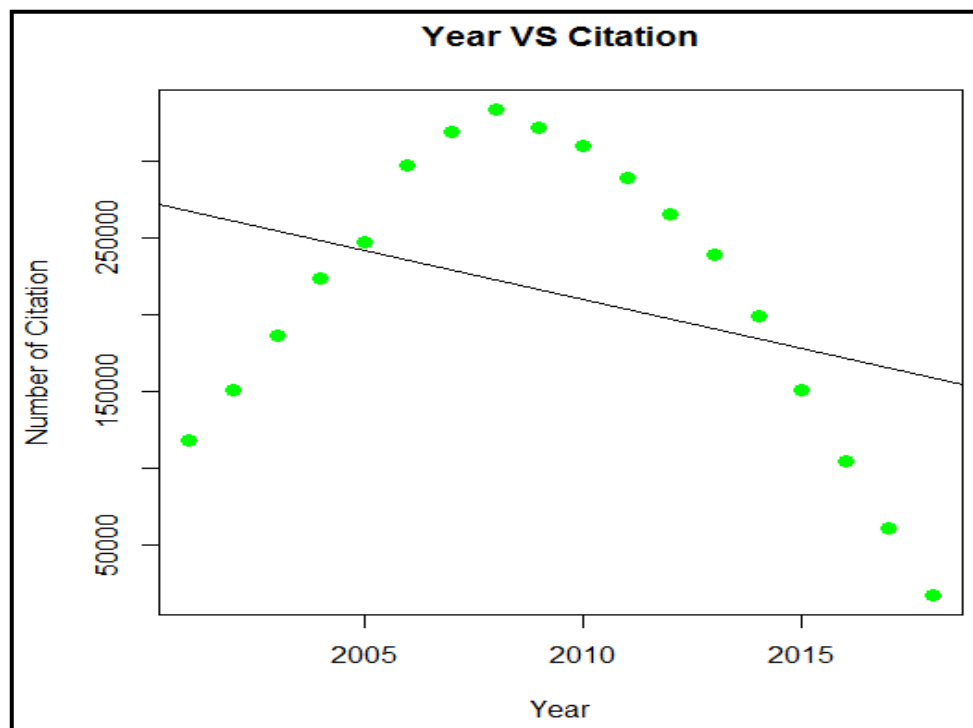

Figure- 3: Relationship between Year Vs Citation (Using R statistical software)

Conclusion

The above study reflects that among the total 137937 publications on stem cell, the highest number of publications i.e. 11653 were published in 2016 and lowest number of publications i.e.1910 were published in 2001. In case of only India, 2017 was the highest productive year and 2001 was the lowest. Among the published documents mostly were in English language (124,745) and it is followed by Chinese language. Journal articles (99468) were the highest in number among different types of publications as nascent information on a subject mainly get reflected in journal articles. Researchers from USA top the list with 42,211 publications on stem cell in the whole world. The year 2008 has received maximum number of citations i.e. 333,921. Finally there is a significant negative correlation between time and growth of citation. From 2014 to 2018 the number of citations has been reduced in comparison to previous years. It also reflects that as it is a growing subject domain the new ideas are emerging everyday and the old ideas are slightly losing ways to give place to the new ones.

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