

Factors Influencing the Citability of Stroke Articles: A Scientometric Study

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ABSTRACT

Achieving new findings in various scientific fields, including medicine plays an important role in improving health. Therefore, the present study aimed to identify the factors affecting the citation of scientific products in the field of stroke. The present study is an applied study that used scientometric methods to examine the status of articles in the field of stroke. The study population included 100 highly-cited articles and 100 lowly-cited articles indexed in the Scopus citation database during 1842-2018. Data analysis was done in SPSS 22 by regression analysis. The total scientific output of the world in the field of stroke includes 119,003 documents. Investigating the factors affecting the citability of articles showed that with increasing the number of authors, title length, abstract length, and article length, the number of citations also increases. The number of reference sources had no effect on the citation rate of articles. Among the studied variables, abstract length, article length, and the number of keywords had the ability to predict the citation rate.

Keywords: Stroke, Bibliometrics, Journal article, Co-word Analysis, Scientometrics.

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INTRODUCTION

Today's world is a world of change and transformation and these transformations have all led to new advances and innovations in all human fields, including medical sciences. Research in medical sciences and health is closely related to human health and quality of life. Given the costs of these studies and the expectations from them, i.e. helping to improve community health indicators, measuring research in the field is important for the medical education and research system.^[1] Despite advances in medical knowledge, one of the major challenges that remain a main public health problem is the issue of stroke, which in most countries is among the four leading causes of death and responsible for a large proportion of the burden of neurological disorders.^[2] Therefore, the research papers published in this field are very important because the results of this research will be effective in medical decisions, and on the other hand, dealing with scientific products in such a particular subject can result in scientific development in that field.^[3]

One of the ways to measure the development and progress of individual authors, research institutions and countries is

to evaluate their scientific products, especially products that have been published in reputable international sources and have been carefully peer-reviewed and evaluated. With the advent of scientometric indices since the late 1960s,^[4] these assessments have become more scientific, so that today the amount of grants provided to individual researchers or research institutions is determined by the scores they gain in terms of scientometric indices. In scientometric studies, not only the number of scientific productions is considered, but also citations are mentioned as the most important indicators showing the degree of scientific influence and impact of scientific works.

Citation can indicate the dynamics of scientific communication and affect the growth of science.^[5] However, paying attention only to the number of citations cannot indicate the qualitative status of the works, because some works, such as review articles, receive more citations due to their nature. A work may be cited solely because of a critique of the method or conclusion of that work.^[6] The researcher may also use the citation to confirm his or her claim, method or findings. Sources are sometimes cited to provide scholars' views or criticisms.^[7] Some articles are cited as good quality research.^[8] According to Garfield, about 20% of articles get more than 80% of citations, while other articles are either not mentioned at all or are rarely cited.^[9]

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Researchers believe that several factors and variables can affect the citation index. In studies, the impact of several factors on the amount of citations received has been investigated. Fox *et al.*^[10] found that longer articles, with more authors and more references were more cited. Although the extent of this positive impact through the article, the number of authors and its references varies, but the increase in each independently predicts an increase in citations received. This positive relationship can be seen in all the journals reviewed. Articles that offer more variety of data and ideas are also more effective and highly-impacted.^[10] Raeesi-ardal and Yaminfirooz 2018^[11] in a study of 200 highly cited and lowly-cited articles in the field of medicine showed that variables such as JIF, journal rank, journal subject quarter, *h*-index of first / corresponding author, number of documents produced by first / corresponding author, SJR and SNIP had a significant positive relationship with the citation rate of articles. Other variables such as article age, article type, number of references, number of authors, indexing databases and journal type had nothing to do with article citation rate.^[11]

Tahamtan *et al.* examined the factors affecting the number of citations. In this review, 198 articles retrieved from Medline, PubMed, and Scopus databases were analyzed. In this study, twenty-eight factors affecting the number of citations were identified. The researchers considered some factors such as the quality of the article, the impact factor of the journal, the number of authors and international cooperation as well as factors such as gender, age and race of authors, characteristics of results and discussion, as more determining factors in this regard.^[12]

Mushtaq and Malik^[13] analyzed the top 500 most cited articles in the field of chemical engineering. The results showed that there was no relationship between the number of keywords and the number of citations. The number of pages and the number of references in a publication have a significant and positive effect on the number of citations received.^[13] By evaluating the factors affecting the number of citations to clinical therapy articles, Beydokhti *et al* 2020,^[14] found a positive relationship of the number of citations with JIF, level of evidence, number of referred sources, number of authors, number of title words, article length, topic, study design type, geographical area of the authors, the type of journal and publisher prestige. Statistical tests predicted that JIF, level of evidence, number of references and number of authors were more effective than other factors in the number of citations received.^[14]

The study on stroke is increasing, but few scientometric studies have reported it from different perspectives. In general, knowing the factors that affect citation rate in a field can help researchers predict the amount of citations received.^[15] However, the factors that can potentially be at work in

research on stroke field, as one of the main considered fields in medical sciences, has not been studied yet. Therefore, this study aimed to identify the factors influencing the citation of scientific productions in the field of stroke. It can provide the basis for quality scientific productions in the field and a guide for authors and researchers for potentially receiving more citations.

MATERIALS AND METHODS

The study was an applied study with a scientometric approach that examined the citation status of articles in the field of stroke indexed in the Scopus database. In order to collect data, first the word Stroke was searched in the medical thesaurus, MESH and its equivalents were retrieved in the Entry Terms section (Table 1).

Extraction of articles has been done in three stages. In the first step, the obtained keywords were placed in the advanced search section of the Scopus database. The search strategy is as follows:

TITLE (Stroke OR Strokes OR Cerebrovascular Accident OR Cerebrovascular Accidents OR CVA OR CVAs OR Cerebrovascular poplexy OR Brain Vascular Accident OR Brain Vascular Accidents OR Cerebrovascular Stroke OR Cerebrovascular Strokes OR Apoplexy OR Cerebral Stroke OR Cerebral Strokes OR Acute Stroke OR Acute Strokes OR Acute Cerebrovascular Accident OR Acute Cerebrovascular Accidents OR Apoplexy, Cerebrovascular OR Vascular Accident, Brain OR Vascular Accidents, Brain OR Stroke, Cerebrovascular OR Strokes, Cerebrovascular OR Cerebrovascular Accident, Acute OR Stroke, Cerebral OR Strokes,

Table 1: Equivalent keywords of stroke in the Entry Terms section.

Stroke	Brain Vascular Accidents	Strokes, Cerebral
Strokes	Vascular Accidents, Brain	Stroke, Acute
Cerebrovascular Accident	Cerebrovascular Stroke	Acute Stroke
Cerebrovascular Accidents	Cerebrovascular Strokes	Acute Strokes
CVA (Cerebrovascular Accident)	Stroke, Cerebrovascular	Strokes, Acute
CVAs (Cerebrovascular Accident)	Strokes, Cerebrovascular	Cerebrovascular Accident, Acute
Cerebrovascular Apoplexy	Apoplexy	Acute Cerebrovascular Accident
Apoplexy, Cerebrovascular	Cerebral Stroke	Acute Cerebrovascular Accidents
Vascular Accident, Brain	Cerebral Strokes	Cerebrovascular Accidents, Acut
Brain Vascular Accident	Stroke, Cerebral	

Table 2: Frequencies of articles and citations.

Percentage of citations received	Number of citations received	Percentage of article number	Number of articles
80.8	2408780	20	23801
19.2	572916	80	95202
100	2981696	100	119003

Cerebral OR Stroke, Acute OR Strokes, Acute) AND PUBYEAR BEF 2019.

The search result contained 119,003 articles during 1842–2018. The results were sorted in the Sort section (according to top highly-cited papers) and the articles with the highest citations were extracted and saved as 2000-digit files in Excel software, and the items that were outside the scope of the research were excluded. Then one hundred articles above the list were selected as the study sample in the group of top highly-cited articles.

In the second stage, in order to apply Pareto law, all articles obtained from the search strategy from the View Citation Overview section were saved as 2000-digit files in Excel software.

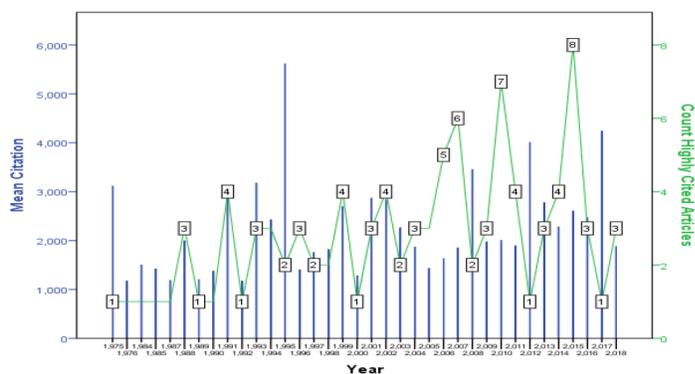
As can be seen in Table 2, 20% of the articles in this field were able to account for 80 % of the citations and 80% of the articles received only 19.2% citations. This result can be generalized to the Pareto principle.

In the third stage, according to the year of publication of 100 highly-cited articles, the other research group (lowly-cited articles) was selected from 80% of the articles that received 20% of citations. These articles were reviewed by an expert in this field and after being approval, they were extracted from the Scopus database. To extract these articles, the title of each search article and research-related variables were retrieved and stored in Excel software.

Data were analyzed using SPSS software and Mann-Whitney tests and regression coefficient were applied. The p -value was considered significant at the level of .05.

RESULTS

An initial search of the Scopus database yielded 119,003 documents in the field of stroke, starting with a document in 1842 and reaching 7.688 in 2018. After ranking the documents based on the number of citations and deleting irrelevant articles, 100 highly cited articles were selected. The first one was from 1975 with 3116 citations. The most cited article with 8561 citations dates back to 1995. Figure 1 shows the 100 most-cited articles in the field of stroke in different studied years. As can be seen, year 2015 included the largest number of highly-cited articles.

**Figure 1: Year-wise highly-cited Articles.****Table 3: Comparison of variables in two groups of articles (ones with high citation and ones with low citation).**

Variable	group	min	max	mean	SD	Z	p -value
Author number	High	1	441	25.46	49.48	-7.40	0.000
	low	1	26	4.68	3.48		
Title length	High	7	50	17.5	8.59	-3.98	0.000
	low	3	29	13.24	5.35		
Page number	High	2	458	32.43	74.23	-5.07	0.000
	low	1	55	8.28	6.37		
Abstract length	High	63	736	296.57	106.82	-6.07	0.000
	low	61	479	213.02	79.96		
Keyword number	High	0	9	1.67	2.66	-4.15	0.000
	low	0	9	3.18	2.52		
Reference number	High	2	2430	130.85	371.48	-1.18	0.236
	low	2	168	37.10	25.27		

Table 4: Model fitting results.

R	R Square	F	p -value
0.56	0.31	14.474	0.000

Table 3 shows the characteristics of research variables. Comparison of the average citations of the two groups based on the number of authors, title length, article length, abstract length and the number of keywords showed that there is a significant difference between the two citation groups ($p < 0.05$). Articles of the top citation group have more authors, long title and more pages and more words in their abstract. While examining the number of keywords, the result was the opposite, which means that in high citation articles, the average number of keywords is less than those in the lower citation group. Calculating the number of references of the articles indicates that there is no statistically significant difference between the two citation groups ($P > 0.05$).

Multiple regression analysis was used to predict the citation rate of articles. According to the test in Table 4, the value of F is equal to 14.474 and its probability is equal to 0.000 ($p < 0.05$). Therefore, the fitted regression model is significant.

The coefficient of determination was 0.31, which indicates that 31% of the changes that take place in the dependent variable, i.e. the number of citations, occur by the independent variables. In other words, the model is able to predict 31% of the citation rate. The relationship between the number of citations and research variables is presented in Figure 2.

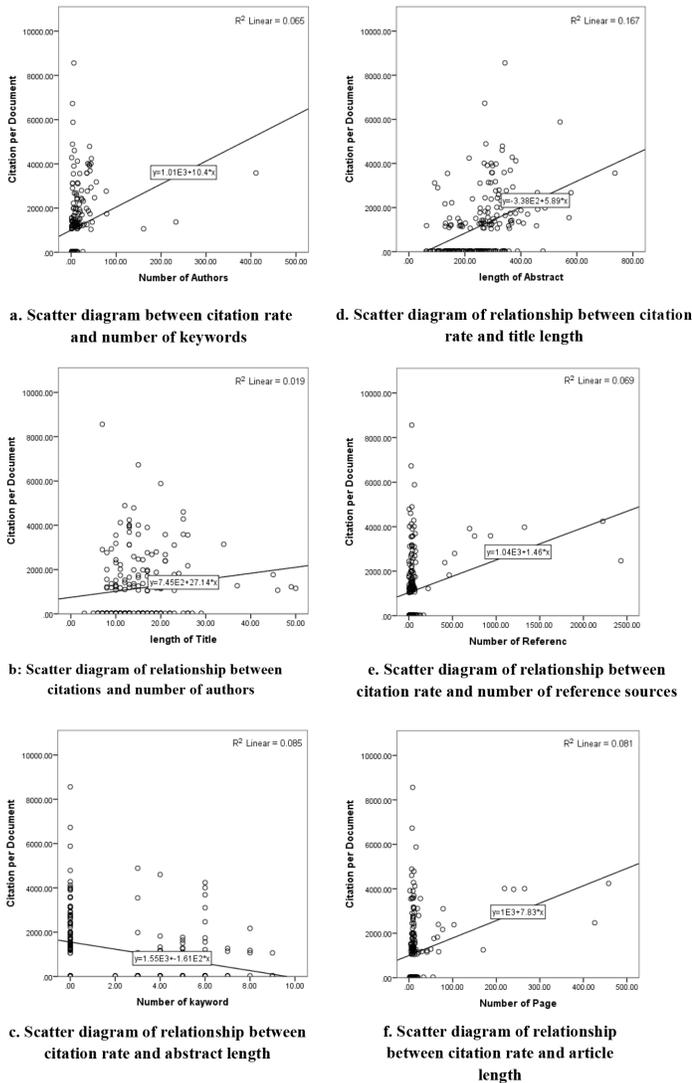


Figure 2: The scatter diagrams of relationship between the number of citations and research variables.

Table 5: Results related to regression coefficients for predicting the number of citations received by articles using research variables.

	B	Beta	t	Sig.
(Constant)	-13.37		-0.05	0.964
Author number	4.84	0.12	1.91	0.057
Title length	14.79	0.07	1.18	0.241
Page number	6.20	0.23	2.30	0.023
Abstract length	4.15	0.29	4.47	0.000
Keyword number	-137.75	-0.25	-3.91	0.000
Reference number	0.31	0.06	0.58	0.564

In Table 5, regression coefficients and significance test of each of the predicting variables were examined. As can be seen, the length of the abstract is the most important independent variable that can positively predict the number of citations to the articles ($p=.000$ and $\beta = .29$). The second independent variable is the number of keywords that negatively predicts the citation rate of the articles ($p= .000$ and $\beta = -.25$). The length of the article is positively (significant as the third variable predicting the number of citations received ($p= .023$ and Beta = .23). However, the number of authors, the length of the title and the number of references have no significant effect on the model ($p>0.05$).

DISCUSSION

Findings showed that the amount of scientific production in the field of stroke based on the documents indexed in Scopus databases was in increasing trend during the years under study (1842–2018) so that starting from a document in 1842 and in 2018 reached 7968 documents. A total of 119,003 documents in this field are indexed in the Scopus database.

Scientific documents are intermediaries through which researchers share their ideas and findings, and citation determines the quality of published document. In fact, citation rate is one of the tools to measure the productivity of research, which can be influenced by several factors.

One of the effective factors in citing articles is the number of authors. Since the research of several authors is the result of the co-operation and consensus of a group of people, it usually offers higher quality and more important content and has more value and credibility.^[16] On the other hand, the number of authors of an article is a criterion for showing the level of scientific cooperation. In this case, if the scientific cooperation includes the international participation of authors or several different disciplines, it can cause more visibility and impact of scientific productions. The present study shows that the average number of authors in high citation articles is higher than that of the low citation group and there is a significant relationship between the number of authors and the citation rate of articles.

In general, there is an average relationship between the number of authors and citations. Therefore, the greater the number of authors of the article, the more likely it is to be cited. This result is also found in previous studies^[10,12,14–15,17] although in some results this relationship is weak.^[18] Faizabadi *et al.*^[19] and Yaminfirooz and Raesi-Ardali^[11] did not find a relationship between the number of authors and the amount of citation of articles.

The length of the title is one of the factors affecting the number of citations. The title is the most important element of any scientific production and the main reminder of its

subject. Choosing good words in the title not only indicates clearly the content of the text, but also plays an effective role in document retrieval. For this reason, among the hundreds of articles that are published each year in each discipline and compete for readability, the title plays an important role in article marketing.^[20] The title is the first entity that comes to the reader, so it can play an important role in attracting citations. Examining the relationship between article title length and citation rate shows that the average number of title words in the group of high citation articles is more than the low citation group and there is a significantly positive relationship in this regard.

The present study showed that the length of the title is accepted to some extent and more than that, the citation may be reduced. According to the findings, the title length of less than 40 words is associated with an increase in citations and more than this number, reduces citations by half. In this regard, a number of studies have shown that the length of the article title is one of the factors increasing the number of citations.^[14-15] In a study conducted by Feyzabadi *et al.* In medical review articles, the length of the title had no effect on the number of citations.^[19] By examining 28 factors influencing the citation rate, Tahman *et al.*, introduced the length of the title as one of the least effective factors in attracting citations.^[12] Guo *et al* 2018.^[21] also claimed that online searches had a direct relationship between the length of the title and the number of citations, so that the results of their study showed that the correlation between the title and the number of citations received by a document was negative between 1956 and 2000, but after 2000, with the advent of online search, this relationship became positive.

One of the predictors of citation in scientific documents is the length of the article. The longer the article, the more content it has and the more likely it is to be seen and cited. In the present study, there is a significant relationship between the length of the article and the amount of citations it received. But how many pages can be more interesting to researchers is not predictable. Findings of previous studies in various fields also emphasize the relationship between citation and the length of the article and consider more detailed content and greater variety of data and ideas as reasons for attracting citations in these articles.^[12,15,22]

Fox *et al.*^[10] argue that merely lengthening articles seem not to be effective in citation and believe that increasing the length of an article without simultaneously increasing the quality of scientific content will have a negative effect. In this research, the rules of journals about the length of the article are also considered. In fact, the priority in some journals is short and concise articles. Therefore, the length of the article is also affected by other factors. In their study, Feyzabadi *et al.* showed with different findings that the length of the article

did not play a role in attracting citations of medical review articles.^[19]

Another factor influencing the number of citations received is the length of the abstract. The abstract is in fact the extract of the article and then as the second title that is presented to the reader. Therefore, the amount of information that the abstract provides to readers is important. The more and more interesting this section is, the more effective it is in the reader's decision to use the article. The number of views of the abstract is one of the characteristics that can be considered in publications. Some articles, despite having a large number of views of their abstracts, have low downloads. Therefore, not only the length of the abstract but also the use of explicit phrases in them can provide a complete and accurate understanding of the article. The present study showed that there is a significant relationship between the length of the abstract and the number of citations received and the abstracts of the articles in the top citation group have a higher mean than the abstract in the low citation group. However, no regular trend was observed between the length of the abstract and the number of citations. Therefore, it is not possible to say with certainty what length of the abstract is most important to researchers. In general, articles with more than 500 words in their abstracts also have a higher citation average. Falagas *et al* 2013.^[15] and Tahman *et al* 2016.^[12] have reached similar results, namely the importance of increasing the length of the abstract in increasing the number of citations. They also argue that because articles with long abstracts are rich in data or ideas and point to more cues in the content of the article, it is likely to interest the reader.^[15] However, Feyzabadi *et al.*^[19] considered the length of the abstract to be ineffective in the number of received citations.

One of the most important principles in scientific research is the principles of writing keywords. Keywords form the basis of indexing and abstracting, and are the bridges between textual content and users and provide easy access to the text. Keywords are selected from parts of the article that describe the content of the work in a very simple and concise format.^[20] Therefore, choosing the right keywords plays a role in better introducing the content of the text and increases the possibility of citations. An examination of the number of keywords in the present study indicates that half of the articles were written without keywords. About 70% of the top citation articles were without keywords. In other articles, fewer keywords have been considered. Also, examining the relationship between the number of keywords and the amount of citations shows an inverse relationship between these two variables and the average number of keywords in high citation articles is less than those in low citation articles. These findings are in line with the results of other studies^[13,19] that have been conducted in various subject areas. In these studies, there was

no relationship between the number of keywords and the number of citations. Tahman^[12] has considered the keyword to be effective in attracting citations; however, this factor is one of the less effective factors.

Number of references are among the factors affecting the citation of articles. One of the most important tasks of researchers after choosing a topic is to search for different sources and gather information, because the information resources in a research is a sign of its validity. The more different parts of it are documented, the stronger the scientific support will be. Therefore, the more accurate and diverse the selection of sources, the greater the value and credibility of the research will be.^[23] In this study, the number of references and its effect on the number of citations were evaluated. The results showed that the mean number of references in the two citation groups did not differ significantly. The research findings of Yaminfirooz and Raisi-Ardali^[11] also confirm this point. In previous researches,^[10,13,14,19,24] the relationship between citation and the number of references has been emphasized. Inodera and Yoshikan^[18] considered the number of references as the most important predictor of citations. Referring to various researches, Tahman^[12] considered the characteristics of being new (although not very newly-published) and the international nature of the references as effective in the amount of citations received.

We considered some affecting factors in receiving citation by articles on stroke. However, scholar reputation and publication quality could also be important features affecting the citation impact that need to be studied in future studies. Future studies need to be conducted for identifying other affecting factors in citability as noted by some researchers in scientific fields.^[25]

Research has long been considered as one of the important axes of development. If there is no research, human knowledge will be stagnant. Today, due to the rapid growth of information and rapid scientific progress, quantitative and qualitative evaluation of scientific products is inevitable in order to show their function in each of the scientific fields. In recent years, experts use scientometric indicators to measure scientific activities in various fields. One of these important indicators is the amount of citations received by scientific products. Given the importance of research in the field of health and its significant role in promoting health and development indicators, researchers in the present study examined the factors affecting the citation of scientific products in the field of stroke.

CONCLUSION

The study of the factors affecting the citation of articles showed that with increasing the number of authors, the length of the title, the length of the abstract and the length

of the article, the number of citations also increases. Also, the number of reference did not affect the citation rate of articles. Meanwhile, the number of keywords not only does not play a role in receiving citations, but also has a negative effect. Also, the identification of predictor variables showed that the length of the abstract, the length of the article and the number of keywords used have the ability to predict the number of citations received.

In general, in the present study, we have witnessed the increasing growth of scientific productions in this field. Therefore, researchers need to identify the factors affecting the citation rate of scientific products, choose the most appropriate references in their research and take into account these factors to write their papers so that they can better and more widely share their findings.

Like other scientometric research, this study has some limitation regarding database used for data collection. The scientometric analyses are all limited to data derived from the related databases, including Scopus.

instructions were instrumental in bringing this project to a successful conclusion.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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