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The Twitter Factor: How Does Twitter Impact #Stroke Journals and Articles?

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Title: The Twitter Factor: How Does Twitter Impact #Stroke Journals and Articles?

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This is a Master Thesis in scientific article format written abiding the norms of publication of Stroke and the directives of the Faculty of Medicine of Coimbra University.

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Abstract

Background and Purpose

The number of medical journals that use social media to disseminate their articles has been growing. One of the social media most used in the medical literature is the microblogging site Twitter. The aim of this study was to analyze the presence of stroke journals on Twitter and verify how its use influences the impact factor (IF) of these journals and the citation rates of stroke articles.

Methods

We queried Journal Citation Reports (JCR) for journals whose title included “cerebrovascular” and/or “stroke” and we identified their Twitter profiles. Using JCR, we collected the 10 most cited articles in 2020 from each journal present on Twitter. Through Twitonomy software, we analyze Twitter profiles for over one year. We recorded the Social Authority score of each journal. We collected Altmetric Attention Scores and data about the Twitter activity of each article with Altmetric software. Statistical analyzes were performed to identify associations between Twitter activity and the IF of journals or the number of citations of the articles.

Results

Of the 10 stroke-dedicated journals we found, four (40%) have dedicated Twitter profiles. We found a very strong correlation between 2020 IF and the number of followers, the number of tweets, the number of retweeted tweets, the number of articles with a link to an article, and the number of years the journal has been active on Twitter, although not statically significant. The number of citations of the top ten most cited articles in each journal is associated with the number of tweets ($r^2=0.986$, ρ 0.731, $p<0.001$), the number of tweeters ($r^2=0.989$, $\rho=0.725$, $p<0.001$), and the potential reach ($r^2= 0.989$, $\rho=0.721$, $p<0.001$). We found an increase in citations of 0.67 (95% CI 0.65-0.70, $\beta = 0.993$, $p<0.001$ for every tweet and an increase in citations of 0.78 (95% CI 0.76-0.81, $\beta = 0.995$, $p<0.001$) for every tweeter.

Conclusions

A higher engagement on Twitter seems to contribute to a higher IF for journals and an increase in citation rates for articles in Stroke Medicine.

Resumo

Introdução

O número de jornais médicos que utilizam as redes sociais para divulgar os seus artigos tem vindo a aumentar. Uma das redes socais mais utilizadas na literatura médica é o site de *microblogging* Twitter. O objetivo deste estudo passou por analisar a presença de jornais dedicados ao Acidente Vascular Cerebral (AVC) no Twitter e verificar como a sua utilização influencia o fator de impacto destes jornais e o número de citações de artigos sobre AVC.

Métodos

Consultamos o JCR em busca de revistas cujo título incluísse “cerebrovascular” e / ou “stroke” e identificamos os seus perfis no Twitter. Usando o JCR, registamos os 10 artigos mais citados em 2020 de cada revista com conta no Twitter. Através do software Twitonomy, analisamos os perfis do Twitter por um período de um ano. Registamos o *Social Authority Score* de cada jornal. Recolhemos os *Altmetric Attention Scores* e dados sobre a atividade no Twitter de cada artigo através do software Altmetric. Análises estatísticas foram realizadas para identificar associações entre a atividade do Twitter e os fatores de impacto das revistas ou número de citações dos artigos.

Resultados

Das 10 revistas dedicadas ao AVC que encontrámos, quatro (40%) tinham perfis próprios no Twitter. Encontramos uma correlação muito forte entre o fator de impacto de 2020 e o número de seguidores, o número de tweets, o número de retweeted tweets, o número de artigos com um link para um artigo e o número de anos há que o jornal está ativo no Twitter, embora não seja estatisticamente significativa. O número de citações dos 10 artigos mais citados de cada revista está associado ao número de tweets ($r2 = 0,986$, ρ 0,731, $p < 0,001$), o número de tweeters ($r2 = 0,989$, $\rho = 0,725$, $p < 0,001$) e o alcance potencial ($r2 = 0,989$, $\rho = 0,721$, $p < 0,001$). Encontramos um aumento nas citações de 0,67 (IC 95% 0,65-0,70, $\beta = 0,993$, $p < 0,001$) por cada tweet e um aumento de 0,78 (IC 95% 0,76-0,81, $\beta = 0,995$, $p < 0,001$) nas citações por cada tweeter.

Conclusão

A divulgação científica no Twitter parece contribuir para um maior fator de impacto das revistas e para um aumento do número de citações dos artigos em *Stroke Medicine*.

Keywords: Cerebrovascular disorder; Journal Impact Factor; Social Media; Stroke

Subject Terms: Cerebrovascular Disease, Ischemic Stroke, Thrombosis, Digital Health

Word Count: 4616

Introduction

Twitter was created in 2006 and its primary goal is to allow users to share their ideas and thoughts, with a limit of 280 characters per post. It has about 186 million active users and 500 million new tweets daily. (1)(2) The meaning of some terms most commonly used on Twitter is displayed in table 1. More recently, Twitter has been used by health professionals as a tool for discovering, disseminating, and discussing scientific publications, cultivating, and facilitating networking. More and more scientific journals are joining Twitter, namely in the area of cerebrovascular diseases, disseminating their articles and evaluating their impact on this and other social media. (3) Thus, although academic journals are mostly rated according to their IF, social media metrics, known as altmetrics, are increasingly crucial for journals and authors.

Previous studies in different fields of medicine have already addressed the influence of social media and, specifically, of Twitter activity on articles citations and journal IF, with some contradictory results. A study that included Plastic Surgery journals showed that the presence of a Twitter profile and the number of followers was not associated with a higher IF for the journal. However, since joining Twitter, five of the six journals with Twitter profiles experienced an increase in their IF. (4) Other studies involving Pediatric Urology, Trauma and Orthopedic Surgery and Urology journals revealed that the presence of a Twitter profile was associated with a higher IF.(5)(6)(7) Coret M et al. concluded that having a Twitter account, in and of itself, does not seem to increase a researcher's h-index of thoracic surgeons. Nevertheless, for surgeons who have a Twitter account, being engaged in more Twitter activity appears to be associated with a higher h-index. (8)

Despite the large volume of scientific publications in the field of cerebrovascular diseases, such as stroke, the importance of social media in disseminating information in this area is still poorly studied. It is known that stroke trainees can gain significant educational, professional, and academic benefits from engaging with social media. (3) It is also known that the #stroke hashtag is widely used on Twitter, mainly in discussions between stroke support groups and non-healthcare-related individuals. (9) However, to our knowledge, there are no studies that assess the relationship between Twitter and traditional journal and article metrics.

The aim of this study is to verify the prevalence of stroke journals on Twitter, assess whether the IF is positively associated with the Twitter activity of stroke journals, and analyze the relationship between Twitter activity and citation rates of stroke articles.

Table 1 Definition of Twitter terms.

Twitter Term	Definition
Tweet	A message posted on Twitter containing text, photos, a GIF, and/or video.
Tweeter	A person who posts on Twitter.
Retweet	A tweet that has been written by one Twitter user and republished by another.
Like	A way of showing that you literally like the content posted by another user. On Twitter, a Like is indicated by a heart.
Follower	A user who follows or subscribes to another user's Twitter account.
Following	Subscribing to an account as a follower.
Potential reach	The number of individual Twitter users who may have seen a particular tweet.

Methods

In Journal Citation Reports (JCR) ®, we applied the category "Neurology" and selected the indexed journals whose name included "stroke" and/or "cerebrovascular". We recorded its IF each year, from 2009 or its inception until 2020. To identify the Twitter profile of each journal, we ran a query on the Twitter search engine (http://www.twitter.com) and searched on each journal's official website. Journals with an affiliated society Twitter profile were not included in the analysis. Through JCR, we collected the title and the number of citations of the 10 most cited articles in 2020 from each journal with a Twitter account.

We analyzed the Twitter profile of each journal through Twitonomy® (https://www.twitonomy.com/). Twitonomy is a social media analytics software that allows users to monitor and collect data about the activity of Twitter accounts. This tool has already been used in other studies. (10) The data collected through Twitonomy included the Twitter account creation date, the total number of tweets, the number of followers, the number of accounts followed (following), and the followers/following ratio. The following data were collected over one year, from January 2020 to December 2020, also through Twitonomy: the number of tweets published, the number of tweets per day, the number of times the journal username was mentioned, the number of tweets with a link, the number of tweets published that were retweeted and favorited, the total number of retweets and favorites, the number of hashtags and the most used hashtags. Analyzing each tweet individually, we counted the

number of tweets posted in 2020 with a link to an article published by the journal. We also checked which journals had a link to their official website on their Twitter profile.

To better understand the influence of these journals on social media, we collected the Social Authority Score for each one, which is a measure of engagement and influence, provided by the Twitter analytics tool named Followerwonk (https://followerwonk.com/). It is a 1 to 100 point scale and is based on the retweet rate of users' last few hundred tweets, the recency of those tweets, and a retweet-based trained model on user profile data. (11)

We used the Altmetric online analysis software (https://www.altmetric.com/), through which we obtained the Altmetric Attention Score (AAS) of the most cited articles and the mean AAS of the articles of each journal. AAS refers to the weighted count of the amount of attention that an article receives from several sources (for example, the number of mentions in social media, news outlets, and blogs), that are represented in a so-called “donut” (Fig.1). Through Almetric, for each article we also collected the number of mentions in tweets, the number of tweeters, the percentage of tweeters who are practitioners (doctors, other healthcare professionals), the potential reach, and the total number of citations.

All data were recorded between the 22nd and 24th of September 2021.

We performed a descriptive analysis of the data collected. Then, we carried out a linear regression and bivariate correlation analysis between the IF or the number of citations of the journals and articles respectively, and the social media metrics depicted above. We assessed multicollinearity through a variance inflation factor analysis. Statistical analyzes were performed using IBM SPSS Statistics 26.0 ®.

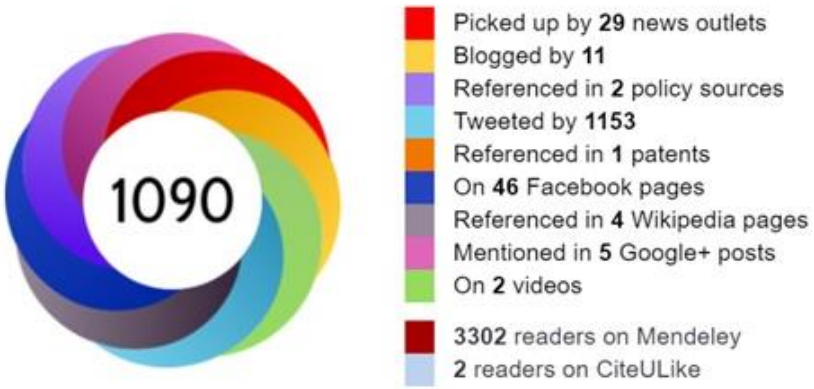

Figure 1 Illustrative donut of the article “2018 Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association”.

Results

We found a total of 10 stroke-dedicated journals (Fig.2), whose mean (SD) 2020 IF was 4.76 (± 2.32). Only four (40%) of these journals (Fig.2) (Table 2) have their own Twitter profile and all have a link to it on their website. The mean (SD) IF when they joined Twitter was 3.46 (± 2.04), while the mean IF in 2020 was 4.85 (± 2.42) (p=0.127). 2020 mean IF for journals without Twitter was 4.67 (± 2.59) while journals with Twitter was 4.85 (±2.42) (p=0.922). Figure 3 shows the evolution of the IF of all journals over the last few years.

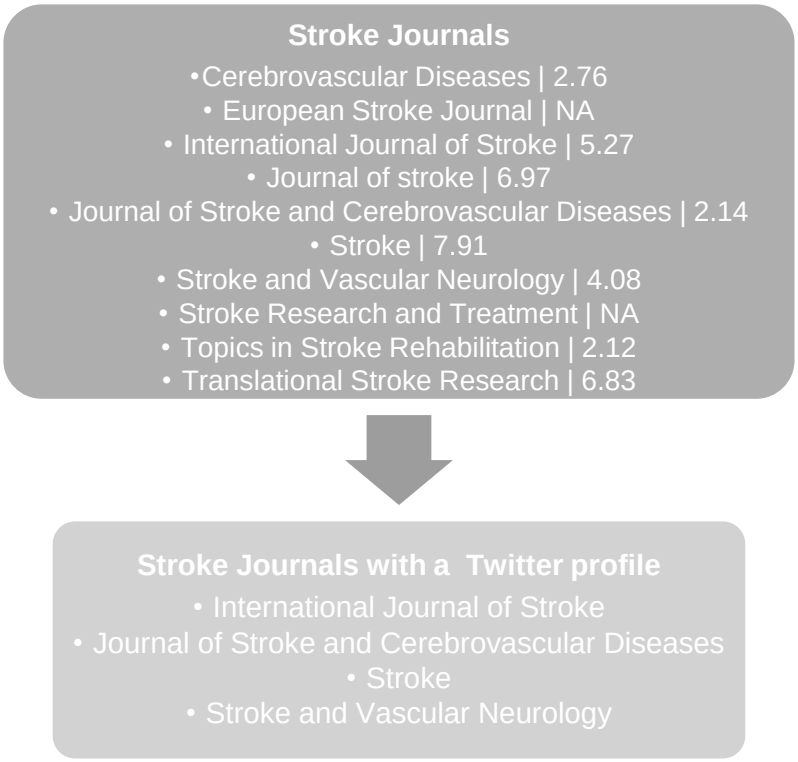

Figure 2 Stroke journals identified in JCR and the respective 2020 IF, followed by those with a Twitter profile.

Table 2 The IF, mean AAS, Social Authority Score, and Twitter data for the 4 stroke journals with a Twitter profile

Journal Name	Twitter Handle	2020 IF	IF at Time of Joining Twitter	Followers	Tweets	Tweets in 2020	Tweets with an article in 2020	Retweeted tweets in 2020	Mean AAS	Social Authority Score
International Journal of Stroke	@IntJStroke	5.27	2.87	11026	10001	1535	349	445	8.5	49
Journal of Stroke and Cerebrovascular Diseases	@JSCVD2	2.14	1.79	764	171	46	28	14	2.7	43
Stroke	@StrokeAHA_ASA	7.91	5.73	20304	16697	1511	571	581	14	65
Stroke and Vascular Neurology	@SVN_BMJ	4.08	NA	48	65	6	0	1	6.7	1

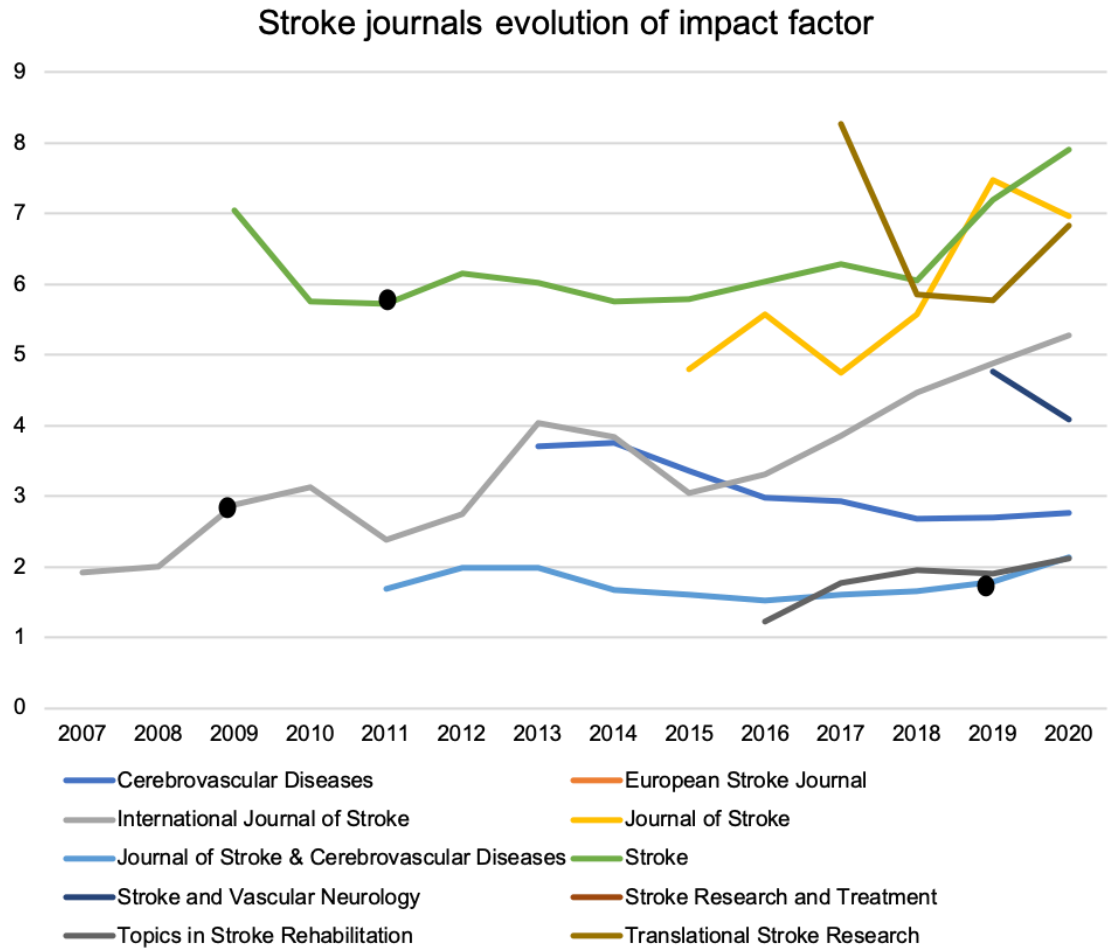

Figure 3 Evolution of the IF of stroke journals

The mean age of Twitter profiles was 7.63 ± 4.37 (range, 2.42 to 12.38), and the first journal joining Twitter was the International Journal of Stroke in 2008. The average number of followers and tweets was respectively 8035.50 ± 9593.99 (range, 48 to 20304) and 6733.50 ± 8113.43 (range, 65 to 16697). The journal with the most followers and tweets was Stroke, followed by International Journal of Stroke. The mean Social Authority score was 39.50 ± 27.29 (range, 1.00 to 65.00), with the highest value belonging to Stroke.

Regarding the AAS, the average value of journals without a Twitter profile and with a Twitter profile was, respectively, 4.42 (± 3.44) and 7.98 (± 4.69) (p=0.233). The journal with the highest mean AAS is Stroke.

In figure 4 we present the hashtags most used by the journals in their Twitter posts.

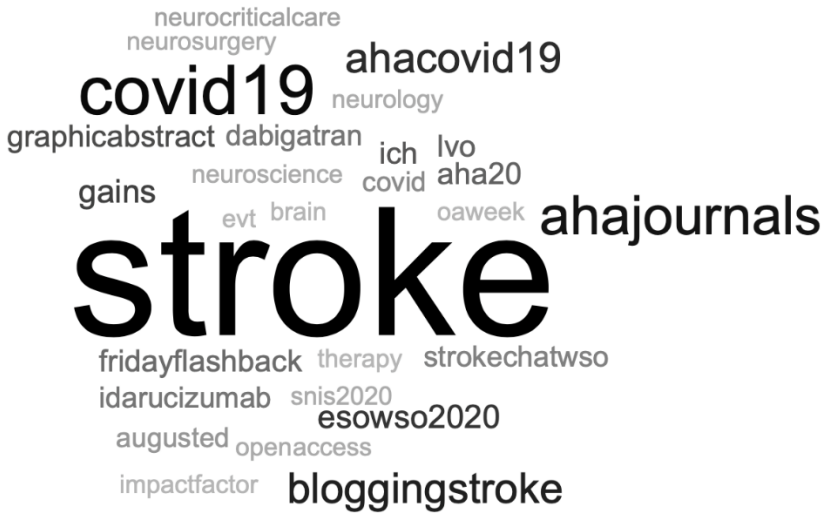

Figure 4 Most used hashtags by stroke journals in 2020

Impact factor and Twitter activity

We found a very strong and linear but statistically non-significant correlation between 2020 IF and the number of followers (ρ=0.8, r2=0.866, p=0.07) (Fig.5A), the number of tweets (ρ=0.8, r2=0.869, p=0.07) (Fig.5B), the number of retweeted tweets (ρ=0.8, r2=0.801, p=0.105) (Fig.5C), the number of articles with a link to an article (ρ=0.8, r2=0.682, p=0.17) and the number of years the journal has been active on Twitter (ρ=0.8, r2=0.577, p=0.240). The same was found for the Social Authority Score (ρ=0.8, r2=0.267, p=0.34) (Fig.6B). A weaker association was found between IF and the number of accounts followed (ρ=0.6, p=0.4, r2=0.290, p=0.462).

Similarly, a strong linear correlation was observed between the IF and the AAS (ρ=0.738, r2= 431, p=0.051) (Fig.6A). The Social authority Score does also correlate very strongly with the AAS (ρ=0.8, r2=0.243, p=0.655).

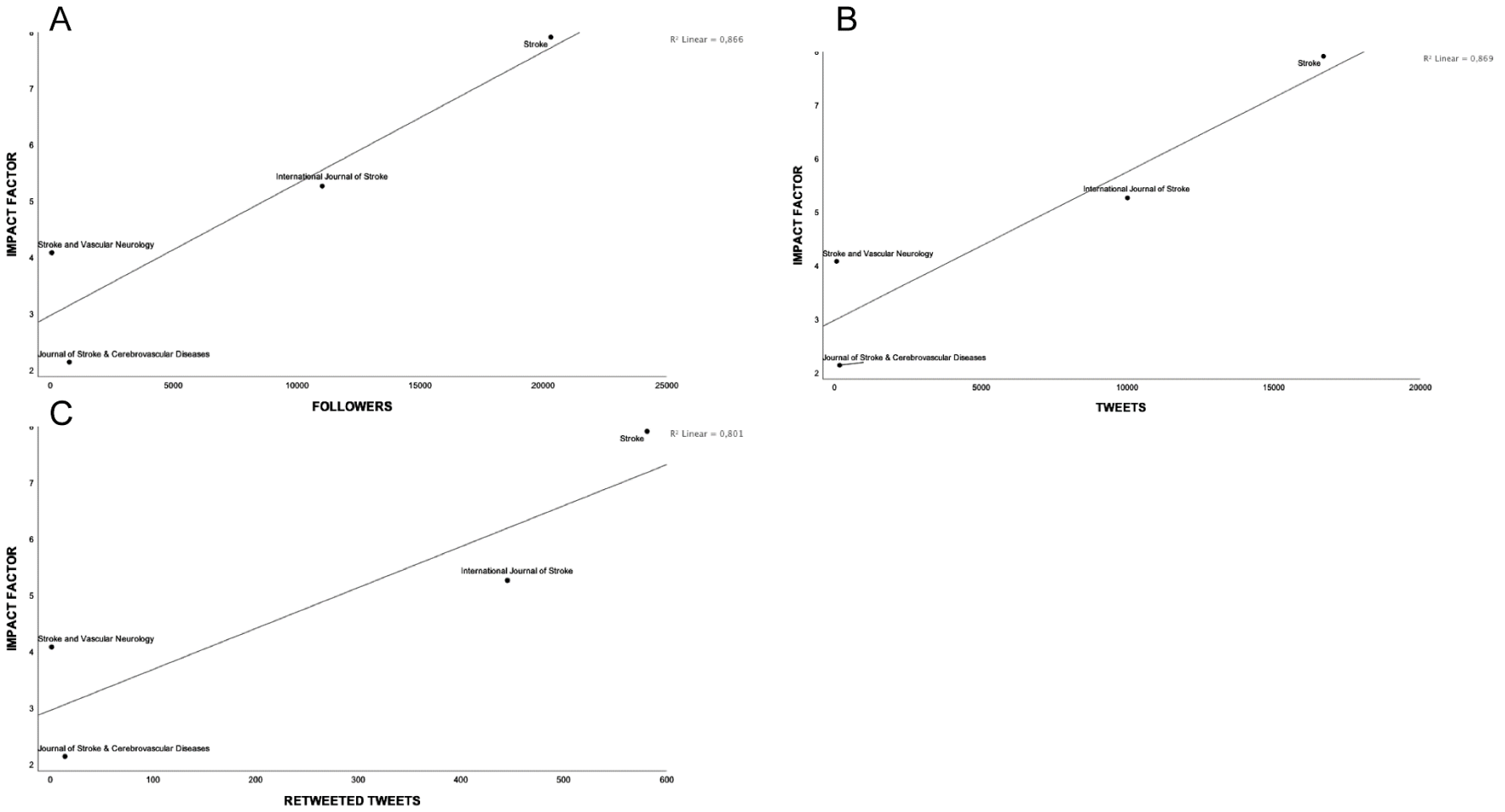

Figure 5 Correlation between IF and the number of followers, tweets, or retweeted tweets

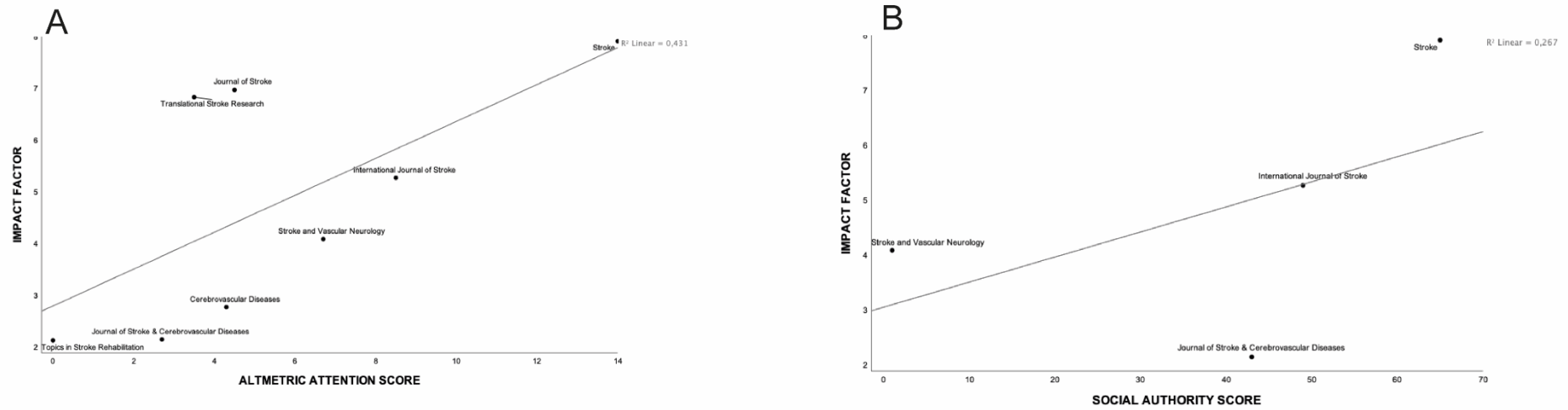

Figure 6 Correlation between IF and the AAS or Social Authority Score

Number of citations and Twitter activity

Concerning the most cited articles in 2020 from each journal with a Twitter account, we found that the mean (SD) number of citations was 54.90 (± 150.67) (range, 7 to 914). Only 11 out of 40 most cited articles had no Twitter activity and 8 articles had null AAS.

The number of citations is influenced by the number of tweets (r2=0.986, ρ 0.731, p<0.001) (Fig.7A), the number of tweeters (r2=0.989, ρ=0.725, P<0.001) (Fig.7B) and the potential reach (r2=0.989, ρ=0.721, P=<0.001). We did not find the time since the publication of the articles to modulate these associations.

For every 1 tweet there is an average 0.67 (95% CI 0.65-0.70, β = 0.993) increase in citations and for every 1 tweeter there is an average 0.78 (95% CI 0.76-0.81,β = 0.995) increase in citations.

We detected multicollinearity in our data and therefore the assumptions to perform a multiple linear regression analysis were not met.

There is also a strong correlation between the number of citations and the AAS (r2=0.975, ρ=0.767, P=<0.001) (Fig.7C).

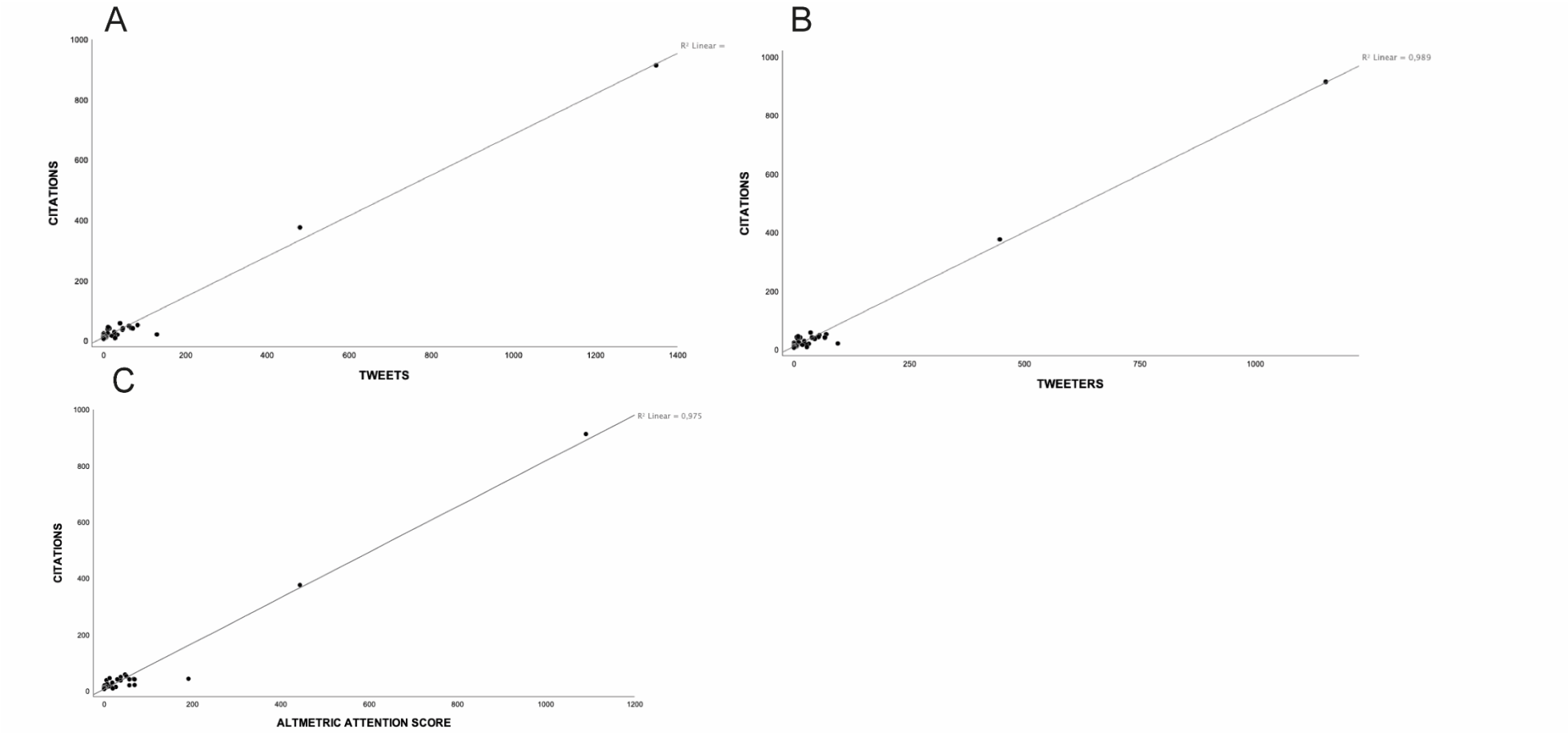

Figure 7 Correlation between the number of citations and the number of tweets, number of tweeters or AAS

Discussion

Our study demonstrated a clear correlation between Twitter metrics, stroke journals' IF, and the number of citations of stroke articles. To the best of our knowledge, this is the first study that analyzes whether there is an association between presence and activity on Twitter and both the IF of stroke journals and the number of citations of stroke articles.

Regarding the usage of Twitter, stroke journals performed comparably well, with four out of ten of them having a Twitter account, a percentage higher than that seen in some medical specialties, such as Urology (21%) and Endocrinology (12.1%). (12)(13)

Journals with a Twitter account had a marginally higher average 2020 IF than journals without Twitter. We also found that there was a very strong correlation between IF and some Twitter metrics, such as the number of followers, the total number of tweets, the number of tweets with a link to an article, the number of retweets, and the number of years on Twitter. However, these results were not statistically significant due probably to the low sample size as further explained. Other studies, however, obtained statistically significant results, namely, a study involving 22 Trauma and Orthopedic journals, which revealed a correlation between presence on Twitter, number of followers, and AAS and the IF. (6) We should take into account that the results obtained convey a correlation and not causality. There is a positive feedback loop that can explain the trend towards a higher number of followers and tweets and higher IF in journals with a Twitter account: journals with a higher IF are more widely known and have more economic and human resources dedicated to managing their Twitter profiles, posting more and attracting more followers; on the other hand, the fact that they have more followers and tweets, particularly tweets with links to articles, leads to more citations and, consequently, a higher IF.

Twitter activity around stroke articles correlates positively and strongly with the citations rates of these articles. Similar findings were obtained in a study published in Journal of Medical Internet Research (14) and in a study that involved ecological journal articles. (15) Again, it is necessary to consider that correlation is not causation, being difficult to understand whether a higher number of citations is due to increased Twitter activity around the article or whether it is the nature and quality of the article itself that lead to a higher number of citations and, at the same time, a greater impact on social media. Probably the two intertwine.

There is a non-statistically significant correlation between the mean AAS and the IF. On the other hand, the AAS and the number of citations of articles are correlated with statistical significance. These results suggest that the attention that is given to articles on other social

media and platforms, in addition to Twitter, also contributes to the increase in IF and citation rates.

The fact that there is statistical significance in the influence of Twitter activity on citation rates of articles, but not in the influence of Twitter activity on the IF, seems to be somewhat contradictory. The IF is calculated by dividing the number of citations in the JCR year by the total number of articles published in the 2 previous years. Taking this into account, the presence of a profile on Twitter could theoretically increase the exposure of an article and lead to a higher number of citations and, consequently, a higher IF. However, the IF can be influenced by other factors, namely, the number of issues per year, the amount, type, and quality of the published articles, the level of the editorial board members and reviewers, and the language used. (16) Nonetheless, the main factor to consider is that the number of articles selected for this study is markedly higher than the number of journals with Twitter that we include. In fact, one of the limitations of our study is the reduced sample size of journals analyzed, since we only included stroke-dedicated journals, a few had their own Twitter profile and some had no IF. Furthermore, there was a big difference in the activity of Twitter profiles, with two of them (with the highest IF - Stroke and International Journal of Stroke) being much more active than the others.

Despite the benefits of using social media and, specifically, Twitter, there are still many journals and doctors who have not joined Twitter, as it happens in stroke medicine. It is known that doctors spend little time reading journal articles. (17) Social media can be useful to filter and bring them key articles and recent information. In addition, users can share their investigations and promote them, bringing knowledge to a wider audience and potentially increasing their citations rates. Our findings highlight the importance of having an active Twitter account from a stroke journals perspective. Broader studies focused on authors' and/or readers' perspectives, involving other areas and perhaps including other social media and platforms are warranted.

Conclusion

It is likely that a higher Twitter interaction by stroke journals contributes to an increase in IF. The citation rates of stroke articles are influenced by their activity on Twitter. Greater engagement on Twitter by journals and practitioners in the field of stroke medicine should be encouraged.

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Conflict(s)-of-Interest/Disclosure(s)

The authors deny any conflict of interest and have nothing to disclose.

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Figure Legends

Figure 1 Illustrative donut of the article “2018 Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association”.

Figure 2 Stroke journals identified in JCR, followed by those with a Twitter profile.

Figure 3 Evolution of the IF of stroke journals

Figure 4 Most used hashtags by stroke journals in 2020

Figure 5 Correlation between IF and the number of followers, tweets, or retweeted tweets

Figure 6 Correlation between IF and the AAS or Social Authority Score

Figure 7 Correlation between the number of citations and the number of tweets, number of tweeters, or AAS

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Figures

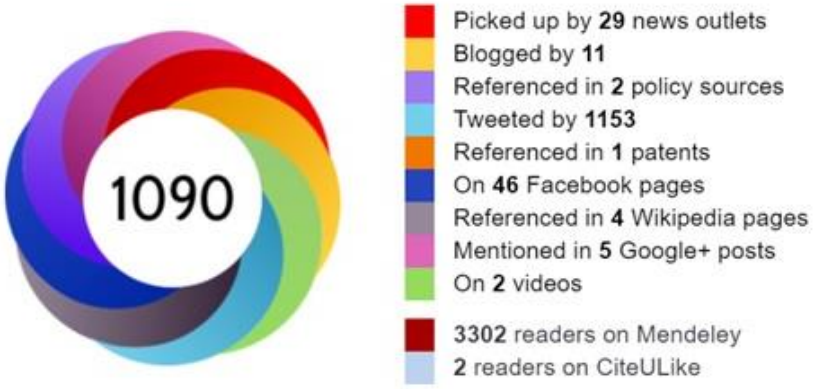

Figure 1 Illustrative donut of the article "2018 Guidelines for the Early Management of Patients with Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association".

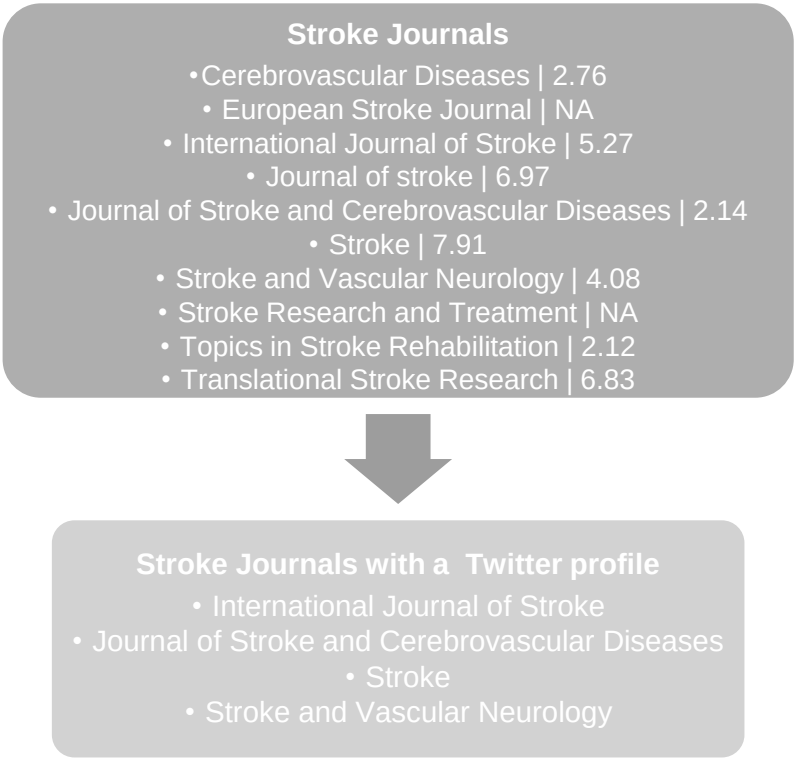

Figure 2 Stroke journals identified in JCR and the respective 2020 IF, followed by those with a Twitter profile.

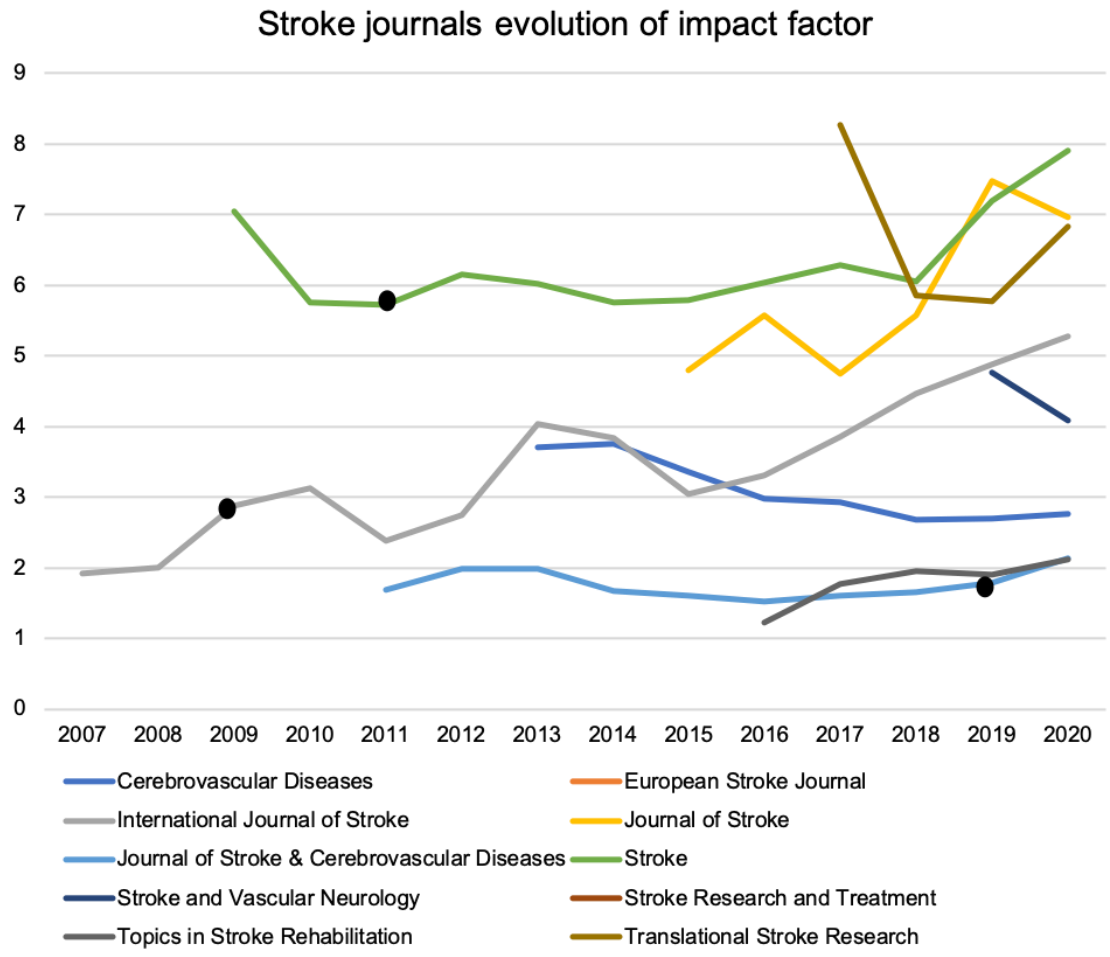

Figure 3 Evolution of the IF of stroke journals

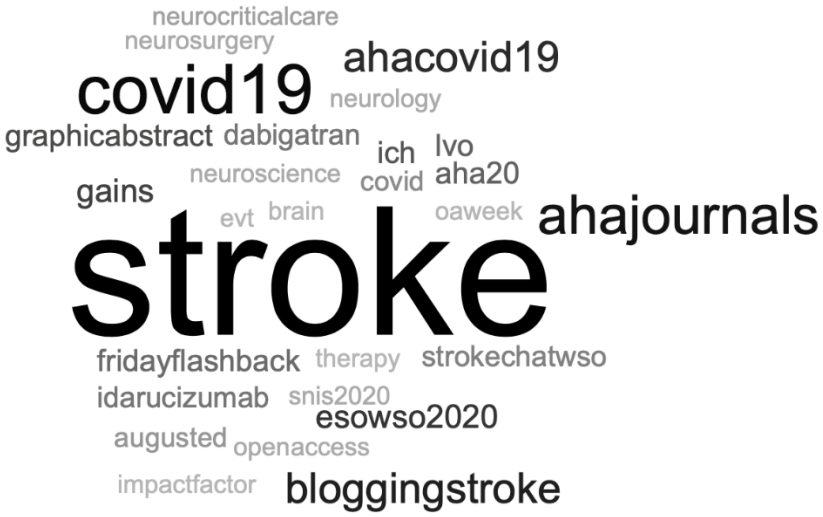

Figure 4 Most used hashtags by stroke journals in 2020

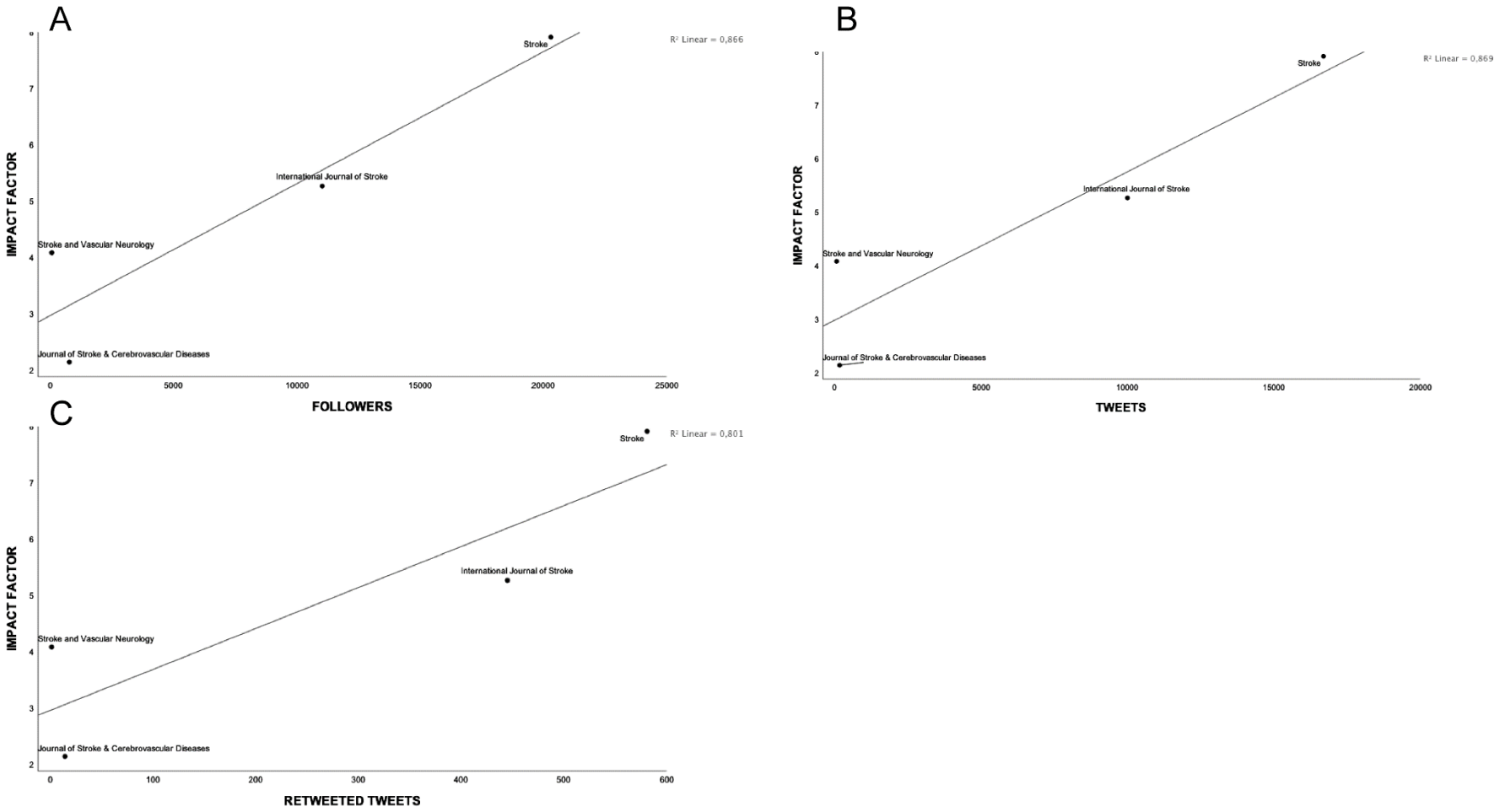

Figure 5 Correlation between IF and the number of followers, tweets, or retweeted tweets

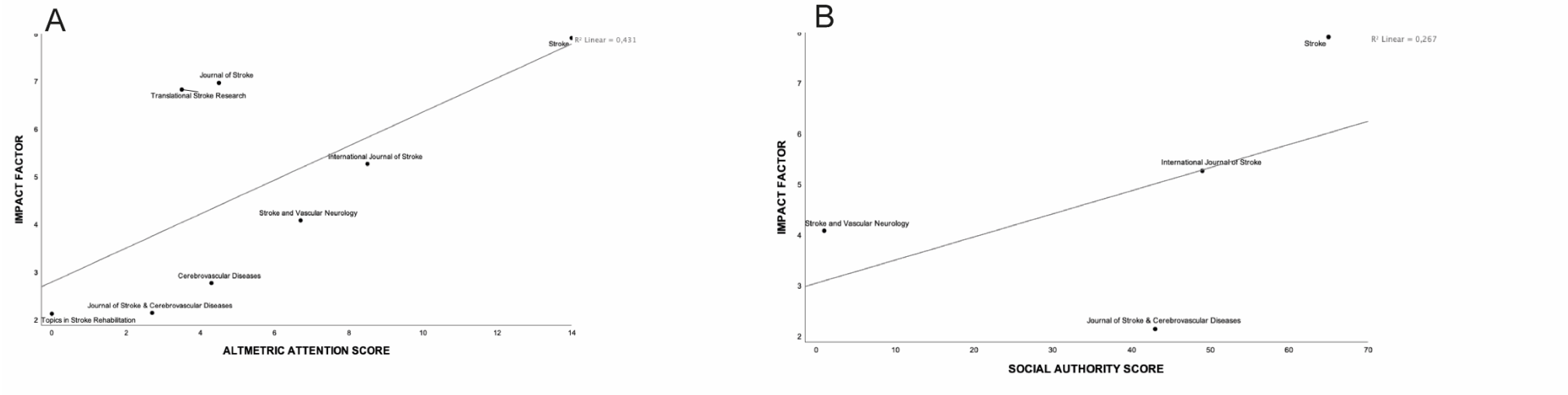

Figure 6 Correlation between IF and the AAS or Social Authority Score

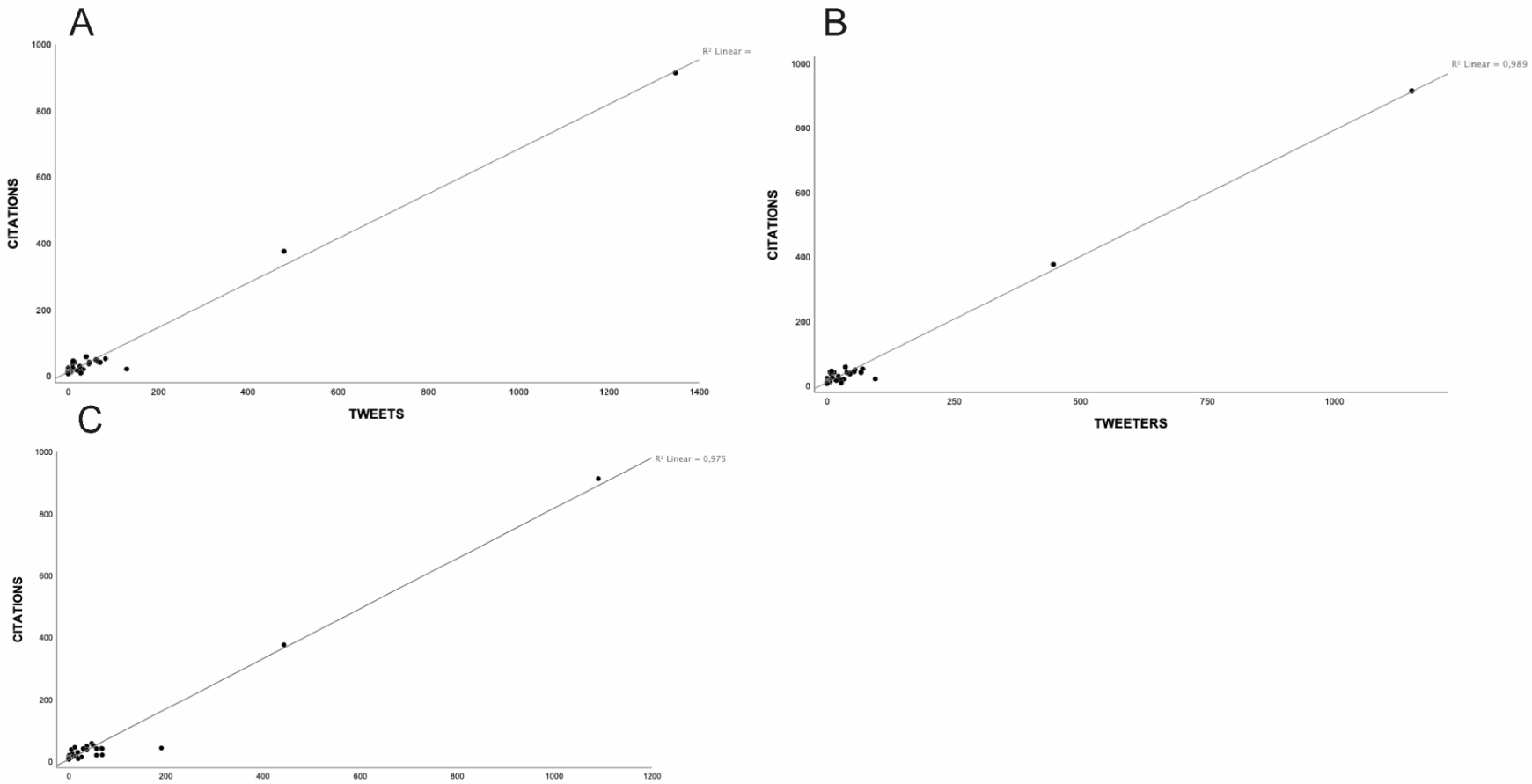

Figure 7 Correlation between the number of citations and the number of tweets, number of tweeters or AAS

Tables

Table 1 Definition of Twitter terms.

Twitter Term	Definition
Tweet	A message posted on Twitter containing text, photos, a GIF, and/or video.
Tweeter	A person who posts on Twitter.
Retweet	A tweet that has been written by one Twitter user and republished by another.
Like	A way of showing that you literally like the content posted by another user. On Twitter, a Like is indicated by a heart.
Follower	A user who follows or subscribes to another user's Twitter account.
Following	Subscribing to an account as a follower.
Potential reach	The number of individual Twitter users who may have seen a particular tweet.

Table 2 The IF, mean AAS, Social Authority Score, and Twitter data for the 4 stroke journals with a Twitter profile

Journal Name	Twitter Handle	2020 IF	IF at Time of Joining Twitter	Followers	Tweets	Tweets in 2020	Tweets with an article in 2020	Retweeted tweets in 2020	Mean AAS	Social Authority Score
International Journal of Stroke	@IntJStroke	5.27	2.87	11026	10001	1535	349	445	8.5	49
Journal of Stroke and Cerebrovascular Diseases	@JSCVD2	2.14	1.79	764	171	46	28	14	2.7	43
Stroke	@StrokeAHA_ASA	7.91	5.73	20304	16697	1511	571	581	14	65
Stroke and Vascular Neurology	@SVN_BMJ	4.08	NA	48	65	6	0	1	6.7	1

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