



Brief report

The top 100 Twitter influencers in cardiology

Running title: Cardiology influencers on Twitter

Onoriode Kesiena^{1,*}, Henry K Onyeaka², Setri Fugar³, Alexis K Okoh⁴ and Annabelle Santos Volgman³

¹ Department of Internal Medicine, Piedmont Athens Regional Medical Center, Athens, USA

² Department of Psychiatry, Massachusetts General Hospital/Mclean, Boston, USA

³ Division of Cardiology, Department of Internal Medicine, Rush University Medical Center, Chicago, USA

⁴ Division of Cardiology, Cardiovascular Research Unit, RWJ Barnabas Health, NBIMC, Newark, New Jersey, USA

* **Correspondence:** Email: o.kesiena@tamu.edu

Abstract: *Importance:* Twitter represents a growing aspect of the social media experience and is a widely used tool for public education in the 21st century. In the last few years, there has been concern about the dissemination of false health information on social media. It is therefore important that we assess the influencers of this health information in the field of cardiology. *Objective:* We sought to identify the top 100 Twitter influencers within cardiology, characterize them, and examine the relationship between their social media activity and academic influence. *Design:* Twitter topic scores for the topic search “cardiology” were queried on May 01, 2020 using the Right Relevance application programming interface (API). Based on their scores, the top 100 influencers were identified. Among the cardiologists, their academic h-indices were acquired from Scopus and these scores were compared to the Twitter topic scores. *Result:* We found out that 88/100 (88%) of the top 100 social media influencers on Twitter were cardiologists. Of these, 63/88 (72%) were males and they practiced mostly in the United States with 50/87 (57%) practicing primarily in an academic hospital. There was a moderately positive correlation between the *h-index* and the Twitter topic score, $r = +0.32$ (p -value 0.002). *Conclusion:* Our study highlights that the top ranked cardiology social media influencers on Twitter are board-certified male cardiologists practicing in academic settings in the US. The most influential on Twitter have a moderate influence in academia. Further research should evaluate the relationship between other academic indices and social media influence.

Keywords: Twitter; cardiology; influence; *h-index*

1. Introduction

Social media platforms such as Twitter using posts called tweets have altered the way people disseminate information [1]. Sharing of information is made possible by the interactions a tweet generates among users. As compared to a regular user, tweets from a small proportion of users called influencers tend to generate the most interactions. These influencers typically have a large online following and may or may not be experts in the issue of discourse [2,3]. With the help of these influencers, health information may be communicated to a large audience promptly in situations where it is necessary to do so.

Studies have reported health-related benefits from the use of social media platforms such as Twitter as well as a concern. It has been reported as an excellent place to discover current topics of discourse about vaccines and also to promote vaccination [4]. By using semantic analysis to identify influencers on Twitter, vaccine-hesitant communities can be identified and targeted for interventions. Perhaps as a platform for information dissemination about health, interactions on Twitter can positively influence users by improving their health-seeking behaviors. They can then become aware of the right source of information and seek the right remedy for their health conditions [5,6].

However, sometimes, it is unclear which individuals are influencing these interactions. Given the potential that exists for the dissemination of inaccurate health information [7], there is a need to have experts at the forefront of information dissemination on this platform. Cardiovascular health is an area in which interactions that can lead to a positive health-seeking behavior is needed. This need is made obvious by the growing burden of cardiovascular diseases despite the traditional efforts from various stakeholders [8]. As experts, cardiologists can increase awareness, build partnerships and act as advocates of cardiovascular health in their roles as Twitter influencers [9,10].

Traditionally cardiologists are considered experts by their years of experience and their research output. This research output can be measured by different matrixes, one of which is the *h-index* [Hirsch index—productivity in terms of number of publications and impact (number of citations) of the publication] [11]. One would expect that the most influential cardiologists on Twitter also have the highest research output, but this may not be the case. It will also be interesting to see if the most influential Twitter users in the field of cardiology experts are indeed, in this case physicians. The goal of this study therefore, is to assess the top influencers in the field of cardiology who are actively influencing information dissemination on Twitter and to assess if there is any correlation between the Twitter influence and academic influence of the practicing cardiologists.

2. Methods

On May 01, 2020, similar to the method used in other studies [12,13], the Right Relevance Application Programming Interface (API) (www.rightrelevance.com, San Francisco, CA, United States) was queried using the search word “cardiology”. The API generated a Twitter topic score for “cardiology”. This score is a measure of how much interactions from other users an influencer earns from a tweet about a topic in the field of cardiology. Subsequently, a rank list of the top 100 cardiology Twitter influencers with their Twitter handles, Twitter names, Twitter profiles, and the number of followers was generated.

We excluded handles belonging to organizations as the study's focus was on individual users. Individuals were characterized by sex, duration in years post fellowship training, occupation, area/field of focus for those who were cardiologist physicians, practice setting (academic hospital practice, academic & private hospital practice, non-academic hospital practice, private hospital practice, and both hospital practice & entrepreneurship), and location. These characteristics were identified on their Twitter profiles and web sources such as Doximity (San Francisco, CA, United States), LinkedIn (Sunnyvale, CA, United States), ResearchGate (Berlin, Germany), and practice and institutional websites. The *h-index* scores of the top cardiologist influencers were obtained using Scopus (Reed Elsevier, London, United Kingdom) on May 07, 2020, and added to the database to represent their academic influence. The median *h-index* of the influencers that were cardiologists was calculated and a Pearson correlation was performed between the *h-indices* of the cardiologists and their Twitter topic score to evaluate the relationship. Statistics and graphical representation were performed in Microsoft Excel (Seattle, WA, United States).

3. Results

The top 100 most influential individuals in cardiology on Twitter were evaluated (Table 1). Males made up 70 (70%) of the influencers while 30 (30%) were females. Eighty-eight (88%) of the top influencers were cardiologists; 5 (5%) were journalists; 2 (2%) were surgeons (bariatric and cardiothoracic surgeons); 2 (2%) were other physicians (Family medicine physician and a Lipidologist); 2 (2%) consisted of a physician assistant and a senior hospital scientist, and 1 (1%) was a representative for cardiology patients (Figure 1). Eighty-eight (88%) of influencers worked in the United States and 12 (12%) worked outside the United States. In the US, the most common locations in which they worked include Massachusetts 12/88 (13%) and California 11 (13%). Outside the United States, the most common locations included the United Kingdom 4/12 (33%) and Canada 3/12 (25%) (Table 2).

Table 1. API generated ranking of the top 100 influential individuals in cardiology on Twitter.

| Rank | Twitter handle | Twitter name | Post-fellowship duration (years) | Occupation |
|------|------------------|------------------------|----------------------------------|-----------------------------|
| 1. | cmichaelgibson | Michael C. Gibson | 27 | Interventional cardiologist |
| 2. | erictopol | Eric Topol | 35 | Cardiologist-scientist |
| 3. | drpascalmeier | Pascal Meier | 20 | General cardiologist |
| 4. | drmarthagulati | Martha Gulati | 19 | Preventive cardiologist |
| 5. | drjohnm | John Mandrola | 25 | General cardiologist |
| 6. | heartotxheartmd | John P Erwin III | 22 | General cardiologist |
| 7. | heartbobh | Robert Harrington | 27 | Interventional cardiologist |
| 8. | drsethdb | Seth Bilazarian | 27 | Interventional cardiologist |
| 9. | hmkyale | Harlan Krumholz | 28 | General cardiologist |
| 10. | drsheilasahni | Sheila Sahni | 3 | Interventional cardiologist |
| 11. | cardiobrief | Larry Husten | N/A | Medical journalist |
| 12. | dlbhattmd | Deepak L. Bhatt | 20 | Interventional cardiologist |
| 13. | gina_lundberg | Gina Lundberg | 26 | Preventive cardiologist |
| 14. | mw Waltonshirley | Melissa Walton-Shirley | 29 | General cardiologist |
| 15. | erinmichos | Erin D. Michos | 13 | Preventive cardiologist |

Continued on next page

| Rank | Twitter handle | Twitter name | Post-fellowship duration (years) | Occupation |
|------|-----------------|------------------------|----------------------------------|-----------------------------------|
| 16. | ajaykirtane | Ajay Kirtane | 14 | Interventional cardiologist |
| 17. | shelleywood2 | Shelley Wood | N/A | Medical journalist |
| 18. | greggwstone | Gregg W. Stone | 31 | Interventional cardiologist |
| 19. | rwyeh | Robert W. Yeh | 10 | General cardiologist |
| 20. | svraomd | Sunil V. Rao | 16 | Interventional cardiologist |
| 21. | drtoniyasingh | Toniya Singh | 17 | General cardiologist |
| 22. | docsavagetju | Michael Savage | 35 | Interventional cardiologist |
| 23. | drlaxmimehta | Laxmi Mehta | 14 | Preventive cardiologist |
| 24. | keaglemd | Kim Eagle | 34 | General cardiologist |
| 25. | minnowwalsh | Minnow Walsh | 21 | Cardiologist non-invasive imaging |
| 26. | drkevincampbell | Kevin Campbell | 17 | Cardiologist-electrophysiology |
| 27. | heartdocsharon | Sharon Mulvagh | 31 | Cardiologist non-invasive imaging |
| 28. | drroxmehrnan | Roxana Mehran | 25 | Interventional cardiologist |
| 29. | nmheartdoc | Clyde Yancy | 31 | General cardiologist |
| 30. | willsuh76 | William Suh | 10 | Interventional cardiologist |
| 31. | drjmieres | Jennifer Mieres | 28 | Cardiologist non-invasive imaging |
| 32. | chadialraies | Chadi Alraies | 4 | Interventional cardiologist |
| 33. | samrrazamd | Sam Raza | 2 | Cardiologist non-invasive imaging |
| 34. | venkmurthy | Venk Murthy | 8 | Cardiologist non-invasive imaging |
| 35. | arh_cardio | Andrew R. Houghton | 14 | Cardiologist non-invasive imaging |
| 36. | sharonnehayes | Sharonne Hayes | 30 | Preventive cardiologist |
| 37. | pamelasdouglas | Pamela S Douglas | 36 | Cardiologist non-invasive imaging |
| 38. | cpcannon | Christopher Cannon | 20 | General cardiologist |
| 39. | drlindamd | Linda Girgis | N/A | Family medicine physician |
| 40. | ejsmd | Edward J Schloss | 23 | Cardiologist-electrophysiology |
| 41. | fischman_david | David L. Fischman | 29 | Interventional cardiologist |
| 42. | ankurkalramd | Ankur Kalra | 3 | Interventional cardiologist |
| 43. | doctorwes | Westby Fisher | 22 | Cardiologist-electrophysiology |
| 44. | califf001 | Robert M Califf | 38 | General cardiologist |
| 45. | vietheartpa | Viet Le | 16 | Cardiology-physician assistant |
| 46. | tctmd_yael | Yael L. Maxwell | N/A | Medical journalist |
| 47. | drdave01 | David E. Albert | 39 | Cardiologist-entrepreneur |
| 48. | pooh_velagapudi | Poonam Velagapudi | 2 | Interventional cardiologist |
| 49. | anastasiasmihai | Anastasia S Mihailidou | N/A | Senior hospital scientist |
| 50. | cpgale3 | Chris P Gale | 6 | General cardiologist |
| 51. | majazayeri | Ali Jazayeri | 0 | Cardiology fellow |
| 52. | nihdirector | Francis S. Collins | 36 | General cardiologist-scientist |
| 53. | sethbaummd | Seth J. Baum | 30 | Interventional cardiologist |
| 54. | drraviele | Raviele Antonio | 46 | Cardiologist-electrophysiology |
| 55. | leftbundle | Mintu Turakhia | 12 | Cardiologist-electrophysiology |
| 56. | lipiddoc | James Underberg | N/A | Lipidologist |
| 57. | richardbogle | Richard Bogle | 13 | Interventional cardiologist |
| 58. | michaeltctmd | Michael O'Riordan | N/A | Medical journalist |

Continued on next page

| Rank | Twitter handle | Twitter name | Post-fellowship duration (years) | Occupation |
|------|-----------------|--------------------------------------|----------------------------------|--------------------------------------|
| 59. | jgrapsa | Julia Grapsa | 7 | Cardiologist non-invasive imaging |
| 60. | ethanjweiss | Ethan Weiss | 17 | Preventive cardiologist |
| 61. | neilflochmd | Neil Floch | N/A | Bariatric surgery |
| 62. | davidmaymd | David May | 32 | Interventional cardiologist |
| 63. | herbaronowmd | Herb Aronow | 17 | Interventional cardiologist |
| 64. | drryanpdaly | Ryan P. Daly | 10 | Cardiologist non-invasive imaging |
| 65. | skathire | Sek Kathiresan | 12 | Preventive cardiologist/entrepreneur |
| 66. | cardiacconsult | Jordan Safirstein | 12 | Interventional cardiologist |
| 67. | pnatarajanmd | Pradeep Natarajan | 5 | Preventive cardiologist |
| 68. | debbemccall | Debbe McCall | N/A | Patient research/representative |
| 69. | davidlbrownmd | Clinically Conservative Cardiologist | 27 | Interventional cardiologist |
| 70. | jjheart_doc | James Januzzi | 20 | Cardiologist non-invasive imaging |
| 71. | onco_cardiology | Juan Lopez-Mattei | 7 | Cardio-oncologist |
| 72. | drjohndaymd | John Day | 20 | Cardiologist-electrophysiology |
| 73. | aalahmadmd | Amin Al-Ahmad | 17 | Cardiologist-electrophysiology |
| 74. | toddneale | Todd Neale | N/A | Medical journalist |
| 75. | josejgnews | Jose Juan Gomez | 25 | Cardiologist non-invasive imaging |
| 76. | jonhsumd | Jonathan Hsu | 7 | Cardiologist-electrophysiology |
| 77. | mkittlesonmd | Michelle Kittleson | 15 | Heart transplant cardiologist |
| 78. | lisarosenbaum17 | Lisa Rosenbaum | 8 | Interventional cardiologist |
| 79. | toaster_pastry | Wayne Whitwam | 14 | Cardiologist-electrophysiology |
| 80. | avolgman | Annabelle Volgman | 30 | Cardiologist-electrophysiology |
| 81. | rblument1 | Roger Blumenthal | 28 | Preventive cardiologist |
| 82. | achoiheart | Andrew D. Choi | 10 | Cardiologist non-invasive imaging |
| 83. | mgkatz036 | Michael Katz | 5 | Cardiologist-electrophysiology |
| 84. | prashsanders | Prashanthan Sanders | 17 | Cardiologist-electrophysiology |
| 85. | bcostellomd | Briana Costello | 0 | Interventional cardiologist |
| 86. | popmajeffrey | Jeffrey Popma | 30 | Interventional cardiologist |
| 87. | adribaran | Adrian Baranchuk | 23 | Cardiologist-electrophysiology |
| 88. | sandylewis | Sandra Lewis | 37 | General cardiologist |
| 89. | yadersandoval | Yader Sandoval | 3 | Interventional cardiologist |
| 90. | drquinnccapers4 | Quinn Capers | 21 | Interventional cardiologist |
| 91. | dramirkaki | Amir Kaki | 11 | Interventional cardiologist |
| 92. | jamesbeckerman | James Beckerman | 14 | General cardiologist |
| 93. | eirangorodeski | Eiran Gorodeski | 11 | General cardiologist |
| 94. | docstrom | Jordan Strom | 3 | Cardiologist non-invasive imaging |
| 95. | dbelardomd | Danielle Belardo | 0 | Cardiology Fellow |
| 96. | sergiopinski | Sergio Pinski | 27 | Cardiologist-electrophysiology |
| 97. | arieblitzmd | Arie Blitz | N/A | Cardiothoracic surgeon |
| 98. | ash71us | Ashish Aneja | 8 | General cardiologist |
| 99. | tjaredbunch | Thomas Jared Bunch | 12 | Cardiologist-electrophysiology |
| 100. | rfredberg | Rita Redberg | 32 | General cardiologist |

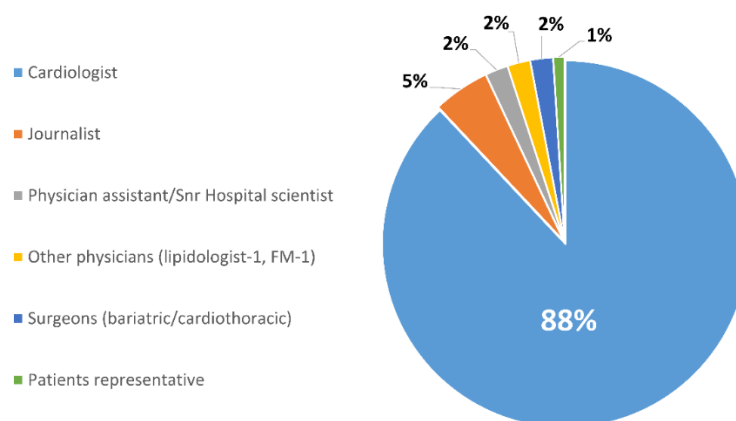


Figure 1. Percent distribution of the top influencers in the field of cardiology.

Table 2. Practice location of the top 100 most influential individuals.

| United States | Percentage | International | Percentage |
|----------------|------------|----------------|------------|
| Massachusetts | 13.64% | United Kingdom | 33.33% |
| California | 12.50% | Canada | 25.00% |
| Texas | 7.95% | Switzerland | 8.33% |
| New York | 7.95% | South wales | 8.33% |
| Ohio | 6.82% | Italy | 8.33% |
| New Jersey | 4.55% | Spain | 8.33% |
| Connecticut | 3.41% | Australia | 8.33% |
| Baltimore | 3.41% | | |
| North Carolina | 3.41% | | |
| Pennsylvania | 3.41% | | |
| Michigan | 3.41% | | |
| Illinois | 3.41% | | |
| Utah | 3.41% | | |
| Kentucky | 2.27% | | |
| Missouri | 2.27% | | |
| Indiana | 2.27% | | |
| Minnesota | 2.27% | | |
| Kansas | 2.27% | | |
| Florida | 2.27% | | |
| Oregon | 2.27% | | |
| Arizona | 1.14% | | |
| Georgia | 1.14% | | |
| Nebraska | 1.14% | | |
| Rhode Island | 1.14% | | |
| Washington | 1.14% | | |
| Wisconsin | 1.14% | | |

Approximately 63/88 (72%) of the top influencers that were cardiologists were males and 25/88 (28%) were females. Of the 88 cardiologists, 87 were actively practicing. Of the practicing

cardiologists, about 50/87 (57%) of them worked primarily in an academic hospital setting, 33/87 (38%) in non-academic hospitals, 2/87 (2%) in both academic & private facilities, 1/87 (1%) in private hospitals alone, and 1/87 (1%) worked both in a non-academic hospital and as an entrepreneur. As shown in Figure 2, Twenty-seven (31%) of cardiologist influencers were focused in interventional cardiology, 20/88 (23%) in general cardiology, 15/88 (17%) in electrophysiology, 13/88 (15%) in cardiac non-invasive imaging and 9/88 (10%) in preventive cardiology.

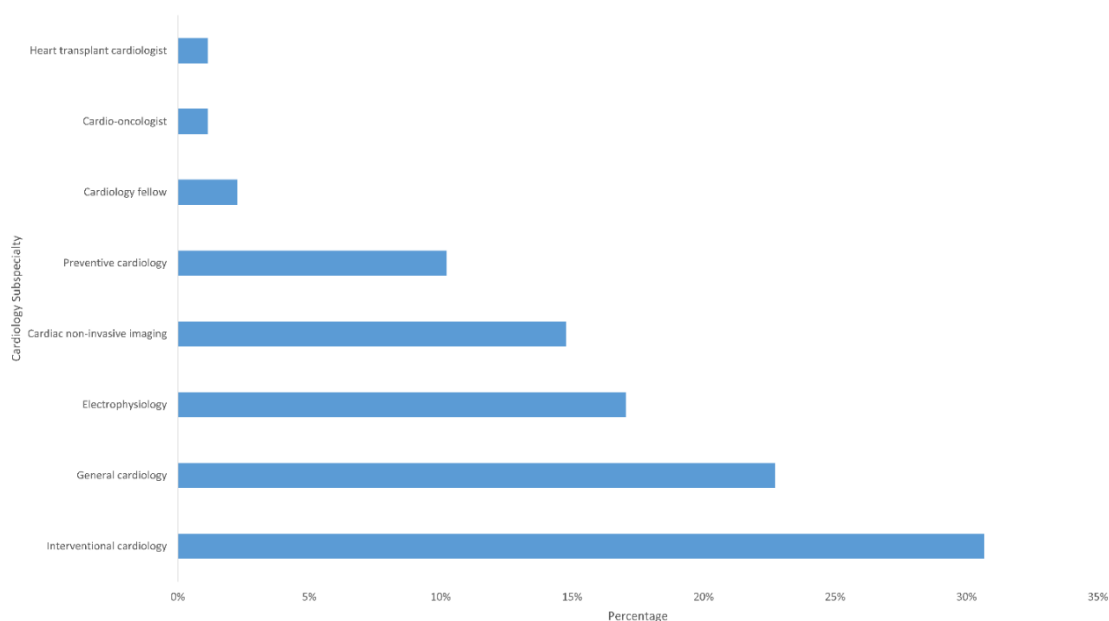


Figure 2. Distribution of cardiologist by specialty.

The median and mean *h-index* of the top influencers who were cardiologists was 22 (interquartile range = 32.5) and 41.84 ± 9.89 (mean \pm 95% CI) respectively. There was a moderately positive correlation between their Twitter topic score and *h-index*, $r = +0.32$ (p -value 0.002).

4. Discussion

The study aimed to assess the top individuals driving the discussions in cardiology on Twitter and to analyze if they were as influential in academia as they were on Twitter. We found out that the top 100 Twitter influencers were male cardiologists in the United States with 30% women, they work in academic hospitals and interventional cardiologists represent the largest proportion of cardiologists among the influencers. In addition, there was a moderately positive correlation between their academic and Twitter influence.

Most of the top 100 cardiology Twitter influencers were US cardiologists. This made up about 85% of the total population studied. They also practice mostly in academic institutions. These individuals are currently influencing the engagements in the field of cardiology on Twitter, and it is consistent with findings from other studies. These other studies evaluated the top influencers in other medical fields on Twitter and found them to be experts in these fields [12,13]. This is important given that people are more likely to engage a post on Twitter when experts lead the discussion [14]. However, this may not be enough

to prevent the dissemination of false information which leads to public mistrust [14,15], as among the top 100, 12% were non-cardiologists and may be considered as non-experts.

We also found out that among the influencers that were cardiologists, 2 out of 3 were males. This mostly can be attributed to the small percentage of women who are currently cardiologists [16]. A recent study reported that despite the high percentage of female internal medicine residents, only about 13% of cardiologists are women [17]. Although it is not surprising that females are a minority, with 1 in 3 cardiology influencers being females, it however shows a larger representation of female cardiologists on Twitter which doubles the current trend in the US. There also seems to be a flattening of the hierarchy with a mix of early career (e.g., Briana Costello, Sam Raza), mid-career (e.g., William Suh, Andrew R. Houghton) and advanced stage career (e.g., Michael Gibson, Martha Gulati) professionals being among the top influencers. A positive finding given the criticism the historical hierarchy in medicine has received in recent years [18].

With regards to their location, only a few cardiologists outside the US were part of the top 100 cardiology influencers. This may be attributed to reports of anti-social media policies in some European countries [19] and the resultant low adoption rates of social media platforms [20,21]. This may account for why fewer cardiologists outside the US are currently in the top 100 influencers on Twitter. Nevertheless, findings of the massive use of Twitter during European conferences to share impressions have been reported [22,23]. In addition, Twitter has been reported as a source of data in the research of noncommunicable diseases in European studies [24]. These reports are inconsistent with the reported anti-social media policies outside the US and there may be other reasons behind these findings.

In addition, we found out that most of the top cardiologist influencers practice in academic hospitals. Studies have shown a high research output from cardiologists who practice in this setting as compared to those who practice in non-academic settings [25]. This is due to the heavy emphasis on research in academic hospitals as compared to non-academic hospitals. These cardiologists have also been found to be more likely to tweet about conferences, research activities, and meetings they attend [26] as compared to those in non-academic settings.

With regards to the overall academic influence, the median *h-index* of the top cardiologist influencers (median *h-index*, 22) found in our study was higher than that of the orthopedic (median *h-index*, 7) and plastic surgeons (median *h-index*, 5) in studies done in 2018 and 2019 respectively [12,13]. In a comparison of the median *h-index* and their Twitter influence, there was a moderately positive correlation between the two. The moderate positive relationship implies that not only are these top influential cardiologists more active in research as compared to other specialties, they are also almost as influential on Twitter as they are in academia. The most active influential cardiologists may be tweeting more about breakthroughs in cardiovascular research [27]. This is relevant as social media has become a tool to reach millions of people and gather data, and as such, physicians need to be conversant and active in its use. Twitter is a tool to promote and direct attention to specific research topics [28] and was found to be an effective way to increase citations of a publication, influencing the *h-index* of an author [29].

This study has a few strengths. First, the large sample size of this study allowed for adequate characterization of the influencers. Second, we used the Right Relevance API which has successfully been used to mine data from Twitter for other studies. Third, the academic influence was computed using the *h-index*, a scoring system that shows a high correlation with other variants [30]. Despite the strengths of this study, it has some limitations worthy of note. First, the data was made of incomplete Twitter profiles that had to be completed using sources such as Doximity and LinkedIn. Second, a different API using another algorithm may generate a data set entirely different from this data set.

Third, there are other social media platforms apart from Twitter where other cardiologists may be more active such as Facebook and Instagram. Lastly, the h-index pays attention only to h-core papers, ignores most papers with a low citation frequency, and lacks sensitivity to highly cited papers.

In conclusion, our study showed that when examining the influential voices in cardiology on Twitter, there is a broad range of sub-specialties represented, with interventional cardiologists being the most prominent. There was a geographical diversity as well as a flattening of the hierarch, with a mix of early career (e.g., Briana Costello, Sam Raza), mid-career (e.g., William Suh, Andrew R. Houghton) and advanced stage career (e.g., Michael Gibson, Martha Gulati) professionals. Thirty percent were women, which more than doubles the number of women estimated to be practicing cardiovascular medicine. This reflects the challenges that remains in closing the gender gap between men and women as influencers in cardiovascular medicine. These influencers were as influential in the academia as they are on Twitter. Future studies should exam the contents of the posts made by these influencers and also consider other indexes of academic influence like g-index, AR-index, p-index, and integrated impact indicator or academic trace as they relate to social media influence.

Conflict of interest

The authors have no conflict of interest to declare.

References

1. Lokot T, Diakopoulos N (2016) News Bots: Automating news and information dissemination on Twitter. *Digit Journal* 4: 682–699.
2. Arora A, Bansal S, Kandpal C, et al. (2019) Measuring social media influencer index- insights from facebook, Twitter and Instagram. *J Retail Consum Serv* 49: 86–101.
3. Lou C, Yuan S (2019) Influencer Marketing: How Message Value and Credibility Affect Consumer Trust of Branded Content on Social Media. *J Interact Advert* 19: 58–73.
4. Featherstone JD, Ruiz JB, Barnett GA, et al. (2020) Exploring childhood vaccination themes and public opinions on Twitter: A semantic network analysis. *Telemat Inform* 54: 101474.
5. McNeill A, Harris PR, Briggs P (2016) Twitter influence on UK vaccination and antiviral uptake during the 2009 H1N1 pandemic. *Front Public Health* 4: 26.
6. Borgmann H, Loeb S, Salem J, et al. (2016) Activity, content, contributors, and influencers of the twitter discussion on urologic oncology. *Urol Oncol* 34: 377–383.
7. Waszak PM, Kasprzycka-Waszak W, Kubanek A (2018) The spread of medical fake news in social media – The pilot quantitative study. *Health Policy Technol* 7: 115–118.
8. Yusuf S, Rangarajan S, Teo K, et al. (2014) Cardiovascular Risk and Events in 17 Low-, Middle-, and High-Income Countries. *N Engl J Med* 371: 818–827.
9. Xu WW, Chiu IH, Chen Y, et al. (2015) Twitter hashtags for health: applying network and content analyses to understand the health knowledge sharing in a Twitter-based community of practice. *Qual Quant* 49: 1361–1380.
10. Park H, Reber BH, Chon MG (2016) Tweeting as Health Communication: Health Organizations' Use of Twitter for Health Promotion and Public Engagement. *J Health Commun* 21: 188–198.
11. Bornmann L, Daniel HD (2005) Does the h-index for ranking of scientists really work? *Scientometrics* 65: 391–392.

12. Chandawarkar AA, Gould DJ, Grant Stevens W (2018) The Top 100 Social Media Influencers in Plastic Surgery on Twitter: Who Should You Be Following? *Aesthet Surg J* 38: 913–917.
13. Varady NH, Chandawarkar AA, Kernkamp WA, et al. (2019) Who should you be following? The top 100 social media influencers in orthopaedic surgery. *World J Orthop* 10: 327–338.
14. Pulido CM, Villarejo-Carballido B, Redondo-Sama G, et al. (2020) COVID-19 infodemic: More retweets for science-based information on coronavirus than for false information. *Int Sociol* 35: 377–392.
15. Chou WYS, Oh A, Klein WMP (2018) Addressing Health-Related Misinformation on Social Media. *JAMA* 320: 2417–2418.
16. Mehta LS, Fisher K, Rzeszut AK, et al. (2019) Current Demographic Status of Cardiologists in the United States. *JAMA Cardiol* 4: 1029–1033.
17. Mehta LS, Fisher K, Rzeszut AK, et al. (2019) Current Demographic Status of Cardiologists in the United States. *JAMA Cardiol* 4: 1029–1033.
18. Panhwar MS, Kalra A (2019) Breaking Down the Hierarchy of Medicine. *Eur Heart J* 40: 1482–1483.
19. Aaltonen S, Kakderi C, Hausmann V, et al. (2013) Social media in Europe: Lessons from an online survey. In: *Proceedings of the 18th UKAIS Conference*. Available from: <http://usir.salford.ac.uk/id/eprint/28500/>.
20. Java A, Song X, Finin T, et al. (2007) Why we twitter: understanding microblogging usage and communities. In: *Proceedings of the 9th WebKDD and 1st SNA-KDD 2007 Workshop on Web Mining and Social Network Analysis - WebKDD/SNA-KDD '07*. ACM Press, 56–65.
21. Moreno A, Navarro C, Tench R, et al. (2015) Does social media usage matter? An analysis of online practices and digital media perceptions of communication practitioners in Europe. *Public Relat Rev* 41: 242–253.
22. Bert F, Zeegers Paget D, Scaioli G (2016) A social way to experience a scientific event: Twitter use at the 7th European Public Health Conference. *Scand J Public Health* 44: 130–133.
23. Hudson S, Mackenzie G (2019) ‘Not your daughter’s Facebook’: Twitter use at the European Society of Cardiology Conference 2018. *Heart* 105: 169–170.
24. Uhl A, Kolleck N, Schiebel E (2017) Twitter data analysis as contribution to strategic foresight-The case of the EU Research Project “Foresight and Modelling for European Health Policy and Regulations” (FRESHER). *Eur J Futur Res* 5: 1.
25. Kapoor R, Sachdeva S, Zacks JS (2015) An Analysis of Global Research Trends in Cardiology Over the Last two Decades. *J Clin Diagn Res JCDR* 9: OC06–OC09.
26. Tanoue MT, Chatterjee D, Nguyen HL, et al. (2018) Tweeting the Meeting: Rapid Growth in the Use of Social Media at Major Cardiovascular Scientific Sessions from 2014–2016. *Circ Cardiovasc Qual Outcomes* 11: e005018.
27. Tanoue M, Nguyen H, Sekimura T, et al. (2018) To Tweet or Not to Tweet: Rapid Growth in the Use of Social Media at Major Cardiovascular Meetings. *J Am Coll Cardiol* 71: A2633. d
28. Lee G, Choi AD, Michos ED (2019) Social Media as a Means to Disseminate and Advocate Cardiovascular Research: Why, How, and Best Practices. *Curr Cardiol Rev* 15.
29. Ladeiras-Lopes R, Clarke S, Vidal-Perez R, et al. (2020) Twitter promotion predicts citation rates of cardiovascular articles: a preliminary analysis from the ESC Journals Randomized Study. *Eur Heart J* 41: 3222–3225.

-
30. Bornmann L, Mutz R, Hug SE, et al. (2011) A multilevel meta-analysis of studies reporting correlations between the h index and 37 different h index variants. *J Informetr* 5: 346–359.



AIMS Press

© 2021 the Author(s), licensee AIMS Press. This is an open access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>)