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Nicholas Corsi
Henry Ford Health, ncorsi1@hfhs.org

David-Dan Nguyen

Mohit Butaney
Henry Ford Health, mbutane1@hfhs.org

Sami E. Majdalani
Henry Ford Health, smajdal1@hfhs.org

Matthew P. Corsi

See next page for additional authors

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Authors

Nicholas Corsi, David-Dan Nguyen, Mohit Butaney, Sami E. Majdalani, Matthew P. Corsi, Taylor Malchow, Austin J. Piontkowski, Quoc-Dien Trinh, Stacy Loeb, and Firas Abdollah

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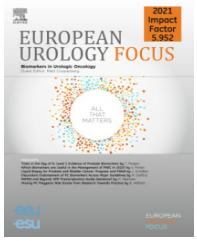

Education

Top 100 Urology Influencers on Twitter: Is Social Media Influence Associated with Academic Impact?

Nicholas Corsi [a,b], *David-Dan Nguyen* [c], *Mohit Butaney* [b,d], *Sami E. Majdalany* [b,d], *Matthew P. Corsi* [a], *Taylor Malchow* [e], *Austin J. Piontkowski* [a,b], *Quoc-Dien Trinh* [f,g], *Stacy Loeb* [h,i,j], *Firas Abdollah* [b,d,*]

[a] *Wayne State University School of Medicine, Detroit, MI, USA;* [b] *Vattikuti Center for Outcomes, Research, Analytics, and Evaluation, Detroit, MI, USA;* [c] *Division of Urology, University of Toronto, Toronto, Canada;* [d] *Vattikuti Urology Institute, Henry Ford Hospital, Detroit, MI, USA;* [e] *Boonshoft School of Medicine, Wright State University, Dayton, OH, USA;* [f] *Center for Surgery and Public Health, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA;* [g] *Division of Urological Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA;* [h] *Department of Urology, NYU School of Medicine, New York, NY, USA;* [i] *Department of Population Health, NYU School of Medicine, New York, NY, USA;* [j] *Manhattan Veterans Affairs Medical Center, New York, NY, USA*

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Abstract

Background: Social media use in medicine has exploded, with uptake by most physicians and patients. There is a risk of dissemination of inaccurate information about urological conditions on social media. Physicians, as key opinion leaders, must play a role in sharing evidence-based information through social media.
Objective: To identify and describe the top 100 urology influencers on the Twitter social media platform and to correlate Twitter influence with academic impact in urology.
Design, setting, and participants: Twitter influence scores for the search topic "urology" were collected in April 2022 using published methodology. The top 100 personal accounts with the highest computed scores were linked to individuals' names, all-time *h* index, geographic location, specialty, attributed sex, and board certification status in this cross-sectional study.
Outcome measurements and statistical analysis: We examined the correlation between influence rank and *h* index.
Results and limitations: Of the top 100 Twitter influencers on the topic of urology, the majority are from the USA (64%), male (85%), and practicing urologists (91%). Some 93% of US urology influencers are board-certified. Only 22 of the 50 US states are represented. The second most frequent country is the UK, with ten urology influencers. The median all-time *h* index is 42 (interquartile range 28.25–58). There is a weak positive correlation between influence rank and *h* index (r = 0.23; p = 0.02). Limitations of the study include the inability to validate the accuracy of the proprietary ranking algorithm and investigation of just one social media platform.
Conclusions: The top Twitter influencers in urology are mostly board-certified US urologists. Collectively, influencers have a relatively greater academic impact in comparison to the average urologist, although there is a weak positive correlation between Twitter influence and *h* index among top Twitter influencers.

* Corresponding author. Vattikuti Center for Outcomes Research, Analytics, and Evaluation, Henry Ford Hospital, 2799 W Grand Boulevard, Detroit, MI 48202-2689, USA. Tel. +1 313 6737463.
E-mail address: firas.abdollah@gmail.com (F. Abdollah).

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Patient summary: Given the explosion of medical information on Twitter, we report the personal accounts with the greatest impact for the topic of "urology". We found that most urology influencers on Twitter are US board-certified urologists with a strong research history.

1. Introduction

In the past decade, there has been an explosion of information available online in an increasingly connected world. Social media use in medicine has skyrocketed, with most physicians and patients using social media to disseminate, communicate, or access relevant medical information. Unsurprisingly, there has also been a dramatic increase in the use of social media by the urology community, particularly the microblogging platform Twitter. In 2017, just over half of American Urological Association (AUA) members used Twitter [1]. Use of Twitter increased further during the COVID-19 pandemic, with an estimated 113 US academic urology programs holding an account in 2020 [2].

There is also a substantial amount of social media discourse related to urological health topics. For example, Twitter activity related to urological malignancies grew by 122% in 2014 alone, with more than 100 000 tweets by approximately 40 000 participants, largely dominated by the #prostatecancer discussion [3]. Pediatric urology studies have also reported an increase in parental health-seeking behavior on social media platforms such as Twitter [4]. It has been shown that physicians play a role in guiding the information disseminated on Twitter [5].

Despite great potential for global scientific exchange and patient outreach, previous studies have also highlighted the pitfalls of social media. This includes exposure of health information consumers to misleading or inaccurate information about urological conditions on Twitter and other social networks [6]. These findings highlight the important role of urologists and other key urology opinion leaders in sharing evidence-based information through social networks.

Considering the significant influence of social media on the dissemination and communication of urology information, we sought to identify and describe the personal accounts with the greatest impact and user reach on Twitter, including board certification status and specialty. We also aimed to determine the relationship between social media influence and academic impact.

2. Materials and methods

2.1. Identification of the top 100 Twitter influencers

Twitter influence scores for "urology" were generated in April 2022 using Right Relevance software (Fig. 1). The time frame for Twitter activity used for analysis was the time of account creation up to April 2022. As a result, Right Relevance captured the activity of every account from the time of creation up to the same endpoint in April 2022, which then factored into their influence score. Right Relevance software uses a fully algorithmic process through machine learning and semantic analysis to provide a two-level proprietary rank [7]. This is based on (1) connections (followers/following) to other influencers on a particular topic ("urology") and (2) engagement (likes, retweets, and views) [8]. This software and methodology have been used for other surgical specialties including neurosurgery [9], plastic surgery [8], orthopedics [10], and general surgery [11].

2.2. Demographic data collection for the top 100 influencers

The top 100 personal accounts with the highest computed scores were linked to individuals' names, along with their Twitter handle, all-time *h* index, total documents published, geographic distribution, specialty, attributed sex, number of followers, date of joining Twitter, and board certification status. Our study used the Gender-API (Munich, Germany; gender-api.com) algorithm to estimate whether the account holder was male or female. Gender-API has been used successfully in prior urological studies for attributed sex [12] and is one the strongest performers in head-to-head classification error studies [13]. Our study cross-referenced the Scopus reported *h* index to the Google Scholar *h* index for quality assurance. Account names, including middle initials, were cross-referenced with academic institution profiles and practice websites. Accounts linked to societies or practice groups were excluded. Board certification was verified as of April 2022 on the American Board of Urology, American Board of Radiology, and American Board of Internal Medicine websites. Verification of board certification was restricted to influencers practicing in the USA. The academic *h* index was collected from the Scopus Preview Author profile (Scopus, Reed Elsevier, London, UK). The *h*-index scores were obtained as of April 31, 2022. Total documents published according to Scopus were also collected. Document types covered in Scopus include peer-reviewed articles, articles in press, books, chapters, conference papers, data papers, letters, reviews, and editorials.

2.3. Statistical analysis

Descriptive statistics were used to summarize the data. An unpaired *t* test was performed to compare populations. The Pearson correlation coefficient (*r*) was calculated. Data figures and analyses were completed using Microsoft Excel (Seattle, WA, USA). A two-sided value of $p < 0.05$ was considered statistically significant.

3. Results

3.1. Demographics of the top 100 Twitter influencers

The accounts of the top 100 influencers were catalogued (Table 1). Topic scores on "urology" generated from the Right Relevance algorithm ranged from 96 to 82. Most (91%) of the top Twitter influencers were urologists. The other influencers in the top 100 consisted of medical oncologists (6%), nonphysicians (researchers with a PhD degree; 2%), and a radiation oncologist (1%). Only 15% of the influencers were female. For the influencers who were physicians (98/100), almost all had completed their respective medical specialty training, apart from three influencers

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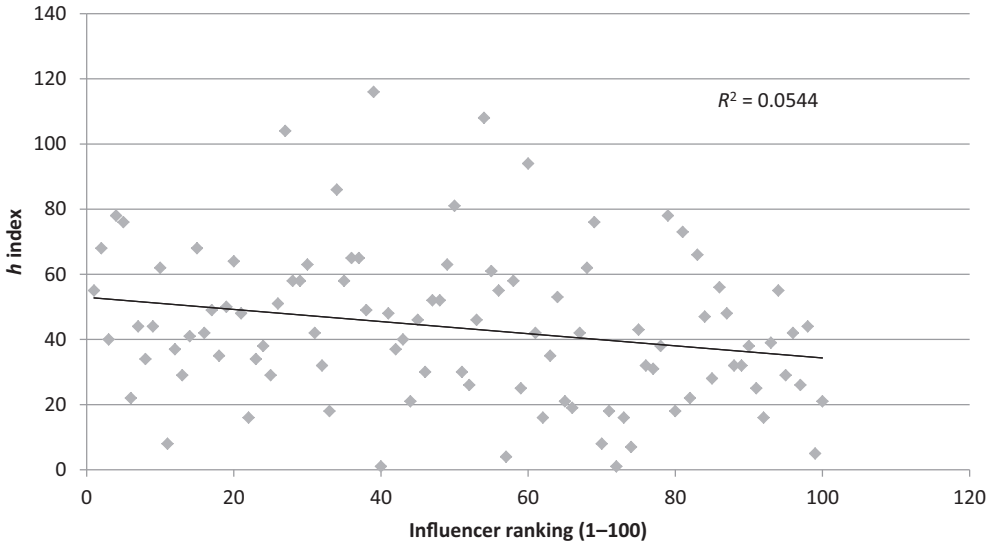

Fig. 1 – Correlation between Right Relevance Twitter ranking and all-time *h* index for the top 100 Twitter influencers.

who were trainees (resident physicians) at the time of the search. Of the influencers located in the USA, 93% had active board certification (American Board of Urology, American Board of Internal Medicine, or American Board of Radiology certificate in radiation oncology). The average number of years for which the influencers had a Twitter account was 10 yr. The majority (77%) had created their Twitter account by January 2014. The mean number of followers as of April 2022 was 5131.8 (interquartile range [IQR] 2669–5808.5). The maximum number of followers at the time of the initial query was 67 990 and the minimum was 1262.

3.2. *Research activity of the top 100 Twitter influencers*

The median *h* index was 42 (IQR 28.25–58). The mean *h* index was 43.54 with standard deviation of 23.17, and ranged from a maximum of 116 to a minimum of 1, which indicates that all influencers published at least one peer-reviewed paper. The association between the *h* index and influencer rank was positive but weak (r = 0.23; p = 0.02). According to Scopus, the mean total number of publications was 294.6, with standard deviation of 171.8. The maximum number of publications was 715 and the minimum was two. The association between the number of publications and influencer rank was also weak, but statistically significant (r = 0.20; p = 0.04).

3.3. *Geographic distribution of the top 100 Twitter influencers*

Most influencers (64%) were located in the USA, followed by the UK (10%) and Australia (6%). Figure 2 depicts the geographic distribution of influencers by country. Supplementary Figure 1 shows the state distribution of US influencers. Only 22 of the 50 US states are represented. New York, California, and Pennsylvania were tied for first rank (7 influencers each), followed by Michigan and Massachusetts (6 each).

4. Discussion

Given the growing importance of social media in the practice of urology [14] and the increasing number of urologists and trainees with Twitter accounts [15,16], we focused on identifying the 100 most active and wide-reaching Twitter users in urology. We found that influencers in urology have a significant track record of producing high-quality research, with a mean *h* index of 43.54. In 2019, it was estimated that the mean Scopus *h* index for academic urologist is 16.1, sampled across 2214 academic urology faculty (2015 in the USA and 199 in Canada) [17]. This is consistent with other reports on the mean *h* index for urology faculty captured from the top 20 urology programs in the USA, as determined by the *US News and World Report* 2008 rankings. The mean *h* index was 22.0 for full professors (n = 103), 13.8 for associate professors (n = 71), and 8 for assistant professors (n = 92) [18]. There was a statistically significant albeit weak correlation between influencer ranking and *h* index. Notably, the correlation coefficient may be weak because the sample was highly selected. For example, an individual ranked number 76 on influencer score is likely to be much more similar in research activity to an individual ranked number 14 than to a standard academic urologist not among the top 100 Twitter urology influencers. Ultimately, as a group, the top 100 influencers have a substantially higher academic impact (more than the average urologist); however, among the top 100 group itself, there is a weak correlation between Twitter rank and scientific impact. Furthermore, we were unable to determine whether Twitter influencer rank was seemingly driven by the *h* index (proxy for research impact) or number of documents published (proxy for research productivity).

In characterizing the profile of the most active and influential users in urology on Twitter, health care professionals and patients will understand who to consider following for reliable urology content. Novel ideas, research, and innovative techniques in urology are no longer restricted to aca-

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Table 1 – Top 100 Twitter influencers on the topic of urology as reported by the Right Relevance algorithm

#	Twitter handle	Name	Specialty	*h* index	#	Twitter handle	Name	Specialty	*h* index
1	loebstacy	Stacy L. Loeb	Urologist	55	51	bekidneystone	Brian H. Eisner	Urologist	30
2	dr_coops	Matthew Cooperberg	Urologist	68	52	kguromd	Kirsten L. Greene	Urologist	26
3	uretericbud	Alexander Kutikov	Urologist	40	53	Cgratzke	Christian Gratzke	Urologist	46
4	declangmurphy	Declan G. Murphy	Urologist	78	54	DrChoueiri	Toni Choueiri	Oncologist	108
5	jimcatto	Jim Catto	Urologist	76	55	jstuartwolf	James Stuart Wolf Jr.	Urologist	61
6	daviesbj	Benjamin J. Davies	Urologist	22	56	urojdr	Jay D. Raman	Urologist	55
7	wandering_gu	Todd M. Morgan	Urologist	44	57	ashleygwinter	Ashley G. Winter	Urologist	4
8	mariajribal	Maria J. Ribal	Urologist	34	58	prof_nick_james	Nick James	Oncologist	58
9	qdtrinh	Quoc-Dien Trinh	Urologist	44	59	doctorsotelo	René Sotelo	Urologist	25
10	prokarurol	Prokar Dasgupta	Urologist	62	60	erickleinmd	Eric A. Klein	Urologist	94
11	storkbrian	Brian R. Stork	Urologist	8	61	joshmeeks	Joshua J. Meeks	Urologist	42
12	drhwoo	Henry Woo	Urologist	37	62	urooncologist	Anthony T. Corcoran	Urologist	16
13	angiesmith_uro	Angela M. Smith	Urologist	29	63	ben_breyer	Benjamin N. Breyer	Urologist	35
14	benchallacombe	Ben Challacombe	Urologist	41	64	siadaneshmand	Siamak Daneshmand	Urologist	53
15	urogeek	David F. Penson	Urologist	68	65	spsutkamd	Sarah P. Psutka	Urologist	21
16	drphil_urology	Phillip M. Pierorazio	Urologist	42	66	carolynbestphd	Carolyn Best	Nonphysician	19
17	uroegg	Scott E. Eggener	Urologist	49	67	ndowjames	James N'Dow	Urologist	42
18	peepeedoctor	Khurshid R. Ghani	Urologist	35	68	maxinesun	Maxine Sun	Nonphysician	62
19	m_e_nielsen	Matt E. Nielsen	Urologist	50	69	ficarravincenzo	Vincenzo Ficarra	Urologist	76
20	urodocash	Ashish M. Kamat	Urologist	64	70	drjaminb	Jamin V. Brahmbhatt	Urologist	8
21	allaf_mo	Mohamad E. Allaf	Urologist	48	71	_theurologist_	Mike Leveridge	Urologist	18
22	mattbultitude	Matthew Bultitude	Urologist	16	72	dr_imogen	Imogen Patterson	Urologist	1
23	jdhdavis	John W. Davis	Urologist	34	73	jgomezrivas	Juan Gómez Rivas	Urologist	16
24	dytcmd	David Yen Tang Chen	Urologist	38	74	drmarniqueb	Marni Basto	Urologist	7
25	tdave	Timothy D. Averch	Urologist	29	75	otraxer	Olivier Traxer	Urologist	43
26	nakadasteve	Stephen Y. Nakada	Urologist	51	76	ranjithramamd	Ranjith Ramasamy	Urologist	32
27	alan_partin	Alan W. Partin	Urologist	104	77	jenangermd	Jennifer T. Anger	Urologist	31
28	montypal	Sumanta K. Pal	Oncologist	58	78	michael_gorin	Michael Gorin	Urologist	38
29	erplimackmd	Elizabeth R. Plimack	Oncologist	58	79	juddmoul	Judd W. Moul	Urologist	78
30	mroupret	Morgan Roupret	Urologist	63	80	jteoh_hk	Jeremy Teoh	Urologist	18
31	gpalapa2	Ganesh S. Palapattu	Urologist	42	81	jimmontie	James E. Montie	Urologist	73
32	dannymak76	Danil V. Makarov	Urologist	32	82	uroncdoc	Jeffrey J. Tomaszewski	Urologist	22
33	matthayn	Matthew H. Hayn	Urologist	18	83	ashtewarimd	Ashutosh K. Tewari	Urologist	66
34	heinvanpoppel	Hein Van Poppel	Urologist	86	84	lawrentschuk	Nathan Lawrentschuk	Urologist	47
35	tanejauro	Samir S. Taneja	Urologist	58	85	tsoburol	Tim O'Brien	Urologist	28
36	urocancermd	Sam S. Chang	Urologist	65	86	joanfundi	Joan Palou Redorta	Urologist	56
37	michaelcookso18	Michael S. Cookson	Urologist	65	87	alexmottrie	Alex Mottrie	Urologist	48
38	endourologyucsd	Manoj Monga	Urologist	49	88	pgrivasmdphd	Petros Grivas	Oncologist	32
39	drshariat	Shahrokh F. Shariat	Urologist	116	89	karitikkinen	Kari Tikkinen	Urologist	32
40	drbriansteixner	Brian L. Steixner	Urologist	1	90	onco_uroloog	Inge van Oort	Urologist	38
41	rogerkirby12	Roger Kirby	Urologist	48	91	mehrazinmd	Reza Mehrazin	Urologist	25
42	mrsprostate	Caroline Moore	Urologist	37	92	ojwiseman	Oliver Wiseman	Urologist	16
43	gorejohn	John L. Gore	Urologist	40	93	trwherrmann	Thomas RW Herrmann	Urologist	39
44	keithkow	Keith J. Kowalczyk	Urologist	21	94	drfabdollah	Firas Abdollah	Urologist	55
45	ebmurology	Philipp Dahm	Urologist	46	95	albertobreda1	Alberto Breda	Urologist	29
46	resnickmj	Matthew J. Resnick	Urologist	30	96	foxal72	Alessandro Volpe	Urologist	42
47	pcvblack	Peter Black	Urologist	52	97	apolo_andrea	Andrea B. Apolo	Oncologist	26
48	urooncmd	Antonio Finelli	Urologist	52	98	drspratticus	Daniel E. Spratt	Radiationoncologist	44
49	jimhumd	Jim C. Hu	Urologist	63	99	drtortolero	Leonardo Tortolero	Urologist	5
50	uropro	Gerald L. Andriole	Urologist	81	100	drdanielmoon	Daniel Moon	Urologist	21

demic centers and hospital systems. Instead, social media allows the mass dissemination of ideas to nearly anyone with a Twitter account in the world. The consequences of this reach cannot be understated, particularly for a topic such as urology that requires a deep understanding and specialization. Most influencers had active board certification in the USA. An interesting finding is the very small number of trainees in the top 100 (n = 3). This is probably simply a reflection of time since joining the social media platform. In addition, unfortunately only 15% of the influencers were female. This is probably a reflection of the greater landscape of urology in the USA, as the 2021 AUA specialty-wide census indicated that females make up 10.3% of practicing urologists [19]. It will be necessary to follow whether there is

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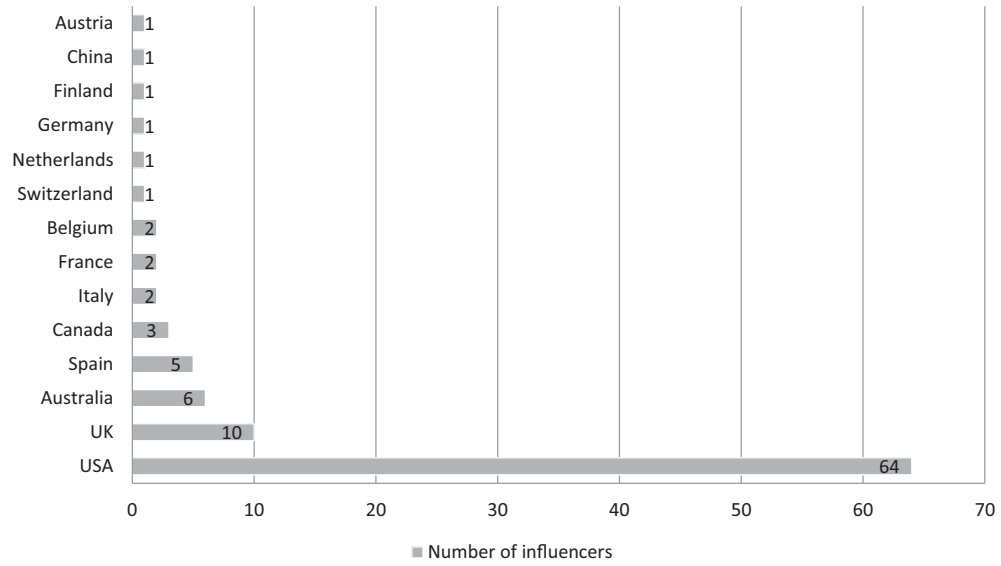

Fig. 2 – Distribution of urology Twitter influencers by country.

continual growth in female representation, as females are a much-needed voice as urology thought leaders in the social media space. In addition, when calculating the topic score, the Right Relevance algorithm does not measure retweets and followers alone but also factors in bidirectional engagement with other influencers. This may explain why there is a weaker association between the *h* index and the number of followers ($r = 0.16$; $p < 0.001$) and between the number of followers and influencer rank ($r = 0.13$; $p < 0.001$). It is most likely that influencer rank and topic score in urology are linked to strong connections to other physician leaders that arose organically outside of the web. In fact, data from physician interviews show that building trust on social media mostly relies on face-to-face relationships in real life, and physicians establish trust on social media via previous personal interactions, authenticity, and relevance of voice [20].

We recognize that this study is cross-sectional in nature and only provides a snapshot of the ranking of influencers, specifically in April 2022, when the search was performed. Influence can of course change over time. However, as in research, influence appears to be a cumulative process. This would support our finding that a significant number of urology influencers (48%) created an account on Twitter ≥10 yr ago, and only 2% created an account in the past 5 yr. Specifically, more quality posts with high levels of peer engagement on Twitter over extended periods of time probably contribute to ranking position. Data show that Twitter activity may be an early indicator of the ultimate academic impact of a urology publication [21,22]. It seems that more emphasis is being placed on the lasting social media imprint and involvement by physicians. For example, there is a statistically significant correlation between Twitter activity and US News World Report reputation scores for urology departments [23]. In fact, in early 2016 the Mayo Clinic Academic Appointments and Promotions Committee began including social media scholarship among the criteria considered in review of proposals for academic advancement [24].

Our study is not without limitations. First, the rankings used in this study are based on the algorithm created by Right Relevance. Even though it has been widely accepted in multiple prior publications, there is no way to validate the accuracy of the proprietary algorithm. Using graph theory, machine learning, and natural language processing, Right Relevance determines how accounts congregate to form "communities" that share common interests within the context of a topic or trend (eg, urology). The custom proprietary rank algorithm is derived from Google page rank but is specialized for social graphs (instead of links or webpages). The algorithm dampens follower counts, tweet counts, and noisy signals, and puts much more focus on the topical network itself [7]. The actual code and weighted attributes of the custom algorithm for influencer score are not published, and it is under the ownership of Right Relevance. An example of undervaluing by the algorithm is the position of one account, @AshleyGWinter. Specifically, as of August 2022, the handle @AshleyGWinter has more than 107 100 followers, which is an enormous urologic social media presence and greater than any other profile in the top 100 according to the algorithm. In addition, this account is rapidly growing in popularity. Since our study design is cross-sectional in nature, we are unable to draw any conclusions on longitudinal trends in social media rankings. Second, Scopus may not have captured all the research publications of an influencer. However, it is unlikely that the limitations of Scopus introduce differential biases into our study. Scopus does sum an influencer's research activity across multiple institutions. The *h* indices generated via Google Scholar profiles were also collected if available to validate the Scopus *h* indices. Only 54 influencers had a Google Scholar profile with a reported all-time *h* index. Among these, the median all-time *h* index was 52.5 (IQR 40.5–68), which supports the finding of high

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academic contribution among Twitter influencers in urology compared to data published by academic urologists in general. In addition, the *h* index itself is imperfect when assessing academic influence, as it favors researchers who have been active for a longer period of time and is inherently biased against younger researchers [25]. Third, our limited sample does not permit us to draw overarching conclusions, but does provide insight into which urologists effectively communicate within the "Twitterverse". Our findings are encouraging in terms of combating the spread of misinformation in urology. Fourth, we did not collect self-identified male or female gender. However, our software detection tool is considered one of the most accurate, with a 0.3% rate of unrecognizable names [13,26]. Lastly, we only investigated one social media platform. However, previous research has found that Twitter is a dominant platform used for urology discussions and consequently is a reasonable platform to use to assess the expertise of key influencers on an important research question.

5. Conclusions

Our results indicate that most urology influencers on Twitter are board-certified urologists practicing in the USA. Influencers have a relatively high academic impact as a group in comparison to other academic urologists. Among influencers, there is a weak but statistically significant correlation between Twitter rank and academic productivity.

Author contributions: Nicholas Corsi had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: N. Corsi, Nguyen, Butaney, Majdalany, M.P. Corsi, Malchow, Piontkowski, Trinh, Loeb, Abdollah.
Acquisition of data: N. Corsi, Nguyen, Butaney, Majdalany, M.P. Corsi, Malchow, Piontkowski.
Analysis and interpretation of data: N. Corsi, Nguyen, Butaney, Majdalany, M.P. Corsi, Malchow, Piontkowski, Trinh, SL, FA.
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Appendix A. Supplementary data

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