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SHORT REPORT

Mapping and quantification of the twitter footprint of cardiologists

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Aims The increasing importance placed by medical journals for dissemination of published articles on social media, such as posting Altmetric scores, has further expedited the need for differentiating *bona fide* science from pseudo-science. The 'Kardashian index' (a.k.a., K-index) was suggested, which correlates the citations of a scientist with his/her Twitter followers.

Methods and results From a list of top 100 cardiology hospitals in accordance with the most recent US News and World Report rankings, 1500 cardiologists were selected based on institutional physician profile pages complete with cardiologists' headshots. The K-index of cardiologists, and variables like all-time posts, and posts for the past 12 months (1 June 2019 to 31 May 2020) from cardiologists were documented and analysed. The K-index of cardiologists in our study was stratified into the following categories (upper boundary inclusive); K-index 0–1 ($n = 104$); K-index 1–2 ($n = 30$); K-index 2–3 ($n = 24$); K-index 3–4 ($n = 14$); K-index 4–5 ($n = 5$); and K-index >5 ($n = 22$). There was no statistically significant difference ($P = 0.94$) in the citation number across the K-index categories (no consistent pattern observed, median citations ranging from 237 to 610). However, cardiologists with higher K-index categories had a higher number of 12-month posts (median 14 vs. 392 for K-index categories 0–1 and >5, respectively; *P*-value <0.001).

Conclusion Considering no evidence of a difference in the number of citations across K-index categories, the stigma associated with higher K-index needs to be reconsidered.

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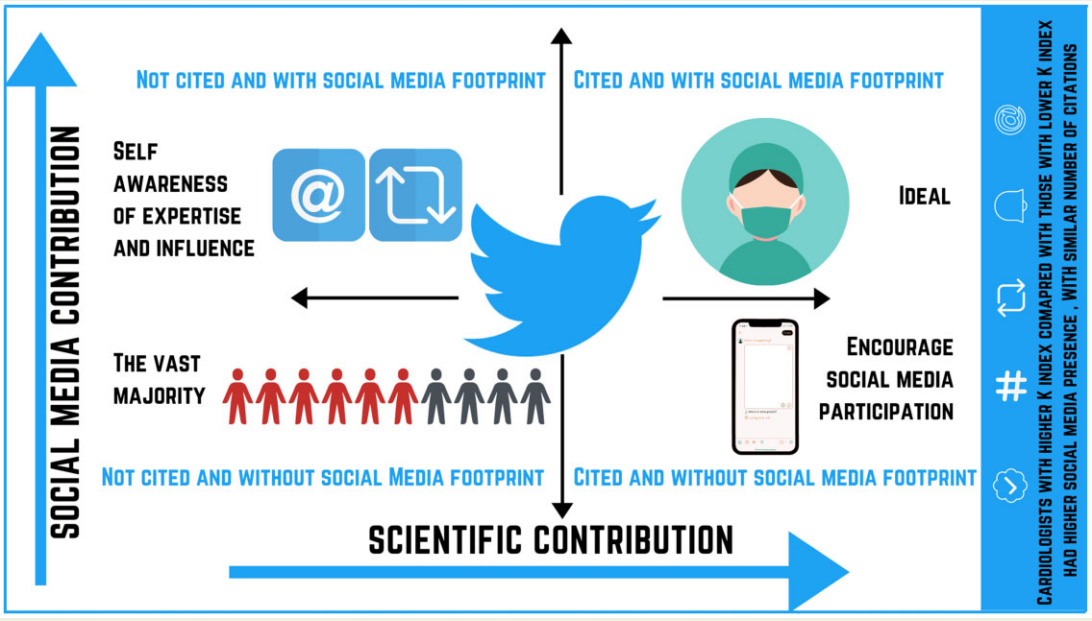
Graphical Abstract



Keywords Social media • Twitter • Cardiologist

Social media (SoMe) use is encouraged among healthcare professionals—it is used to broaden one's professional network, share scientific information, discuss and influence public health policies, occasionally engage in social interactions with the public, enhance health literacy among patients, peers, and students, and for collaboration among peers. While SoMe possesses a myriad of merits for communication and expeditious information dissemination, it also has its pitfalls encompassing misinformation propagation, privacy breach, online intimidation, reduction of complex issues to slogans, and clinician–caregiver–patient boundary infringement.[1] SoMe gives firsthand access to late-breaking scientific literature, stirring thought-provoking debates and discussions, but these exchanges are not chaperoned by the traditional peer-review process. Furthermore, the increasing importance placed by medical journals for dissemination of published articles on SoMe, such as posting Altmetric scores, has further expedited the need for differentiating *bona fide* science from pseudo-science.[2]

In this context, the 'Kardashian index' (a.k.a., K-index) was suggested, which correlates the citations of a scientist with his/her Twitter followers.[3,4] The K-index is calculated by computing *Ft*/*F*, where *Ft* is the number of followers on Twitter, and *F* is the number of followers one should have based on the number of citations (*C*).[3] The *F* factor is further calculated using the formula: $F = 43.3\ (C)^{0.32}$. A previous study stratified cardiologists based on K-index and reported that most cardiologists have a low K-index.[4] Additionally, though the K-index among cardiologists varied considerably, the study did not report reasons for these variations.

From a list of top 100 cardiology hospitals in accordance with the most recent US News and World Report rankings, 1500 cardiologists were selected based on institutional physician profile pages complete with cardiologists' headshots. Of these 1500 cardiologists, only 245 (16.3%) had a Twitter handle. Furthermore, the K-index was available for 199 (81.2%) of these 245 cardiologists with a Twitter handle. We were unable to compute the K-index for the remainder of 46 (18.8%) cardiologists as their citation metric was zero. The total number of followers for each of the 199 Twitter handles was documented, and the followers were further stratified as medical doctors, cardiologists, other healthcare professionals, or media. All-time posts, posts for the past 12 months (1 June 2019 to 31 May 2020), and original posts/replies without retweets for each handle were extracted. Total posts per day and original posts per day were documented for each handle. Posts by other cardiologists which mentioned the 199 cardiologists in the study over a 3-month period (1 March 2020 to 31 May 2020) were extracted for each Twitter handle. Furthermore, these were categorized as all posts and original posts/replies (excluding retweets). The total number of citations for each of the 199 cardiologists was obtained from Scopus. Numeric variables were expressed as median and interquartile range, and tested for trend across the K-index categories using the Jonckheere–Terpstra test. *P*-values were two-sided, and $P < 0.05$ was considered statistically significant. All statistical analyses were conducted in R statistical software version 3.6.2 (R Project for Statistical Computing).

The K-index of cardiologists in our study was stratified into the following categories (upper boundary inclusive); K-index 0–1 ($n = 104$);

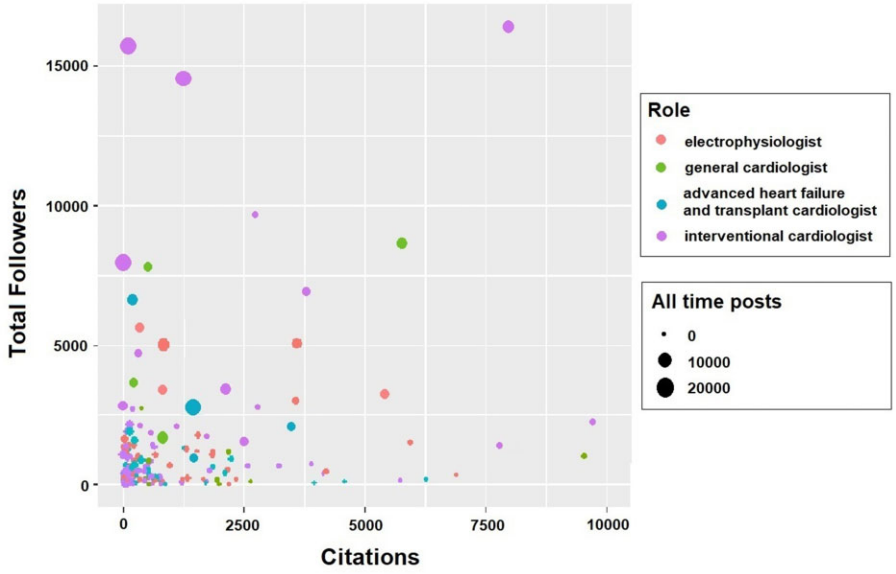


Figure 1 Scatter plot with *X*-axis representing citations and *Y*-axis representing total followers. The colour of the bubbles in the scatter plot represents the role of cardiologists, while the size of the bubbles represents number of all-time posts.

K-index 1–2 ($n = 30$); K-index 2–3 ($n = 24$); K-index 3–4 ($n = 14$); K-index 4–5 ($n = 5$); and K-index >5 ($n = 22$) (*Table 1*). There was no statistically significant difference ($P = 0.94$) in the citation number across the K-index categories (no consistent pattern observed, median citations ranging from 237 to 610). However, cardiologists with higher K-index categories had a higher number of 12-month posts (median 14 vs. 392 for K-index categories 0–1 and >5, respectively; $P < 0.001$). Similarly, cardiologists with higher K-index categories had significantly higher 12-month posts without retweets, total all-time posts, and mentions by cardiologists over the past 3 months. No specific relationship was noted between citations and total number of followers on Twitter among the cardiologists included in the present analysis (*Figure 1*). Furthermore, while there were cardiologists with many citations and many followers, there were also cardiologists with few citations and many followers.

Our study stratified cardiologists based on their K-index and found no statistically significant association with their citation numbers. Cardiologists with higher K-index had higher all-time posts, posts for the past 12 months, and mentions by other cardiologists over the past 3 months. Considering no evidence of a difference in the number of citations across K-index categories, the stigma associated with a higher K-index needs to be reconsidered. A higher number of followers, and a resulting higher K-index is often due to higher engagement rates of these cardiologists on Twitter, as indicated by a higher total and 12-month Twitter posts. However, we did not account for age or academic seniority of cardiologists in the present analysis; this is a limitation of our study. The results of a recent analysis had similar conclusions with only factors related to SoMe activity deciding the number of followers, with citation count having no effect.[5] Our study complements these findings suggesting that cardiologists with different K-indices may be similar 'academically' based on citation counts, and have a higher K-index because of their SoMe activity. More importantly, for consumers of scientific information on Twitter, our data provide insight into the significance of knowing both the K-index (measure of SoMe contribution) and the H-index (measure of scientific contribution, defined as the h number of publications of a scientist that each have at least h citations) of the Twitterati. A Twitter handle with congruent H- and K-indices may represent the ideal balance of scientific contribution and SoMe influence/voice.

Furthermore, Twitter handles with a low K-index/H-index ratio should perhaps be encouraged to be more active on SoMe. Further research is needed prior to using Twitter presence as a factor in academic promotions, as it is not yet clear that it independently provides evidence of meaningful contribution to education, though it might have that potential.[6] The landscape of medical practice has changed with the extensive availability of information achieved by the various SoMe posts that are public and rapidly searchable.[7] Physicians should be empowered to post content that fosters dissemination of scientifically verified content for the public.[8] However, extensive focus should be placed on encouraging judicious use of SoMe by physicians and responsible interpretations of the content on SoMe.

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Table 1 **Kardashian index groupings of cardiologists included in the study (upper bound inclusive)**

	Kardashian index (0–1) (*N* = 104)	Kardashian index (1–2) (*N* = 30)	Kardashian index (2–3) (*N* = 24)	Kardashian index (3–4) (*N* = 14)	Kardashian index (4–5) (*N* = 5)	Kardashian index (>5) (*N* = 22)	*P*-value
12 months post	14 (1–79)	95 (18–217)	188 (88–391)	169 (98–400)	467 (232–1525)	392 (321–849)	<0.001
12 months PPD	0.0 (0.0–0.2)	0.3 (0.1–0.6)	0.5 (0.2–1.1)	0.5 (0.3–1.1)	1.3 (0.6–4.2)	1.1 (0.9–2.3)	<0.001
12 months post no RT	8 (1–54)	41 (11–134)	94 (40–265)	88 (62–306)	317 (167–775)	298 (80–409)	<0.001
12 months PPD no RT	0.0 (0.0–0.2)	0.1 (0.0–0.4)	0.3 (0.1–0.7)	0.2 (0.2–0.8)	0.9 (0.5–2.1)	0.8 (0.2–1.1)	<0.001
All-time post	54 (12–210)	393 (71–727)	737 (318–1102)	613 (404–997)	1581 (1001–3992)	2955 (1611–4406)	<0.001
Total followers	199 (94–486)	556 (449–1173)	1265 (908–1818)	1808 (1378–2108)	2742 (1600–2766)	5083 (2100–7891)	<0.001
Cardiology followers	67 (22–158)	220 (131–438)	430 (355–656)	690 (525–909)	808 (577–1154)	1058 (517–1908)	<0.001
MD followers	86 (34–206)	286 (178–519)	566 (448–929)	857 (629–108)	1215 (779–1350)	1490 (961–2541)	<0.001
Media followers	4 (1–8)	13 (9–30)	25 (19–36)	30 (22–34)	33 (25–63)	88 (53–116)	<0.001
Other healthcare followers	22 (10–59)	80 (47–163)	155 (117–221)	204 (165–243)	297 (202–383)	458 (282–632)	<0.001
Total categorized followers	115 (49–280)	361 (243–722)	724 (617–1195)	1112 (818–1372)	1661 (976–1680)	2032 (1401–3230)	<0.001
Mentions by cardiology 3 months	12 (1–64)	64 (19–168)	185 (70–270)	350 (172–551)	428 (337–485)	447 (159–1357)	<0.001
Mentions by cardiology 3 months no RT	5 (0–31)	39 (13–111)	77 (31–142)	191 (89–309)	289 (157–291)	252 (100–892)	<0.001
Citations	610 (162–2260)	258 (92–943)	528 (121–2018)	589 (97–1452)	237 (197–1447)	326 (93–2588)	0.94
Kardashian index	0.5 (0.3–0.8)	1.5 (1.3–1.8)	2.5 (2.3–2.8)	3.6 (3.3–3.8)	4.5 (4.2–4.5)	8.7 (7.0–14.6)	

MD, medical doctor; PPD, posts per day; RT, retweet.

Conflict of interest: D.L.B. discloses the following relationships—Advisory Board: Cardax, CellProthera, Cereno Scientific, Elsevier Practice Update Cardiology, Level Ex, Medscape Cardiology, PhaseBio, PLx Pharma, Regado Biosciences; Board of Directors: Boston VA Research Institute, Society of Cardiovascular Patient Care, TobeSoft; Chair: American Heart Association Quality Oversight Committee; Data Monitoring Committees: Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute, for the PORTICO trial, funded by St. Jude Medical, now Abbott), Cleveland Clinic (including for the ExCEED trial, funded by Edwards), Contego Medical (Chair, PERFORMANCE 2), Duke Clinical Research Institute, Mayo Clinic, Mount Sinai School of Medicine (for the ENVISAGE trial, funded by Daiichi Sankyo), Population Health Research Institute; Honoraria: American College of Cardiology (Senior Associate Editor, Clinical Trials and News, ACC.org; Vice-Chair, ACC Accreditation Committee), Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute; RE-DUAL PCI clinical trial steering committee funded by Boehringer Ingelheim; AEGIS-II executive committee funded by CSL Behring), Belvoir Publications (Editor in Chief, Harvard Heart Letter), Canadian Medical and Surgical Knowledge Translation Research Group (clinical trial steering committees), Duke Clinical Research Institute (clinical trial steering committees, including for the PRONOUNCE trial, funded by Ferring Pharmaceuticals), HMP Global (Editor in Chief, Journal of Invasive Cardiology), *Journal of the American College of Cardiology* (Guest Editor; Associate Editor), K2P (Co-Chair, interdisciplinary curriculum), Level Ex, Medtelligence/ReachMD (CME steering committees), MJH Life Sciences, Population Health Research Institute (for the COMPASS operations committee, publications committee, steering committee, and USA national co-leader, funded by Bayer), Slack Publications (Chief Medical Editor, Cardiology Today's Intervention), Society of Cardiovascular Patient Care (Secretary/Treasurer), WebMD (CME steering committees); Other: Clinical Cardiology (Deputy Editor), NCDR-ACTION Registry Steering Committee (Chair), VA CART Research and Publications Committee (Chair); Research Funding: Abbott, Afimmune, Amarin, Amgen, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, Cardax, Chiesi, CSL Behring, Eisai, Ethicon, Ferring Pharmaceuticals, Forest Laboratories, Fractyl, Idorsia, Ironwood, Ischemix, Lexicon, Lilly, Medtronic, Pfizer, PhaseBio, PLx Pharma, Regeneron, Roche, Sanofi Aventis, Synaptic, The Medicines Company; Royalties: Elsevier (Editor, Cardiovascular Intervention: A Companion to Braunwald's Heart Disease); Site Co-Investigator: Biotronik, Boston Scientific, CSI, St. Jude Medical (now Abbott), Svelte; Trustee: American College of Cardiology; Unfunded Research: FlowCo, Merck, Novo Nordisk, Takeda. Dr. Kalra discloses being the Chief Executive Officer and Creative Director of makeadent.org.

Data availability

No new data were generated or analysed in support of this research.

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