Twitter Networks' Centrality Measures of the Association of Health Journalist (ANIS): the Case of Vaccines - Introduction and Theoretical Framework

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Abstract

The popularization of Internet and the rise of social networks have offered an unbeatable opportunity for anti-vaccines, especially active communicators, to spread their message more effectively causing a significant impact on public opinion. A great amount of research has been carried out to understand the behavior that anti-vaccine communities show on social networks. However, it seems equally relevant to study the behavior that communities and communicators "pro vaccines" perform in these networks. Therefore, the objective of this research has been to study how members of the *Spanish Association of Health Journalist* (ANIS) communicate and use the social network Twitter. More specifically, the different interactions made by ANIS partners were analyzed through the so-called "centrality measures of social network analysis" (SNA), to check the configuration of the user network and detect those most relevant by their indexes of centrality, intermediation or mentions received. The research monitored 142 twitter accounts for one year analyzing 254 twits and their 2.671 interactions. The research concluded that the network of ANIS partners on Twitter regarding vaccines has little cohesion and has several components not connected to each other, in addition to the fact that there are users outside the association that show greater relevance than the partners themselves. We also concluded that there are an important lack of planning and direction in the communication strategy of ANIS on Twitter, which limits the dissemination of important content.

Keywords: Centrality Measures in the Twitter Network of Health Specialized Journalists -The Case of Vaccines

Introduction

Even though vaccination rates in Spain are higher compared to other European countries (European Center for Disease Prevention and Control, 2019), is still insufficient and well below what would be desirable with respect to a considerable number of diseases ((Ministry of Health, 2018))

One explanation is in "the concern" that certain anti-vaccine groups have awakened in the population. Thus, in many cases, the alarm generated about the side effects of vaccines has overshadowed the dangers of diseases preventable by these vaccines (kata, 2010). This has socially relevant consequences since community immunization (herd immunity) weakens or even disappears, increasing the likelihood that such diseases will resurface or spread with greater ease (Gastaaduy, Budd, Fisher et al., 2016).

On the other hand, the increasing presence of new online communication platforms has caused that a large part of the existing debate on vaccines as been transferred to certain social networks (Dredze, Broniatowski, Smith, & Hilyard, 2015; Orr, Baram-Tsabari & Landsman, 2016). In turn, people are increasingly looking on the internet for information on health-related issues (Beck, Nguyen-Thanh, Montagni, Parizot, Renahy, 2014) and specifically, on how to act regarding vaccines (Betsch, Brewer, Brocard, Davies, Gaissmaier, Haase, Leask, et al, 2012; Harmsen, Doorman, Mollema et al., 2013). For example, Salmon et al., (2005) showed that parents who decide not to vaccinate their children have received more messages on the subject via the Internet.

This has produced an increment in the research focused on the study of communication about vaccines in different social networks such as instagram (Basch & MacLean, 2018), Pinterest (Guidry, Carlyle, Messner & Jin, 2015) Facebook, (Fassee , Chatman and Martin, 2016) and, especially Twitter (Zhou, Coiera, Tsafnat, Arachi, Ong & Dunn, 2015; Keim-Malpas, Mitchell, Sun & Kennedy, 2017). The latter being of special interest due to it's ranking, also being the most popular social network for sharing opinions and information.

Previous studies have shown how anti-vaccine movements tend to get organized. Also, they know very well how to take advantage of social networks such as twitter (Broniatowski, Jamison, Qi, AlKulaib, Chen, Benton, Quinn, & Dredze, 2018). However, despite the importance of this issue, there are no studies on how pro-vaccine groups behave on Twitter.

Thus, in line with previous research where social networks have been used to promote health aspects (Chou, Hunt, Beckjord, Moser & Hesse, 2009; Neiger, Thackeray, Van Wagenen, Hanson, West, Barnes & Fagen, 2012), this article analyzes how members of the Spanish Association of Health Journalist (ANIS) relate to each other and send messages about vaccines on the social network Twitter. Specifically, the different interactions that ANIS partners do through the so-called centrality

measures of social network analysis (ARS) are analyzed, to check the configuration of network users and to detect those most relevant by their indexes of centrality, intermediation or mentions received.

Objectives

The objectives were the following:

Measure to what extent ANIS members disseminate content related to the work of the association itself in relation to the subject of vaccines.

Analyze the pattern of vaccine messages on the twitter network, both from the official account of the association and its partners.

Analyze and interpret through the *centrality measures* the most relevant users that appear in the network formed by the interactions of ANIS partners on Twitter regarding vaccines.

Determine what type of external content is the most diffused by the network and by each one of its forming groups.

Methodology

The Node XL pro application (Smith, 2010) was used to collect data, through which all the tweets and interactions (mentions, responses and retweets) of journalists members of ANIS with a user account on Twitter were downloaded as well as those on the official twitter account. The data collected were those published between December 2, 2018 and January 1, 2019. The number of monitored journalists was 345.

All the messages that included the word "vaccine" or any of its derivatives (** vaccine **) were extracted from the generated database. In this way, it was possible to eliminate all the messages that produced noise within the conversation under study.

The main measures of *centrality* (Yep et al., 2014) were calculated with the already filtered database, in addition to creating user groups through the Clauset-Newman-Moore (2014) clustering algorithm.

The centrality measures calculated for the analysis were as follows:

In-degree:

Count of the number of edges pointing to a user in a directional network. This is one of the easiest ways to measure popularity within a network.

Out-degree:

Very prolific users within a network can also be very relevant when they mention or respond to others. They influence other users to join in and keep the conversation topic active. Out-degree levels count the number of times a user mentions or responds to others.

Eigenvector centrality:

The centrality index is determined by the number of connections a user has and the connections that the user's connections have. It is not just about making a count of

connections per user to measure their relevance within the network, but also counting how many connections the users that connect to the user in question have. A user can be a relevant character within the network not only by having many connections, but also by having few connections, who in turn are well connected.

Betweenness centrality

In a network it is not necessary to have many connections or important connections or to be very proactive to be a relevant character. There are users who connect to others acting as a connection bridge. Without these users, the network would lose cohesion and could end up being made up of components not connected to each other. The level of intermediation calculates which users act as connection bridges establishing the shortest path between two other non-connected users.

While in-degree levels and out-degree levels have objective meanings, since they represent counts of incoming and outgoing connections of each user, the levels of eigenvector centrality and intermediation, present relative values and are only valid for users present within the same network.

The in-degree and out-degree levels have objective meanings in network analysis; They are the total number of incoming and outgoing connections that an account has. On the other hand, the Eigenvector centrality and Betweenness centrality indices do not have such meanings. The values of these metrics are relative and can only be compared between accounts within the same network.
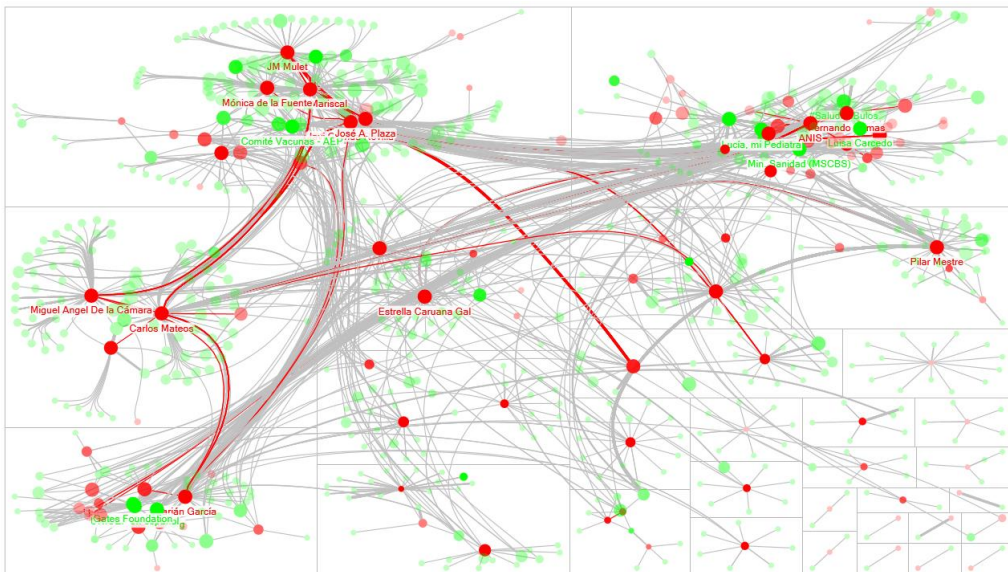
Analysis of Results

Network Analysis

The download of tweets published by ANIS associates with a Twitter account (345), and the association itself, between December 1, 2018 and November 30, 2019 generated a database of 37,239 users who interacted a total of 87,934 times, of these interactions 62,899 were unique and 25,035 duplicated.

Those users who included the term vaccine or its derivations ("** vaccine **) in their messages or interactions were filtered from this database, offering a result in which 142 partners were found, creating a network of a total of 836 users who interacted with each other 2,671 times, with 1,160 unique interactions and the rest repeated. The type of interactions were 256 original tweets, 770 mentions, 437 retweets, 1,099 retweet mentions, and 109 responses. the reciprocity index being 0.020.

The network identified 23 components of which three of them consisted of only one user. The component with the most users had 764 users and the component with the most interactions consisted of 2,586 of the total interactions.

The clustering algorithm used established 38 different user groups. The largest of them consisted of 160 users. Groups 16 to 38 were made up of less than 10 users.

Answers and mentions

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The size of the node indicates the centrality index, the color the membership of ANIS (red) and the opacity the level of intermediation. The thickness of the edge indicates the strength of the connection. Its color, reciprocity (red).

Retuits
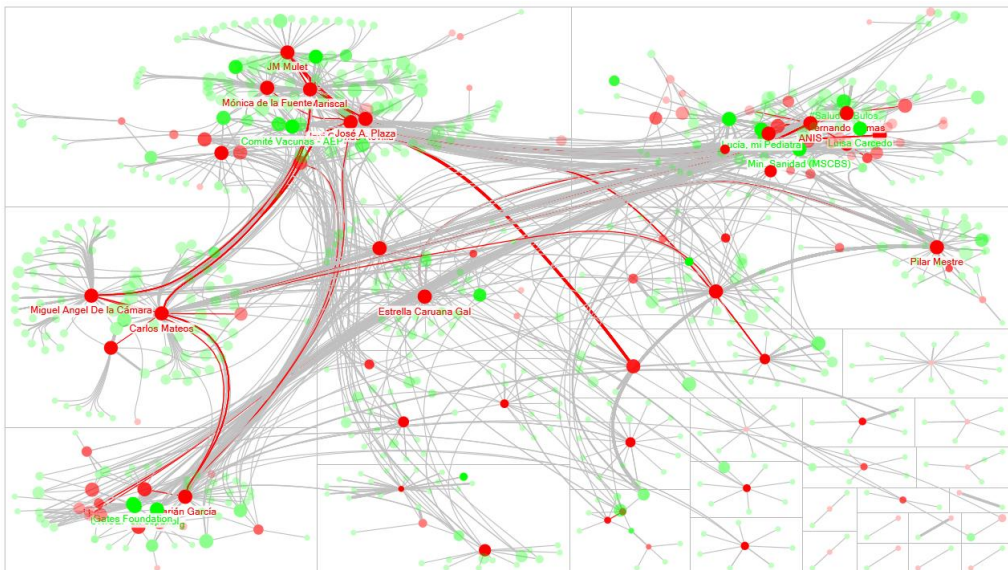
The size of the node indicates the centrality index, the color the membership of ANIS (red) and the opacity the level of intermediation. The thickness of the edge indicates the strength of the connection. Its color, reciprocity (red).

User analysis

The calculation of centrality measures identified the following users as outstanding:

Eingenvector centrality and Betwenness centrality

Name	Centrality	Associated	Name	Intermediation	Associated
Ricardo Mariscal	0.027	Yes	Ricardo Mariscal	123,505.30	Yes
Carlos Mateos	0.023	Yes	Carlos Mateos	105,763.76	Yes
Javi Granda Revilla	0.018	Yes	Miguel Angel Of the Camera	68,414.84	Yes
ANISE	0.017	Yes	Min. Health (MSCBS)	62,902.02	No
Lucia, my Pediatrician	0.013	No	Vaccines.org	61,196.58	No
Miguel Angel Of the Camera	0.012	Yes	Javi Granda Revilla	55,247.43	Yes
José A. Plaza	0.012	Yes	Lucia, my Pediatrician	54,393.65	No
Vaccines.org	0.011	No	JM Mulet	50,690.58	Yes
JM Mulet	0.010	Yes	ANISE	45,313.78	Yes
Pilar Mestre	0.010	Yes	Pilar Mestre	41,849.48	Yes

The centrality index figures highlighted the absence of ANIS as the highest ranking node. ANSI appeared in third position, surpassed by Ricardo Mariscal and Javi Granda Revilla, main users of group 1, in addition to Carlos Mateos, who is the most relevant

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user of group 3. The ANIS account, with a lower centrality index than those previously mentioned, is the most relevant user in group 2.

It was striking that the fifth user in terms of centrality ranking was not a member of the association. This is the user Lucía, my Pediatrician, who together with ANIS is the most important user of the second largest group in the entire network.

The ten users with the highest centrality indexes are concentrated in the four groups with the highest number of users, leaving the rest of the other 38 groups without a leader, or with leaders that are not very relevant within the network as a whole.

At the brokerage or intermediation levels there is a lesser degree of coherence of users belonging to the ANIS association versus those who do not. The three users that established the largest quantity of connections among other users belong to ANIS. Descending in the ranking, accounts of institutional users that already appeared in the previous lists are present, such as the Ministry of Health and the Spanish Association of Vaccines.

In-degree and Out-dregree

Name	In-degree	Associated	Name	Out-degree	Associated
Lucia, my Pediatrician	35	No	Ricardo Mariscal	111	Yes
Min. Health (MSCBS)	3. 4	No	Carlos Mateos	86	Yes
Vaccines.org	28	No	Miguel Angel Of the Camera	67	Yes
Luisa Carcedo	26	No	Javi Granda Revilla	58	Yes
THE COUNTRY	22	No	Pilar Mestre	46	Yes
UNICEF in Spanish	18	No	ANISE	Four. Five	Yes

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Gates Foundation	17	No	JM Mulet	Four. Five	Yes
ANISE	16	Yes	Caruana Star Gal	40	Yes
#SaludsinBulos	14	No	Laura Castellanos	38	Yes
Vaccines Committee - AEP	14	No	José A. Plaza	36	Yes

When the users with the highest number of mentions were analyzed, corporate and institutional have a higher ranking. They do not form a part of the ANIS network. The only accounts of individuals that appeared were from socially well-known users in relation to the object of study, such as the Minister of Health and the aforementioned, Lucia, my Pediatrician. The latter receives many mentions for their social recognition for publishing scientific works and having received a national award for this work. Regarding this index, ANIS partners do not appear.

Remember that the users with higher levels of out-degree are those who mention others the most, maintaining the conversation and the cohesion of the network. In relation to this index, ANIS associates appeared very prominently. The ten users with the highest levels were members of the association, with the ANIS account also appearing in sixth place. It also highlights that the partners with higher levels of centrality also appeared in the first positions in the out-degree levels.

In relation to the groups created with the clustering algorithm, the users with most mentions were distributed to a greater extent in different groups than in the previous cases, since they appear in groups 1, 2, 3, 5, and 7. Significant concentration remains in these groups with regards to the general network, considering that 38 groups were established in total.

Shared external content

Title	Medium	N ° times released
JM Mulet: "Unvaccinated children should not be admitted to a public school"	The world	9
Challenge Ministry of Health, Consumption and	Ministry of Health	5

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Social Welfare - #VacunasSinBulos		
Bioethics Committee: "Parents who do not want to vaccinate must have parental authority withdrawn for a time"	The world	4
A judge endorses the City Council that refused to enroll a child without vaccination in its nursery	The country	4
WHO alert: "dramatic" resurgence of measles in Europe due to 'anti-vaccines'	The vanguard	4
What do we do with anti-vaccines?	iSanidad	3
Nine scientific arguments to dismantle a vaccine	Huffingtonpost.es	3
The Bexsero will not be financed: the Government refuses to pay the meningitis vaccine that costs 400 euros	The Economist	3
Public health adds vaccines against meningococcus A, W and Y	The country	3
A judge against anti-vaccines: "They want others to take the risk to life of their decision"	The world	3

The general media are the chosen sources when external information is disseminated in the network. Only the Ministry of Health appears as a different source, when it

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holds a contest focused on the denial of hoaxes about Vaccines as well as an article published in a specialized media, published by Ricardo Mariscal, who appears online as the most relevant user in the main indexes, both absolute as well as relative.

Discussion and Conclusions

Previous research has shown that social media is one of the main focal points of conversation regarding health issues in general and vaccines in particular. For this reason, in this study we have carried out an analysis on the behavior of the members of the Spanish association of health journalist (ANIS) on Twitter regarding their communications on the subject of vaccines.

In the first place, the fact that only 142 members of the 345 have tweeted some content about vaccines is an indicator that there is not a great participation in this medium regarding the topic.

Secondly, the network presented by the ANIS partners together with the organization itself is very dispersed and incoherent. This is verified for the network cohesion index (0.00213592), and its modularity (0.209467), and also because there are 23 different components and 38 groups.

Third, when the most relevant users of the network formed by the interactions of ANIS partners on Twitter regarding vaccines were identified, it was found that, members of the association had significant influence with respect to out-degree indices. But when analyzing the in-degree indices, the users who receive the most mentions were not members of the association. In turn, regarding the centrality index, it was relevant to see the high scores of other non-ANIS users

To better understand why users are more relevant in terms of centrality, in-degree and out-degree, it would be convenient to study the content of their communications. Therefore, future research should analyze both, the format and content of their communications on twitter and combine the findings with those produced by this network study to achieve a better understanding of the communication style of the members of the association, as well as its effectiveness.

Another aspect that could be taken into account is the possibility that ANIS could contact those users outside the association who are relevant within the network, so that they can associate and collaborate with them when disseminating information related to Vaccines.

Finally, it could also be concluded that, if ANIS wants to increase its influence on the network, it should establish a communication plan, protocols and guidelines with its partners to establish greater cohesion within the network. Configuration of a list of preferred partners on Twitter is recommended so that content of high informative or educational value may increase reach and audience. In this manner the network will

improve overall cohesion instead of having 23 disconnected components and isolated groups with no relevant users.

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