

# Vaccination talks on Twitter. Semantic social networks and public views from Greece

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*Abstract:* - Social media are increasingly used as a source of health information. Opinions expressed on social media, including Twitter, may contribute to opinion formation and impact positively or negatively the vaccination decision-making process. The paper creates networks of Greek users that talk about vaccination on Twitter, during the last quarter of 2021 and analyzes their structure and grouping. Furthermore, some content analysis is also produced by creating networks of words found within tweets. The main purpose is to locate and present the Greek public views on COVID-19 vaccination. Results show that the network of Greek users may be considered as fragmented but by all means not polarized between two different opinions. Anti-vaccination ideas were clearly present during the first period of our study but were rapidly diminished in the following months, maybe due to a large number of deaths and the advent of the Omicron strain. The persisting large percentage of the population refusing to vaccinate may be expressed in other social media platforms.

*Key-Words:* - COVID 19, Twitter, public health, vaccination, anti-vaccination, semantic social networks

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## 1 Introduction

The outbreak of coronavirus (COVID-19) has caused more than 5 million deaths and posed significant threat to people existence [1]. History has shown that vaccines have played critical roles in reducing mortality rates in cases of major infectious diseases [2]. As of today, vaccines are essential to accelerate herd immunity, reduce the number of active cases, limit the fatality rate, enable social measures of restricting and disease's spread to relax, and socioeconomic activity to resume [3, 4].

In today's international health crisis, more than 130 vaccines are in clinical development [3] and 194 in pre-clinical development [4], while 18 vaccines against COVID-19 like Pfizer-BioNTech, Oxford-AstraZeneca, Moderna, Johnson & Johnson's Janssen have been approved by at least one country [6] and industrialized for use in a relatively short period of time compared to other vaccines developed in the past [7]. The rapid development of vaccines has raised concerns about vaccines' safety and the probability of side effects,

and is one of the primary reasons for vaccine hesitancy [6, 8, 9]. Troiano & Nardi[10] in a review study identified the reasons why people refuse vaccination against COVID-19. Reasons include general attitude being against vaccines or considering the vaccine useless, general lack of trust, mistrust of health authorities, concerns about safety as the vaccines were developed in a short time and thus are supposed to be too dangerous, doubts about the efficiency and the provenience of the vaccines etc. Due to these reasons a sizable proportion of people around the globe exhibit reluctance to getting vaccinated [10, 11, 12, 13]. Vaccination uptake relies on a person's weigh of the risks vs benefits perceptions and may be significantly influenced by misinformation [8, 14].

A growing number of people use the web and social media to obtain health information, including information about vaccines [15]. Accurate, reliable, and up-to-date information are disseminated by official websites of public health organizations that are also increasingly invest to wisdom of the crowd

[17]. Stahl et al. [17] identified the major role of social media in disseminating information about vaccination. They claim that social media modify the doctor/patient relationship and impact vaccination decision-making process and vaccines acceptance. The network structure, who delivers the message on social media and how the message is framed, are affecting the vaccine decision-making process [18]. Issues against vaccination are being discussed, but also social media offer an avenue to fight against vaccine hesitancy. Love et al. [19] performed a content analysis of posts about vaccinations on Twitter and found that 33% of the tweets were positive regarding vaccines, 54% were neutral, and 13% were negative. Negative attitudes claim alleged dangers, neutrals share immunization experiences and the positive ones comment on effectiveness and promote vaccines. Substantial misinformation is also widely available through online organized anti-vaccination groups [20, 21]. Government, medical, pharmaceutical conspiracy theories and morality, civil liberties, themes of effectiveness and safety of the vaccines, illnesses that the vaccines cause, alternative medicine and corruption of the mainstream medicine are the most common arguments around anti-vaccination [20]. Previous studies have found that information provided on anti-vaccine websites exert influence on peoples' decisions to vaccinate themselves or their children [21, 22, 23].

The mass uptake of social media has significantly contributed the 'anti-vax' COVID 19 movement [21]. The Center for Countering Digital Hate [25] recorded 400 anti-vax social media accounts with 58 million of followers. Since 2019, the accounts have increased their followers by 7.8 million people. The anti-vaxers use social media to publish false information and discourage people from up-taking vaccines[26]. Social media platforms may develop acts against the anti-vaccine movement. Twitter and YouTube announced that they would label anti-vaccination content [25] and YouTube removed advertisements from anti-vaccine videos and Twitter ensured that first results for anyone searching for vaccine-related topics would be the content created of the National Health Service in the UK or the Department of Health and Human Services in the USA [27]. Facebook announced that it would down-rank or hide anti-vaccination content [25] and offered free advertising space to WHO and national health authorities [27]. Opinions regarding what should be done are contradictory. De-platforming individuals or shutting down social spaces is claimed to be the only effective tool [25]. However, "*this is an issue*

*of freedom of speech*" according to Professor Viswanath [27] and the scientific community agrees that the individual's right to determine to uptake a vaccine and should be preserved [28].

"The world shares a collective responsibility in fighting this pandemic; therefore, continued research on COVID-19 vaccine acceptance and hesitancy should be a priority" claimed Machingaidze & Wiysonge [6]. Learning about vaccination and anti-vaccination content on social media is of great importance for health organization and advocates in order to establish communication and education strategies to resolve main doubts and effectively react, respond and develop anti-vaccine arguments. Research on vaccination and anti-vaccination COVID 19 content on social media is in its infancy and to our best knowledge research on semantic social network analysis regarding discussion on Twitter doesn't exist. "Twitter can provide a great opportunity to understand public opinion regarding COVID-19 vaccines" mentioned Karami et al. [29].

## **2 Vaccination and Anti-Vaccination Against COVID 19 on Social Media**

One of the first studies investigating perception of social media users regarding COVID-19 vaccine was that of Adebisi et al. [30]. They conducted a cross-sectional survey among social media users in Nigeria asking whether users will take the vaccine when it will be available. According to their findings three out of four of the responders intended to take the COVID-19 vaccine. The major reason for non-acceptance was unreliability of the clinical trials, followed by the belief that their immune system is sufficient to combat the virus. Eguia et al.[11] also recruited Twitter users to answer an online questionnaire about users' intention to be vaccinated and the main reason for their answers. A percentage of 22.43% stated that they would not be vaccinated. Lack of effectiveness, of the vaccination, and possibly dangerous adverse effects were the main reasons provided.

In favor of vaccination against COVID-19, the ministry of Health of the Government of Spain started a campaign in Twitter using the hashtag #yomevacuno (igetvaccinated). Herrera-Peco et al. [31] analysed the role of healthcare professionals during the start of the campaign. Dissemination of information within the #yomevacuno was found scarce among healthcare professionals. They were not sharing information about vaccines or vaccination. However, the majority of them had a

favourable storytelling on the vaccine. Piltch-Loeb et al. [32] tried to investigate the use of different media channels for COVID-19 vaccine information and their relationship to vaccine acceptance. Increased vaccine acceptance was found to be related with acquisition of information from traditional channels like TV and newspapers while those who are using social media or both traditional and social media as their source of information are less likely to get the vaccine. The findings suggest the significant role of social media platforms in educating users to accept the vaccine.

Puri et al. [33] tried to identify the role of social media in spreading anti-vaccination content and the impact of the content on public health and vaccine hesitancy. The global pandemic situation, domestic vaccination policies, priority groups and challenges from COVID-19 variants are the main topics discussed on Twitter and Weibo, in U.S.A and China. Twitter users' use the platform to share their individual vaccination experiences and express anti-vaccine attitudes while Weibo users express more positive feelings toward the COVID-19 vaccines and manifest evident deference to authorities. Biden administration's evolving control plans, and vaccination efforts were also discussed on Twitter [34]. Vaccine hesitancy on Twitter was investigated by Thelwall, Kousha & Thelwall [35]. Vaccine development speed, vaccine safety and conspiracies were the main themes discussed. Political topics are also discussed by the majority of vaccine refusers who express right-wing opinions, fear of a deep state and conspiracy theories. Vaccine refusers who do not discuss in political contexts seem to reach a larger audience outside right-wing areas of Twitter. Vaccine opposition was found to be demonstrated through vaccine hesitancy, direct opposition and adverse reactions in the study of Criss et al. [36] who described themes of tweets related to vaccines, ethnicity and race. Political misinformation, scientific misinformation, and race extermination conspiracies were also recorded. In contrast, vaccine support was demonstrated through vaccine affirmation, a need for a vaccine, advocacy through reproach, vaccine development and efficacy, COVID-19 and racism, racist vaccine humor, and news updates. Political motivations of the vaccine opposition movement were also found by Bonnevie et al. [37] who examined shifts in vaccine opposition on Twitter. Conversation about federal health authorities, research and clinical trials and vaccine ingredients were the main themes of the discussions. The study also revealed that vaccine opposition on Twitter increased by 80% across time periods.

Sentiments of tweets containing terms related to the COVID-19 vaccine in the U.S.A were investigated by Karami et al. [29]. Overtime they found that non-negative and negative sentiments are increasing and decreasing respectively, showing that public sentiment become less negative during the two months after starting the vaccination. Regarding discussion topics, negative tweets include topics about vaccine effectiveness and stories of getting vaccines while non-negative tweets discuss vaccine immunity, vaccination hesitancy, mask, and social distancing. Liu & Liu [38] characterized behavioral intentions toward vaccines on the Twitter. On the one hand, positive intentions were affected by the positive values of vaccination such as return to normal life, socioeconomic recovery and reduced risk of infection. On the other hand, negative intentions were associated with lack of knowledge, underestimation of disease severity and low vaccine effectiveness, distrust of vaccines or government and greater confidence and trust in the natural immune system. Sentiments and attitudes of Australian Twitter users were studied by Kwok et al. [39]. According to their findings two-thirds of the tweets expressed positive opinions about the vaccine and one-third negative. Trust and anticipation were the top positive sentiments, while fear was the top negative recorded in the tweets. They concluded that Twitter users in Australia refuted misinformation and supported infection control measures however the level of positive sentiment was not sufficient to increase vaccination coverage to accelerate herd immunity. A different perspective was adopted by Scannell et al. [40] who examined the persuasion frameworks of tweets. Celebrity figures are used as persuasion techniques on both Anti-Vaccination and Pro-vaccinations tweets. Anti-Vaccination tweets use Humor/Sarcasm and Anecdotal stories, while Pro-Vaccine tweets use also Information and Participation.

Finally, Kydros, Argyropoulou & Vrana [41] have investigated the Twitter discussion on COVID-19 in the case of Greece, including data collected in the second half of 2020. In this paper a full analysis, including semantics and sentiment analysis was held, however, in early 2021, vaccination became possible, so these discussions were altogether changed. The present paper can be seen as a follow-up of the above mentioned study.

Having all the above in mind, this paper aims at investigating the actual situation in the Greek Twitter sphere, after vaccines were introduced. We have collected a rather large data set of tweets over a period of four months at the end of 2021 and

venture mainly to find out what are the actual discussions about vaccination on Twitter in the Greek environment. Social Network Analysis is used to identify main characteristics of users' networks, continued by semantic analysis on the actual content of tweets by using networks of word-pairs within tweets.

Overall we venture to answer the following Research Questions (RQs):

RQ1: Is there any structural evidence that Tweeters in Greece are fragmented or polarized regarding COVID-19 vaccination?

RQ2: Are there different categories of users in these conversations? What is their position?

RQ3: Is there a clear, prevailing public view? Are there any objections? What are they about?

The paper is structured as follows: Background on vaccination and anti-vaccination on social media was presented in order to situate the contribution of the paper. The methodology section presents the collections of tweets', network's formation and semantic analysis. Results are presented in the next section. The paper concludes with our final remarks and propositions for further research.

### 3 Methodology

In all subsequent procedures (data mining, cleaning and filtering, metric computations and visualizations), we used NodeXL Pro [42], an Excel template quite suitable for such investigations. We performed the Twitter importing procedures during the last four months of 2021 (from September to December), in order to capture possible shifts in Greek users' opinions. At this point it should be noted that Twitter's API (the protocol that facilitates searching and importing) usually returns data over a range 7 to 10 days prior to the date of importing. Thus, we chose to repeat our importing procedures in order to collect tweets that span the whole time window. In all our searches we used a number of keywords in Greek, such as εμβόλιο – vaccine, αντιεμβολιαστές – antivacciners, εμβολιασμός – vaccination etc. Due to a certain difficulty in searching for Greek characters in Twitter, we first transformed all our keywords in percent notation. However, this exact property (Greek characters) assures us that our data sets were produced to a large extend only by Greek people.

A rather large data set was produced from the above mentioned procedure, forcing some further preprocessing and filtering, such as the complete removal of retweets. Actually, according to Kantrowitz [43], even the engineer that created the retweet button and procedure considers this feature

not only as useless but even as dangerous, since it only adds on to information noise rather than producing useful content. Thus, in the following discussions, only tweets with actual content are identified and processed. Furthermore, in order to proceed with readable data, we merged out results in three different data sets, having in mind three different time-periods within our four-month study. These time periods, along with the volumes of our data sets are shown in Table 1.

Table 1. Data sets and time-periods

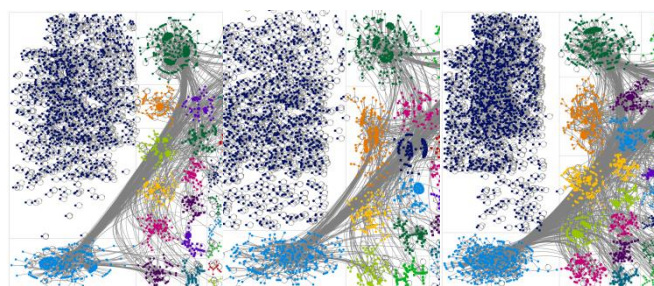
Time period	Number of tweeters (Nodes)	Number of tweets (Links)	Description
September to end of October, 2021	4364	10971	Still summer – tourist period. Low numbers of cases and fatalities. Scientists warn for “worse days ahead of us”. Third (booster) vaccination begins.
November to mid-December, 2021	3915	8878	Weather becomes harsher. The Delta strain. Increased numbers of cases and deaths. Severe problems in the National Health System. Vaccination becomes obligatory to citizens over 60 years of age.
Mid to end of December 2021 (last day of our study was the 28 <sup>th</sup> of December).	5877	13676	Winter time, Christmas period, increased circulation in shopping and night-life. The Omicron strain (in parallel to the ending of the Delta strain). Extremely high numbers of cases, albeit not so large numbers of fatalities. Health System still in congestion.

A network is comprised of nodes and links. In our case, each tweet is produced by a tweeter, so tweeters are the nodes. If a tweet is left “floating alone” (without producing any reply or mentioning) then a link is drawn connecting the tweeter to himself (a self-loop) and the respecting tweeter is an isolated node. More importantly, each reply or mentioning actually connects two tweeters. Hence a directed link is created connecting these two tweeters, who are now joined through a “conversation”. Links can be duplicated, if two users “discuss” over different tweets. By creating all those links, full networks that can be examined through Social Network Analytic techniques are formed.

## 4 Results and Discussion

### 4.1 Visualizations and Structural Results

The three networks discussed in the previous section are pictorially shown in Figure 1, while some structural characteristics are shown in Table 2.



(a) September (b) November (c) December

Fig. 1: Visualizations of the produced networks. Isolates are shown in the top left, while the largest group is shown in the bottom left.

Table 2. Some structural characteristics of the three networks

Network	Unique Links	Links with Duplicates	Isolates	Total Groups	Groups over 5 persons	Nodes in largest Group
September	5027	5944	1325	303	64	306
November	4634	4244	1146	254	49	314
December	7313	6363	1604	331	59	423

In Figure 1 and Table 2, we use the notion of community [44] to bring closely interacting nodes in the same group. A community is a group where

more links are created between nodes of this group than with other nodes. One rather unexpected result is the rather large proportion (about 20% in all three cases) of isolated nodes (nodes that correspond to tweeters who did not produce any reaction by any other tweeter). Actually, isolates are the largest group in our networks. A number of isolates is certainly expected, since in the social media world not everyone has his/hers followers and triggers discussions. However, it can be deduced that in the Greek social media sphere, at least within our search framework, a rather large proportion of users are left “shouting and unanswered”. This result however does not mean that all those tweets were left unread; some of them must have been read and influenced others, but did not create a discussion.

Another proportion of users are actively engaged in discussions over different tweets, as seen by the almost equal numbers of plain and duplicate links. Of course, a “discussion” has a rather loose definition with respect to the actual number of persons involved. It is interesting to note that over all groups in all cases, about 20% of groups are formed with five or more users, while the largest groups are comprised of about 7% of the total number of users, despite the fact that intergroup links are definitely present (Figure 1), denoting intergroup discussions.

Hence it can be deduced that the overall discussion on COVID-19 vaccination in the Greek Twitter case seems to be rather fragmented but not clearly polarized between pros and cons on vaccination. The above discussion answers our RQ1, since no actual polarization was found in structural terms.

### 4.2 Opinions Within Groups

We now turn our attention on our RQ2, which deals with actual users and their status. All calculations were again performed through NodeXL Pro. In Table 3 we present the status (user, media, politician, political party, etc.) of the top-ten users, together with their position on vaccination (pro/con, if clearly implied) by visiting their relevant personal pages in Twitter. We do not include actual names but preferred to show aggregate results for a clearer view.

Table 3. The top ten Tweeters and their positions

	Top Tweeters	Top Replied-to	Top Mentioned
September	Users: 4 / pro: 4	Users: 7 / pro: 3 / con: 2 / undefined: 2	Users: 4 / pro: 1 / con: 3

	Media: 6 / pro:6	Politicians: 2 / pro: 2	Media: 2 / pro: 1 / con: 1
		State: 1 / pro: 1	Ministers: 3 / pro: 3
			Political Parties: 1 / con: 1
November	Users: 9 / pro: 5 / con: 2 / undefined: 2	Users: 6 / pro: 4 / con: 2	Users: 4 / pro:2 / con: 2
	Media: 1 / pro: 1	Ministers: 1 / pro: 1	Ministers: 3 / pro: 3
		Politicians: 3 / pro: 3	Politicians: 1 / pro: 1
			State: 1 / pro: 1
			Media: 1 / pro: 1
December	Users: 5 / pro: 4 / con: 1	Users: 7 / pro: 5 / con: 1 / undefined: 1	Users: 1 / con: 1
	Media: 5 / pro: 5	Politicians: 2 / pro: 2	Politicians: 4 / pro: 4
		Media: 1 / con: 1	Media: 5 / pro: 5

Table 3 includes some important results that clearly answer our RQ2. More particularly, we identified 5 different categories of tweeters: plain users, politicians (including ministers, the prime minister, the head of opposition etc.) only one political party and a number of media such as news agencies, social media or blogs. It is interesting to note that to tweeters are mainly users and media in all three networks. All media and the majority of users support vaccination; however, a clear minor group of users does have their objections against. When it comes to top replied-to and top mentioned, the situation changes with the presence of members of the political life, such as the prime minister, the leader of opposition, ministers, one member of the European parliament and one former member of the European parliament. Actually, one of the top mentioned users is the only active political party in Greece that has a clear position against vaccination (“Popular Orthodox Alert”), together with the only media page that supports it.

Apart from the far-right above mentioned party, all other political parties in Greece have stated their support in the vaccination campaign. However, Table 3 tells a somehow different story: it should be expected that many more active politicians should belong to the first column of Table 3, if they were really active in order to persuade more people to vaccinate. The same thing happens with political parties, which are absent whatsoever. No such

presence was found in the data. A possible explanation might consider the fact that the anti-vaccination movement in Greece bares no political barriers and is spilled throughout the political spectrum.

In order to further clarify the actual reasons for this poor behavior and also in order to investigate the actual content of the discussions, in the next subsection we create and analyze networks of words found in the actual tweets.

### 4.3 Content Though Word-Pairs

Networks of word are created having words within tweets as nodes. A link is created between two words when they are adjacent (word-pairs) in the same tweet. This procedure, after been applied to all tweets and all words of our data sets, created the networks shown in Figures 2, 3 and 4, which can be magnified. Certainly, some words were omitted (such as articles, particles etc.) and all left words were translated from Greek to English, in order to maintain readability. In the above mentioned Figures, we again created groups (communities) of words and also used a metric, betweenness centrality, to size words/nodes. Not all word-pairs are taken into account for reasons of clarity. Actually we filtered out all word-pairs that appear in all tweets less than 10 times. The thickness of links is proportional to the count of appearances of a specific word-pair. As a final remark, it should be noted that Figures 2 to 4 do not show simple word clouds. The presence of links is of utmost importance, since by magnifying specific areas of the visualized word network one can identify sentences or small phrases.

As an example, in Figure 2 that follows, at the top left (light blue) group, the discussion considers the situation in northern Greece (around the city of Thessaloniki), where the counter-vaccination movement was indeed stronger and was partly supported by far right, sectarian religious groups. Actually, such words do penetrate in all larger groups in the September word network, in some cases with truly heavy accusations: in the middle left word groups one can see that the government acts as in a junta, or a discussion on myocarditis (a quite rare symptom after vaccination) is exaggerated. In a similar manner, some discussion also deals with immigrants, supposed “carriers” and not vaccinated. Critique to the government measures is present, but to a mild extend. It is however true that the majority of words, small sentences or phrases do show a strong confidence on vaccination.

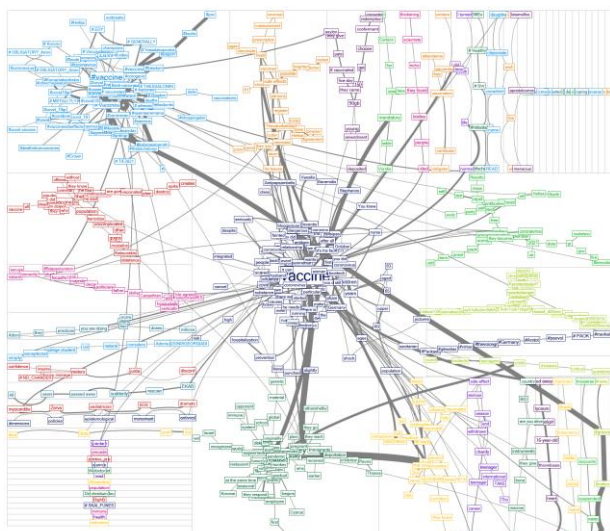


Fig. 2: September's content

In Figure 3, discussions are slightly shifted, although similar views are circulating. One important difference here is the questions on the vaccination schema, since many citizens preferred to take the one-dose vaccine and are now questioning on the second or third dosage. In this network, the mandatory vaccinations in some professional groups is present, however there is no obvious agreement about its correctness. Also, some tweets deal with “freedom” and the supposed rights of citizens to be unvaccinated if they choose so. However, the general “feeling” in this network is that anti-vaccinators have somehow retreated, or at least they are not so prone to stand for their opinions.

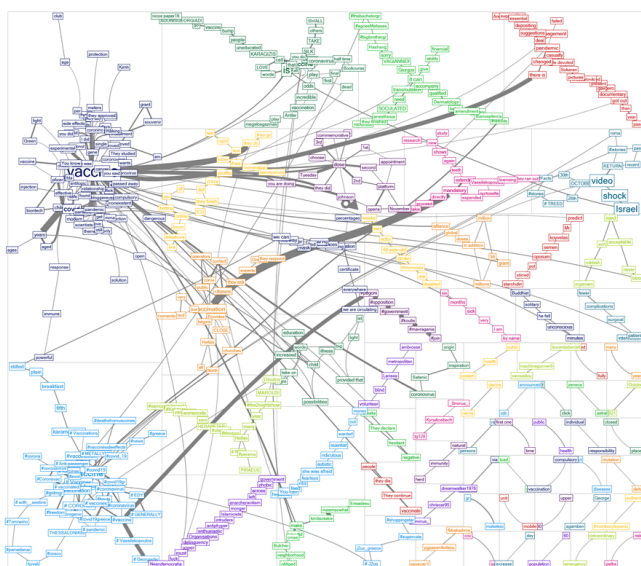


Fig. 3: November's content

Finally, in December's content (Figure 3), it seems that the anti-vaccination movement is

faded out, at least in the Greek twitter. Discussions continue on Greek, European and global news (mainly US and Israeli) and new measures. The Omicron variation, together with discussions on the effect of vaccines is clearly here. Some critique on the non-obligatory vaccination of police force is also present, together with some discussion on newly elected party headers and their views on the subject.

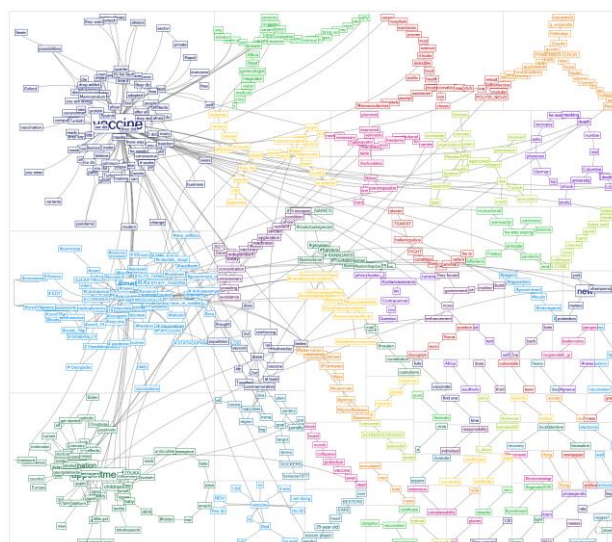


Fig. 4: Decembrer's content

The above analyzed results clearly answer our RQ3. In the Greek Twitter sphere, it seems that the discussions are prevailed by the idea that vaccination for COVID-19 is quite important and should be continued by all means. Different opinions and critique on some of the taken measures is also present, but not in favor of the anti-vaccination movement.

However, it is interesting to note that even after (about) one year of vaccinations and the scientific knowledge retrieved on its safety and importance, in Greece there exists a rather large anti-vaccination movement, since a significant percentage of the population still refuses to vaccinate. On January 5 2022, Greece Coronavirus Full Vaccination Rate was 68.10% [45]. This is a large percentage but its representatives were not traced (to this extend) in our study. A possible explanation on this could be the fact that Twitter is not so popular in the Greek environment, at least to the people involved in such conversations, since they probably prefer to express their views in other social media platforms which do not use limits in character count. Twitter's platform cannot be easily used for propaganda due to the barrier in message length, unless a truly devoted

user or group are continuously twitting on a specific subject.

## 4 Conclusions

In this paper we investigated the Greek Twitter discussions on COVID-19 vaccination during the last quarter of 2021. More specifically, we searched for tweets containing Greek words such as “vaccination”, “anti-vaccination”, “vaccine” etc. through the Twitter API. We formed three different data sets, according to generally accepted “periods” of the above mentioned time period. We then created networks of users and networks of words and analyzed them.

Our results show that the network of Greek users may be considered as fragmented but by all means not polarized between two different opinions. Structurally, users can be algorithmically amortized in groups; however, a clear polarization would not justify more than 3 to 4 different groups, which was not found in our case.

Moreover, an analysis of the content of tweets, made through the creations of networks of adjacent words again showed that anti-vaccination ideas were clearly present during the first period of our study (September to mid-October 2021) but were rapidly diminished in the following months. The December period which coincides with a heavily congested National Health System, a strangely large number of deaths (when compared to other similar in population countries) and the advent of Omicron strain, definitely bears no anti-vaccination discussions on Greek Twitter.

The persisting large percentage of population refusing to vaccinate may be expressed in other social media platforms, although it is known that most platforms make efforts to stop or prohibit such talks. However, it seems that other means of communication is still used for this purpose including word-of-mouth, a quite old but still extremely important means to communicate ideas, especially when time allows for it. Policymakers and public health officials must prioritize effective COVID-19 vaccine-acceptance messaging for Greeks, emphasizing trust in vaccine safety and dispelling potential myths and spread them across all media.

It seems that Twitter users do not extensively share anti-vaccination information. This finding is encouraging and in accordance with the findings of Love et al. [19], suggesting that Twitter users critically think the situation and evaluate the shared medical content. Governments should take into consideration public opinion expressed in social

media toward COVID-19 vaccination, understand the public psychology and evolution of thoughts through time and implement strategies to promote COVID-19 vaccination. Governments have to plan the communication of vaccination health messages based on evidence [46]. Negative emotions like anger and fear should be acknowledged so to be manipulated while governments have to find ways to activate positive emotions like hope and altruism [47].

Findings of the study have several limitations. The study gives evidence of a specific period of time including the Omicron variant emergence. However, it provides insights into comprehending public opinions about vaccination and in addition to other research like those of Luo et al. [34] who focused on users’ opinions toward the vaccine at its initial stage could give a longitudinal perspective. Future research should also focus on other social media platforms to extend the validity of the findings.

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#### **Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)**

Dimitrios Kydros carried out Data curation and Formal analysis, Visualization, Writing  
Vrana Vasiliki has implemented Conceptualization, Methodology, and Writing

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