Whose Voice Matters? Authority and Influence in the Italian Twitter Debates on Covid-19

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Abstract. The Covid-19 pandemic intensified public discourse on social media, with Twitter becoming a key platform for information exchange. In such environments, authorities — influential figures from various domains — play a crucial role in shaping public opinion, having the power to influence offline behaviors both individually and collectively. In this work, we study the role of pro-vaccine and anti-vaccine authorities within the Italian Twitter debate on Covid-19 in five contextually relevant temporal windows corresponding to different pandemic phases. Analyzing a dataset of over $\sim$ 50M tweets, we identify central actors and quantify both their impact and their influence on users' opinions. Our results suggest that while anti-vax authorities were able to gain more consensus during the vaccination phases, pro-vax authorities became more influential in the latter stage of the vaccination campaign.

Keywords: social media, infodemic, network analysis, vaccine hesitancy, social influence

1 Introduction

The Covid-19 pandemic, which began in December 2019 in China and erupted in Italy in 2020 before spreading globally, rapidly became an epochal phenomenon. Its all-encompassing nature revealed the profound disorientation and vulnerability experienced by both communities and individuals, aligning with Marcel Mauss's concept of "total social facts" [15,10] – phenomena that engage all aspects of society and its institutions [15]. Indeed, the pandemic transcended healthcare boundaries [19], impacting social responses, political organization, and media narratives – essentially reshaping the community's health and well-being.

As the virus spread, media outlets — national TV, live streaming, and newspapers — gradually wove a dense web of discourse through which the pandemic was "textualized" and the "community imagined" [2]. This narrative, often characterized by heightened emotions and apocalyptic overtones, contributed to public

confusion and anxiety [14,20,1]. The media's portrayal of the pandemic — combined with a flood of contradictory information — created a chaotic environment that led to panic [23,21], such as the rush to supermarkets and train stations at the first hint of lockdown measures.

At the same time, the rapid shift of social life into the domestic sphere fundamentally altered human interactions. In such context, Online Social Platforms (OSPs) became critical in preserving social ties during isolation [17]. Although the digital transformation of social relations preceded the pandemic, the crisis accelerated the integration of online and offline worlds, creating a new form of trans-spatial connectivity where a large amount of content was shared. This growing reliance on OSPs, however, also gave rise to an "infodemic" [21,25], as defined by the World Health Organization [26] – an overwhelming amount of information, much of it false or misleading, spread across social media. Indeed, the significant appeal of the process of media disintermediation [14] introduced by OSPs in the way people communicate and interact has manifested not only in facilitating synchronization with others and expanding access to an almost infinite amount of information and knowledge, but also in greatly amplifying the dissemination of both reliable and unreliable information. This information overload left citizens struggling to discern credible sources from misinformation, exacerbating the public's sense of uncertainty [25,13].

In this scenario, OSPs emerge as platforms within which an intermediate layer of communicators operates in various ways, disseminating content and expressing opinions without adhering to the strict norms that should govern traditional media communication. Consequently, certain figures with a broad user base emerged as key "authorities" or influencers — ranging from health experts and politicians to journalists and social media personalities. These key actors not only shaped the public discourse on Covid-19 but also played a pivotal role in advocating for or against various measures, including vaccines and containment policies. Their influence was particularly pronounced on platforms like Twitter[4], where real-time discussions and rapid dissemination of information are central to public engagement [24,9,3]. Given the critical role that these influencers played in shaping public perceptions and behaviors during the pandemic, it becomes essential to examine how their influence evolved over time, particularly in a country like Italy, which was one of the hardest hit by Covid-19 in its early stages.

For this reason, in this study, we focus on the Italian Twitter debate surrounding Covid-19 across different phases of the pandemic, from early 2020 to late 2021. Specifically, we explore the impact and the influence of these authorities in shaping public opinion on topics such as vaccines and containment measures. In this framework, *impact* refers to the authority's ability to drive any kind of changes in users' opinion, while *influence* denotes the authority's capability to lead users to adopt the authority's own point of view. Using network analysis and machine learning techniques for opinion estimation, we investigate how the impact and influence of pro/anti-vaccine relevant authorities evolved over time.

[4] Now X. In this article, we refer to Twitter as this was the platform's name during the period of interest.

Our results suggest that both pro/anti-vax authorities had a significant role in shaping the debate on Covid-19. Additionally, while anti-vax authorities were able to gain more consensus during the vaccination phases, pro-vax authorities became more influential later on.

The rest of the paper is organized as follows: in section 2, we discuss relevant literature related to the key themes of this research; in section 3, we describe the methodology to collect, process, and analyze the data; section 4 discusses the main findings, while section 5 concludes the work and suggests directions for future research.

2 Related Works

The Covid-19 pandemic has significantly impacted public discourse on social media platforms, particularly Twitter, which has become a central hub for real-time information sharing and debate. Several studies have examined various aspects of these online debates, focusing on opinion formation, information/misinformation spreading, the role of authorities, and the evolution of public discourse throughout the pandemic. Cinelli et al. [8] conducted a cross-platform comparative analysis of information spreading during the early stages of the pandemic. They found that each platform exhibited unique patterns in terms of user engagement and information diffusion. Also, they observed that Gab was more susceptible to the spread of unreliable information compared to mainstream platforms like Twitter, Facebook and YouTube [4]. This aligns with Lovari et al. [14], who show how major platforms have played a significant role in the effort to counter misinformation within the broader context of public health communication. This role is twofold: on one hand, these platforms have removed or flagged content deemed unreliable; on the other, they have established specific partnerships with official government accounts, such as that of the Ministry of Health, thereby directing user searches towards institutional sources. Crupi et al. [11] analyzed the Italian Covid-19 vaccination debate on Twitter, identifying distinct pro-vaccine and anti-vaccine communities. They found that anti-vaccine groups were more active and polarized compared to pro-vaccine groups. Importantly, they highlighted that vaccine hesitancy in Italy predates the pandemic but was exacerbated by it. Researchers have also investigated the role of key actors and authorities in shaping online discussions. Tesconi et al. [24,9] reconstructed the Italian Twittersphere during the early pandemic period, identifying central accounts in the information dissemination process. They found that accounts belonging to media outlets, political figures, and health institutions played significant roles in the debate. Caliandro et al. [3] specifically focus on misinformation spreading on Twitter during the first lockdown phase in Italy. Their analysis of the most active users in posting and sharing questionable content revealed that Twitter's content moderation policies were relatively effective in limiting the spread of misinformation. This led to a shift in misinformation dissemination tactics, with some users moving to more closed platforms like Facebook groups and Telegram channels. They also identify the most active account in spreading fake news, Ra-

dioSavana, a channel with anti-institutional and racist positions with links with right and far-right party presonalities as proved by Cola et al. [9]. By focusing on the temporal evolution of offline events, Santoro et al. [22] analyzed the Covid-19 vaccine debate on Twitter across five countries. They found that external events, such as vaccine announcements and regulatory decisions, significantly influenced the volume and nature of online discussions. Interestingly, they observed that the announcement of the first Covid-19 vaccine had a more substantial impact on tweet production compared to the suspension of the AstraZeneca vaccine by the European Medicines Agency. This suggests that positive news may generate more engagement than negative developments in the context of vaccine-related discussions. Collectively, these studies underline the importance of considering multiple factors when analyzing social media debates on critical public health issues. For these reason in this work we decide to consider a specific aspect of the Covid debate in on Twitter: starting from a sufficiently large predefined number of authorities, we try to understand their relevance and which impact they have on the opinion formation processes and dynamics.

3 Materials and Methods

In this work we aim to analyze authorities within Covid-19 debates by assessing (i) their relevance in the debate network, (ii) their influence on users' opinions, and (iii) how these aspects evolve over time. To do so, we selected Twitter as a data source for two main reasons. Unlike other social networks such as Reddit, which resemble forums with participation from users maintaining anonymity, Twitter revolves around the production of concise content by individual, non-anonymous accounts, some of which are verified. Secondly, institutional/journalistic communication favored Twitter as one of the main medium for content dissemination. In this section, we discuss how we collect Twitter data, infer user stances on Covid-19 vaccines, and construct the debate network. The anonymized temporal network dataset is stored on Zenodo at [16].

Data Collection. We leverage the Twitter dataset released in [6], which contains a multilingual tweet id collection spanning multiple years. We select Italian tweets from 2020 and 2021 and, using the now-defunct Twitter Research API, we obtain texts and metadata associated with the ids (a procedure informally known as *hydration*). This process yielded 21.310.609 tweets by 1.812.704 users. Subsequently, we manually identify a subset of 84 users and label them as *authorities* — i.e., users that belong to social media communication, or to scientific and institutional dissemination worlds, or to the political field, etc. This selection is based on the assumption that these autorithies play a crucial role in the opinion formation processes and dynamics. Therefore, authorities' stances are known beforehand and do not need to be estimated. Subsequently, we collect all conversations participated by at least one authority by hydrating the corresponding `conversation_id`s, i.e., unique identifiers for discussion threads. This process yielded 495.551 conversations composed of 31.875.490 tweets. The whole

collection procedure took place in February 2023, and resulted in a total of over $\sim$ 50M tweets. In the rest of this work, we will address the first collection as *general users* dataset, and the second as *authorities conversations* dataset.

Opinion Estimation. The wide time span of the data captures several moments of the Covid-19 pandemic: the initial debate on Covid-19, the onset of the pandemic, and the vaccination campaign. Therefore, before estimating user opinions, we partition the datasets into contextually relevant time windows - following the approach adopted in [11]:

- *early covid* (01/01/2020 – 08/03/2020): from Covid's first tracing in Wuhan, China, up to the first lockdown in Italy;
- *pre vaccine* (09/03/2020 – 31/10/2020): from the first Italian lockdown to the start of the vaccination campaign;
- *early vaccine* (01/11/2020 – 16/04/2021): the first months of the vaccination campaign;
- *vaccine drive* (17/04/2021 - 31/07/2021): the main phase of intensive vaccination;
- *late vaccine* (01/08/2021 – 31/12/2021): phase in which a significant portion of the Italian population was fully vaccinated;

Afterwards, for each of the periods above, we identify and filter out outliers in the *general users* dataset, i.e., users that show either scarce or extraordinary tweeting activity in that period.
To estimate non-authorities' stances of with respect to vaccines, we rely on an already-available neural model based on `XLM-RoBERTa-large` [12]. This classifier was trained on Italian tweets about Covid-19 vaccination labeled by human annotators. It assigns a stance label (`Promoting`, `Discouraging`, or `Neutral`) and the associated prediction score with reasonable Accuracy (72.4%) and F1 (72%) [5]. After computing scores for all tweets, we filter out tweets that were assigned a class probability of at least 0.9 to reduce noise. Fig. 1 displays information on the classes' volume over time. The amount of promoting tweets is generally higher than discouraging ones in the first phases of the pandemic, likely due to the hope for freedom that the vaccine could bring. In the last two phases, however, discouraging tweets are comparatively higher, emphasizing a negative reaction to the vaccination campaign. Thus, while anti-vax sentiments remained a minority for most of the pandemic, an increase in such attitudes was observed during the vaccination campaign, ultimately becoming more prevalent in its final phase.
Authority Relevance Analysis. To study the most important actors within the pandemic debate, we employ the *general users* dataset. We model the Twitter information system related to the pandemic as a Snapshot Graph $\mathcal{G} = \{\mathcal{G}_1, \mathcal{G}_2 ... \mathcal{G}_t\}$ where each snapshot $\mathcal{G}_t = (V_t, E_t)$ is composed of accounts active in t, connected with a directed edge (u, v) if v retweeted (i.e., shared) u's tweet. This modeling framework allows to study the position of authorities within the network, as well as how it changes over time (i.e., as related to the pandemic

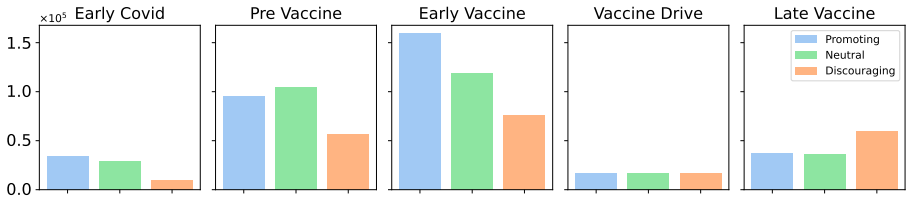


Fig. 1: Distribution of tweets for each period

phases). To understand the importance of accounts within the retweet graphs, we compute closeness centrality for all nodes, formally:

$$Closeness(u) = \frac{|V| - 1}{\sum_{v \neq u} dist(u, v)}, \tag{1}$$

where u is the target node, $dist(u, v)$ is the distance between nodes u and v, and $|V|$ is the number of nodes.

Authority Influence Analysis. To study the influence of authorities on users' opinions, we employ both the *general users* and the *authorities conversation* datasets. Firstly, we identify all discussions between general users and authorities in the conversation dataset. Informally, a discussion is a back-and-forth conversation between two users occurring in a short time period. In this study, we identify discussions by finding all conversations that (i) are participated by an authority and a user, (ii) start and end on the same day, and (iii) consist of at least 5 tweets. For each of these discussions, we infer the general user's initial opinion by computing the most frequent label in her last 5 tweets in the *general users* dataset before the start of the discussion. Then, we infer the post-interaction opinion by computing the most frequent label in her first 5 tweets after the end of the discussion. This allows quantifying whether/how users changed their opinions after debating with an authority. To assess the degree of impact of an authority on the overall debate, we are interested in measuring the amount of opinion changes she induces. To do so, we introduce the *Impact score* Formally:

$$Impact(u) = \frac{|D_{\rightarrow \bullet}|}{|D|} \tag{2}$$

where u is the authority, D is the set of discussions participated by u, and $D_{\rightarrow \bullet} \subseteq D$ is the subset of such discussions that produced an opinion change (regardless of direction). This measure captures the capacity to produce opinion changes in opposing discussants, regardless of whether the discussant ends up agreeing (i.e., persuasion) or disagreeing (e.g., a backfire effect [18]) with the authority. Moreover, to evaluate the influence potential of an authority, namely her ability to persuade an opponent, we introduce the *Influence score*. Formally:

$$Influence(u) = \frac{|D_{\rightarrow o_u}|}{|D|} \tag{3}$$

where u is the authority, D is the set of discussions participated by u, and $D_{\rightarrow o_u} \subseteq D$ is the subset of such discussions that produced an opinion change in the direction of the authority's opinion. Since we are interested in understanding the dynamics of partisan individuals, we discard information on discussions involving neutral accounts.

4 Data Analysis

The main properties of the Snapshot Graph modeling the Twitter information system are presented in Table 1. The networks show similar properties, except

Table 1: Statistics of the Snapshot Graphs

Property	**Early Covid**	**Pre Vaccine**	**Early Vaccine**	**Vaccine Drive**	**Late Vaccine**
Nodes	20,187	75,741	73,575	23,530	43,913
Edges	64,284	215,832	276,497	43,258	115,367
Connected Components	175	1090	838	805	787
Giant Component Size	19,844	73,495	71,907	21,608	42,187
Average Degree	6.368	5.699	7.516	3.676	5.254
Average Shortest Path	4.600	4.905	4.653	5.702	5.070
Global Clustering Coefficient	0.005	0.007	0.005	0.003	0.005
Density	1×10^{-4}	3×10^{-5}	5×10^{-5}	7×10^{-5}	5×10^{-5}
Diameter	13	17	18	19	22

in terms of size. Indeed, *early covid* and *vaccine drive* are comparatively smaller networks, which could be explained by the differently-sized time windows. As with most real-world networks, they are characterized by a highly cohesive giant connected component, encompassing nearly all nodes, followed by several smaller connected components. The average degree is approximately 5-6 in all snapshots except for *early vaccine* and *vaccine drive*, which are respectively marked by higher and lower values. Although each timestamp exhibits a high diameter, they maintain relatively short average path lengths, which indicates a degree of compactness. They also display low density and low global clustering coefficient values, suggesting that they are sparse and weakly clustered. The degree distributions (not shown) outline a power law description $P(k) \sim k^{-\alpha}$, with few highly-connected users, and many nodes with few connections.

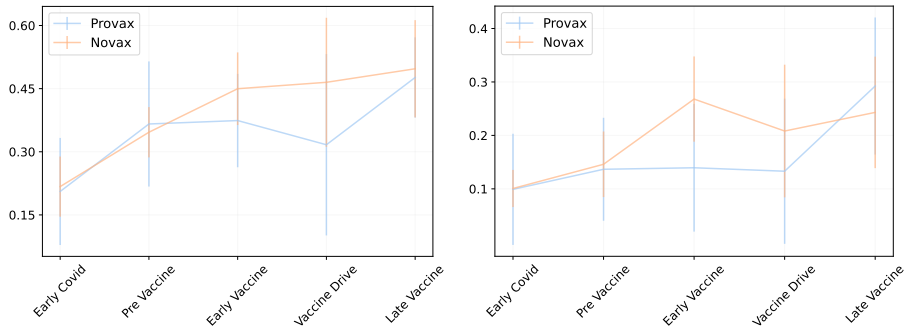
Key Actors in the Debate. The nodes with the highest closeness centrality are reported in Table 2. The composition of the central nodes includes accounts of science communicators, institutions, politicians, news media, and fake news spreaders. Among these, the aforementioned virologist *Roberto Burioni*, who has been particularly active throughout the media debate in favor of vaccines and has faced criticism for his often aggressive rhetorical style; *Alberto Zangrillo*, most notably known for being the personal physician of the ex-Prime Minister Silvio Berlusconi, rose to particular prominence during the pandemic. Similarly prominent is the physician *Nino Cartabellotta*, president of the GIMBE Foundation, which aims to promote and carry out training and research activities in

Table 2: Top-ranked users by Closeness Centrality in each time period. Highest-ranked are at the top.

Early Covid	Pre Vaccine	Early Vaccine	Vaccine Drive	Late Vaccine
RobertoBurioni	Cartabellotta	RobertoBurioni	RobertoBurioni	RobertoBurioni
MinisteroSalute	CottarelliCPI	lefrasidiosho	borghi_claudio	Cartabellotta
RadioSavana	repubblica	Cartabellotta	Cartabellotta	intuslegens
Agenzia_Ansa	RobertoBurioni	Corriere	azangrillo	GiovaQuez
tragicom24	Corriere	MediasetTgcom24	Adnkronos	borghi_claudio
repubblica	Agenzia_Ansa	Palazzo_Chigi	valy_s	ladyonorato
manginobrioches	MassimGiannini	fanpage	Quirinale	valy_s
Quirinale	Fedez	HuffPostItalia	Agenzia_Ansa	emmevilla
robersperanza	Quirinale	repubblica	Corriere	Corriere
catlatorre	matteosalvinimi	gianni_CN	ferrazza	stanzaselvaggia

the healthcare sector. During the pandemic, the foundation focused on analyzing data related to the overall situation of infections and vaccinations within the Italian context. Other types of accounts include politicians such as *Roberto Speranza*, head of the Ministry of Health during the pandemic; *Claudio Borghi*, a novax member of the Italian right-wing party Lega, as well as its party leader, *Matteo Salvini*. There are also institutional accounts of the *Ministry of Health*, the *Quirinale*, and *Palazzo Chigi*, as well as some of the most prominent news agencies, such as *La Repubblica*, *ANSA*, *Adnkronos*, *Huffington Post Italia*, *Il Corriere*, and *TgCom24*. Lastly, there are personal accounts of Italian journalists and commentators (*Massimo Giannini*, *stanzaselvaggia*), satire accounts (*tragicom24* and *lefrasidiosho*), fake news accounts (*intuslegens* and *RadioSavana*). Among this latter group, the case of RadioSavana is particularly interesting, and also emerged in other studies on Italian Covid-19 data [3,24]. RadioSavana disseminates content and fake news with a racist slant, actively promoting anti-European, anti-government, and racist narratives. A study [9] demonstrates the presence of connections between this account and those of other political figures associated with the right and far-right, such as Matteo Salvini and Francesca Totolo, highlighting the underlying ideological links between these entities and their centrality in the debate.

Authority Influence on User Opinions. To assess the extent to which authorities affected opinions in the debate, we turn to Fig.2a, which shows the class-average Impact score (Eq.2) across the five phases. Initially, both provax and novax authorities have low impact on users' opinions, likely due to the fact that the vaccine debate had not yet gained significant traction. As the vaccination campaign progresses, we observe an increase in impact for both groups of authorities. Notably, novax authorities demonstrate a comparatively higher impact than their provax counterparts during this period. Interestingly, the situation rebalances in the *late vaccine* phase, with both types of authorities showing similar levels of impact.
Fig. 2b, which shows Influence trends (Eq. 3), reveals similar patterns to those observed in the impact analysis, with Novax authorities generally acquiring more



(a) (b)

Fig. 2: Average Impact (a) and Influence (b) for each class as a function of time. Vertical lines outline the standard deviation

consensus throughout most of the pandemic phases. However, the most striking difference between impact and influence emerges in the *late vaccine* phase; while the impact of provax and novax authorities is comparable during this period, provax authorities ultimately lead to more opinion changes in their favor than novax users. This discrepancy suggests that although both types of authorities were equally capable of prompting opinion shifts (impact), provax authorities were more successful in swaying opinions towards their stance (influence) in the final phase of the pandemic.

5 Conclusion

Leveraging a collection of 50M tweets related to Covid-19, this work investigates the relevance and influence of pro/anti-vax authorities within the Italian Twitter debate on Covid-19. Key actors in the Italian debate belong to a wide spectrum of fields, including politics, science communication, and journalism. Most of these figures openly identify as provax, although some antivax users were observed as well. These findings confirm what was observed in previous works on the topic [24,9]. Our impact and influence analyses revealed that novax authorities were generally more effective than provax ones in both producing opinion changes and gaining consensus. This could be attributed to the fact that Novax narratives often leverage fear and uncertainty, which can be more emotionally compelling than scientific facts [7]. In the late vaccine phase, however, provax authorities drew more consensus than novax ones. This shift could be attributed to better communication strategies based on earlier challenges, becoming more effective over time. Our study suffers from limitations that could be addressed by future research. Firstly, non-authority user opinions were estimated by a deep neural model, and the consequent lack of ground truth limits the possibility of validating our findings. Future work might employ different approaches, and/or provide

open datasets with surveyed opinions. Secondly, we analyzed a large group of authorities from the most diverse social spheres. Further investigations could focus on specific spheres of influence – politicians, communicators, journalists – in order to further understand how the issue of information dissemination is thematically and emotionally articulated within the social network. Additionally, studying the long-term impact of this online debate on public health outcomes and vaccine uptake rates could provide crucial insights for future public health communication strategies.

Acknowledgements

This work is supported by (i) the European Union – Horizon 2020 Program under the scheme "INFRAIA-01-2018-2019 – Integrating Activities for Advanced Communities", Grant Agreement n.871042, "SoBigData++: European Integrated Infrastructure for Social Mining and Big Data Analytics" (http://www.sobigdata.eu); (ii) SoBigData.it which receives funding from the European Union – NextGenerationEU – National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR) – Project: "SoBigData.it – Strengthening the Italian RI for Social Mining and Big Data Analytics" – Prot. IR0000013 – Avviso n. 3264 del 28/12/2021; (iii) EU NextGenerationEU programme under the funding schemes PNRR-PE-AI FAIR (Future Artificial Intelligence Research).

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