Evidence of distrust and disorientation towards immunization on online social media after contrasting political communication on vaccines. Results from an analysis of Twitter data in Italy.

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Abstract

Background. In Italy in recent years, vaccination coverage for key immunizations, as MMR, showed a worrying decline resulting in large measles outbreaks. As a response in 2017, the Government expanded the number of mandatory immunizations and introduced penalties for families of unvaccinated children. With the upcoming 2018 general elections, immunization policy entered the political debate, with the government accusing oppositions of fuelling vaccine skepticism. The new government established in 2018 temporarily relaxed penalties, and announced the will to introduce forms of flexibility.

Objectives and Methods. By a sentiment analysis on tweets posted in Italian during 2018, we attempted at (i) characterising the temporal flow of communication on vaccines over Twitter, (ii) evaluating the usefulness of Twitter data for estimating vaccination parameters, and (iii) investigating whether the prolonged epoch of contrasting announcements at the highest political level might have originated disorientation amongst the public.

Results. Tweets favourable to vaccination accounted for 75% of retained tweets, undecided for 14% and unfavourable for 11%. After smoothing, a very clear yearly *up-and-down* trend in the favourable proportion emerged, well synchronized with the switch between governments, providing evidence of distrust.

Conclusions. The identified evidence of distrust on vaccination shows that critical health topics should never be used as tools for political consensus, especially given the increasing role of online social media as a source of information. This is reinforced in Italy by the lack of institutional presence on Twitter, a fact calling for efforts to contrast misinformation and the ensuing further spread of hesitancy.

Introduction

Ensuring resilience to vaccination programs during the current phase of generalised low perceived risks from vaccine preventable infectious diseases resulting from decades of high vaccine uptake, is a major task of Public Health in industrialised countries. Indeed, the reluctance to vaccinate, or "vaccine hesitancy" [5] is currently considered one of the top threats to global health (WHO, 2019).

In Italy during 2015, MMR vaccination coverage at 24 months, that was in the region of 91% in 2010, fell at 85.3% and remained low thereafter (ISS), yielding large measles outbreaks, with 844 cases in 2016, 4991 cases in 2017 (with 4 death), and 2029 cases in the first six months of 2018 [8]. As a response, the Italian government increased the number of mandatory immunizations, and introduced penalties for non-vaccinators in the form of fines and restrictions to admittance to kindergarten and school (" vaccines decree", Italian National immunization plan 2017-2019). The ethical acceptability and effectiveness of the decree, especially the introduction of penalties, has been fiercely disputed, especially on online social media. A new government, established in May 2018, after a series of contrasting announcements, eventually allowed unvaccinated children to be admitted to school despite the potential distrust that this might create among parents, the school system, and the general community as a whole.

In the past fifteen years, online social media have emerged as one of the main popular source of information, including health topics [1,6]. However, in social media, anyone can express own opinion regardless of her expertise in the field considered. Therefore, the parents' decision on immunization may be influenced by misconceptions and misinformation [3,7]. As is known, opposition to vaccination has

existed already since the introduction of the smallpox vaccine, but currently, due to online social media, misinformation is spreading at ever achieved rates.

Twitter is a micro-blogging service currently representing one of the main tools used by political leaders to communicate with their public, favoured by the ever increasing access to the internet. This however implies that when political leaders intervene on scientific topics, such as vaccinations, might enact enormous pressure on public opinions.

We used a sentiment analysis on tweets in Italian during 2018 to (i) describing the trend of communication on vaccines on social media, (ii) evaluating the usefulness of Twitter data to estimate key epidemiological parameters such as e.g., the hesitant proportion, (iii) evaluating the effectiveness of institutional communication against misinformation, and (iv) showing that the recent phase of contrasting political announcements on vaccination might have originated a distrust seeding future coverage decline.

Data and Methods

Data extraction. We scraped, over the entire 2018 year, tweets written in Italian containing at least one from a set of vaccination-related keywords.

Tweets Classification. We classified tweets into four categories: (i) favorable (to vaccination), if the tweet unambiguously showed a convinced pro-vaccine position, (ii) contrary, if the tweet unambiguously showed a position contrary to vaccination, (iii) undecided i.e., neither favorable nor unfavorable, (iv) out-of-context, if the tweet did not fit any of the preceding categories.

Data labeling and classification. Supervised classifications algorithms were used to analyze the temporal flow of the tweets. A random sample of 18,000 tweets, out of the 323,574 retained for the analysis, were manually labeled by 18 voluntary master degree students attending a Demography class at University of Catania. Additionally, 15% of sampled tweets were intentionally duplicated, to measure mutual disagreement among annotators. The resulting accuracy was 62% (CI 0.6034 - 0.6557), in line with similar studies [4].
Automatic classification of unlabeled tweets was carried out by considering four different models, namely Classification Tree, Random Forest, Naive Bayes, Support Vector Machine (SVM). Model Selection, carried out by K-Fold Cross Validation, identified SVM as the best classifier that was consequently adopted.

Multinomial test and smoothing of daily tweeting trends. To deep the analysis of the temporal trends of tweeting and polarity, a multinomial test was used jointly with a kernel smoothing procedure, to separate observations that might have originated from pure randomness from those did not.

Results

The presence of noise was disproportionate: only 7% out of analyzed tweets actually expressed a sentiment [6]. After removing noise, the tweeting population appeared to be mostly composed by people spending a large amount of daytime on social media and tweeting about “everything”, especially in polarized situations. Thus, tweeting about vaccines, seemed to be more representative of this “social-hyper activism” – triggered by the polarized nature of the subject - rather than by full awareness of the debate. We termed these users, "serial-twitterers". We feel that this disproportion of "serial-twitterers", besides preventing reliable estimates of relevant socio-epidemiological parameters, is a key determinant of the spread of misinformation. After a polarity analysis, the overall proportions of (tweets) classified as favorable, contrary and undecided throughout the entire year were: F=75,2%, C=10,4%, U=14,4%, respectively.

We attempted at estimating the relevant “hesitant” proportion that is, the hesitant proportion among parents whose children were eligible for immunization currently, and therefore relevant for the true future

vaccination coverage. A search was carried out over retained tweets by further keywords specifically targeting this situation (such as “pregnant”,“newborn”, “mother”, etc). Eventually, the proportion of tweets from parents arguably involved in an actual vaccination decision was negligible (less than 0,2% of retained tweets). Among these, the hesitant proportion was of 20%.

Temporal trends of tweeting activity and characterisation of disorientation

The daily intensity of tweets interactions during the period considered (Figure1, Panel a) is strongly concentrated around three dramatic peaks representing the users’ responses to well-identified announcements of the Italian government on the subject of immunization.

With all the due caveats reported above, the proportion of people “not favourable” to immunization – in the region of 25% - was a worrying symptom of the complicated state of opinions about vaccination in Italy.

As properly defining the concept of “disorientation” can be complicated, to simplify things, we assumed that disorientation (towards vaccines) can be coarsely identified as the lack of well-established and resilient opinions among individuals, therefore causing individuals to change their opinions as a consequence of sufficient external perturbations. To deep the analysis, we applied a multinomial test to the daily flow of tweets, taking as null hypothesis the polarity proportions observed throughout the entire year, and counted the days laying outside a given confidence interval at (1-α) confidence. We found 62 days at α at 5%.

The results of the related smoothing procedure (Figure1, Panels b, c, d) show that the many sudden changes in the daily polarity shares of tweets can be reduced to a small number of more stable longer-lasting fluctuations. All these fluctuations may be traced back to some main politicians' announcements on immunization policy. With reference to the proportion favourable to immunization, the amplitude of these longer oscillations was substantial (from 66% to 79%), providing a coarse evidence of the size of the “non-resilient” component of the population favourable to vaccination.

A stepwise polynomial fit to the smoothed trends in the polarity proportions showed that the parabolic fit was the best one. This documents a marked increase in the proportion favourable to vaccination (and a parallel decline in the proportions undecided and contrary) between January and May, possibly reflecting the tail of the positive effects of the “vaccine decree” by the previous government, and a marked decline thereafter, when the new government was fully established, losing more than 5 percentage points by the end of the year. We feel hard to believe that this phenomenon is unrelated with the continued ambiguous announcements made by the new government on the subject.

Concluding remarks.

Traditional media, as television and newspapers, have always played a critical role in healthcare information dissemination [2]. However, the dramatic spread of online social media where scientific healthcare institutions can have lower relevance compared to various types of social media influencers, including politicians, is a critical phenomenon, due to the inherent risks of misinformation. Motivated by this complicated role of social media as well as by the fact that immunization policy has been a main persistent topic in the recent Italian political debate, with continued ambiguous announcements by policy makers, we carried out a sentiment analysis on Tweets posted in Italian during 2018 on the subject of vaccination.

As a principal finding, a very clear yearly trend emerged, showing that the proportion favourable to vaccination increased up to when the previous government – strongly supporting immunization on the media – was up, and started declining as soon as the new government, promoting a more ambiguous position on penalties for non-vaccinators, was fully established.

This evidence of distrust on vaccination is suggestive of the potentially disruptive role for public health policies played by the use of such topics for purposes of political consensus. This aspect is especially true given the increasing role of social media as a source of information (and misinformation). These facts might

yield social pressures eventually harmful for vaccine uptake. In the Italian case this situation has surely worsened by the lack of a stable institutional presence on Twitter, especially by the National Institute of Health, and calls for rapid actions.

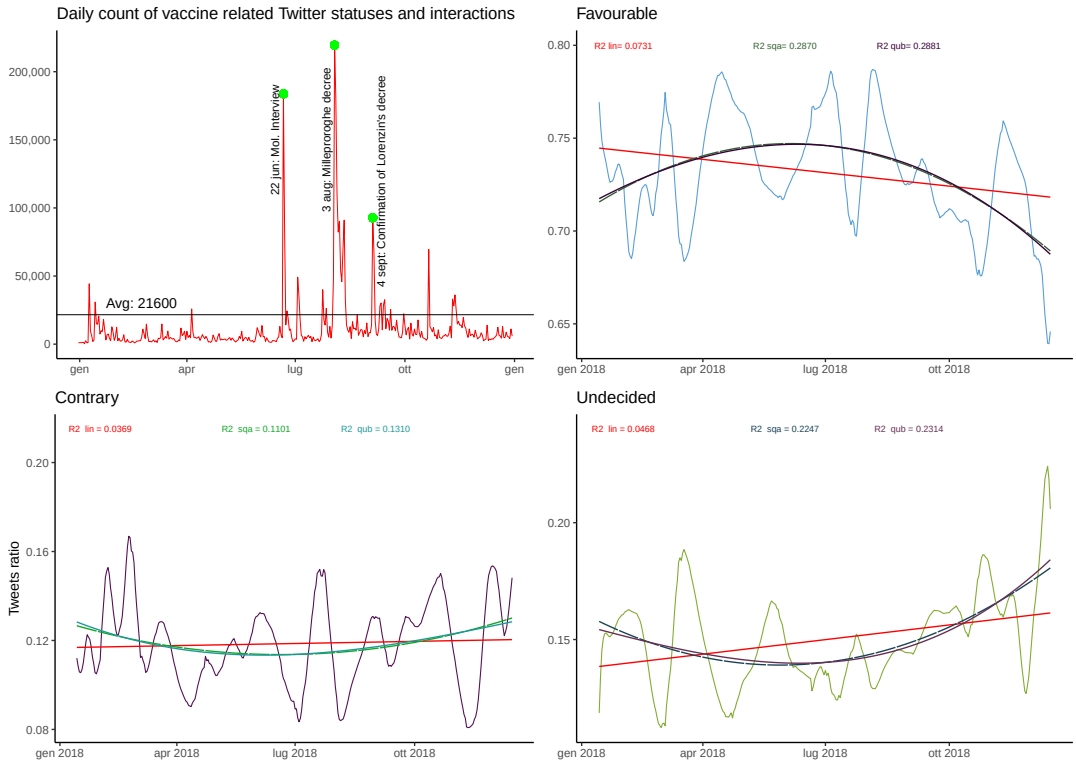

Figure 1. Panel (a): time series of total daily interaction counts (tweets plus like and retweet). Panels (b),(c),(d): kernel smoothing of daily polarity proportions (favourable, contrary, undecided) jointly with the corresponding polynomial interpolations.

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