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The role of peer influence in shaping individuals' vaccine attitude

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Extended Abstract

Vaccination is one of the most cost-effective tools to prevent the spread of infectious diseases. However, the supply of vaccines is not sufficient if is not accompanied by a high willingness of the population to timely accept their administration. Vaccine hesitancy, i.e. a delayed acceptance or refusal of vaccination despite the availability, has been on the rise in recent years [3] and constitutes a major threat to the efforts towards control and eradication of diseases. In this work, we investigate the determinants of parental and non-parental vaccine hesitancy to effectively inform public health campaigns.

Despite the considerable research efforts to identify the determinants of refusal of the COVID-19 paediatric vaccination [2], the literature focuses mostly on prediction tasks aimed at separating individuals into categories: "pro-vax" and "anti-vax". This approach, however, can easily be misleading and induce problem misconception: while the outcome "get vaccinated" and "do not get vaccinated" live in a discrete space, the individuals' opinions and attitudes toward vaccines are more diverse and cannot always be reduced to simple Boolean values [4]. In particular, the intermediate regimes, where individuals are not completely leaning towards one or the other positions, are often neglected.

In this work, we leverage survey data about paediatric vaccination attitudes of adults, 2041 parents and 3511 non-parents, to better understand the different determinants of each one of these three regimes. The survey data were collected during the summer of 2021 from United Kingdom and Italian residents, asking respondents, among other information, their attitude towards paediatric COVID-19 vaccination (responses ranged from 0, "low attitude", to 100, "high attitude").

Results from XGBoost regression show that, overall, three components are the most important determinants of attitude towards paediatric vaccination: the attitudes of an individual's friend group, the age of the children, and the overall attitude towards vaccines in general. Among the three, the attitude of friends is the one showing the highest average absolute SHAP values (see Fig. 1). In terms of the three different opinion regimes, we can distinguish two situations: individuals with high or low attitudes can be characterized with very low models' error (MAE 4.4 ± 0.2 and 3.4 ± 0.1 respectively); in contrast intermediate attitudes with more than double model error (MAE 9.4 ± 0.3).

Albeit more difficult to characterize, from a policy perspective, this segment of the population with intermediate attitudes ("undecided") is a key target for interventions aiming to enhance vaccine-positive positions, as these people are more likely to be influenced compared to the highly sceptical and strongly polarized individuals. In this perspective, the attitude of friends plays a particularly interesting role. It is found, as for the other groups, to be one of the most important features characterising intermediate positioning and can thus be used as a seed to study cascade dynamics following targeted information campaigns.

Here, we propose a network model that encodes the individual (node) opinion dynamics within the XGBoost model and triggers a cascade opinion change following "friendship" connections over the network. Friendship connections are generated using the Friends&Family

dataset [1] inferring the number of parents and non-parents number of friends by means of a Standard Vector Classifier (SVC). Friendships are inferred between parents, non-parents and from one group to the other. The resulting network consists of directed friendship links (the link starts from a node and points to her friends) between nodes labelled either as parents or non-parents. First, nodes are assigned labels based on the country parent/non-parent ratio. Second, a maximal independent set of nodes is randomly assigned with an attitude value (and a "friends attitude" one) based on population-representative probabilities. Third, the remaining nodes are assigned an attitude value (and a "friends attitude" one) conditioning on the sampling with the average attitude value as expected by all her "in-neighbours".

Under the assumption of individual with extremely polarized attitudes, i.e. either with 0 or 100 attitude values, being committed groups which cannot change their attitude based on friends, we can then study how the network affect the distribution of attitudes. Being connected and interacting with friends smooth the distribution in its intermediate regime (see Fig. 2 "data" and "'networked attitudes"). Moreover, by applying a mean field, acting on the perceived attitudes of friends a a drift component, we show that it is possible to shift the attitude distribution towards higher values of individuals' attitudes (see Fig. 2 "'networked attitudes + mean field").

More in general, this approach could provide estimates for policies aimed at reducing infodemic spread through targeted fake-news content obfuscation. Future steps will study targeted information campaign strategies.

References

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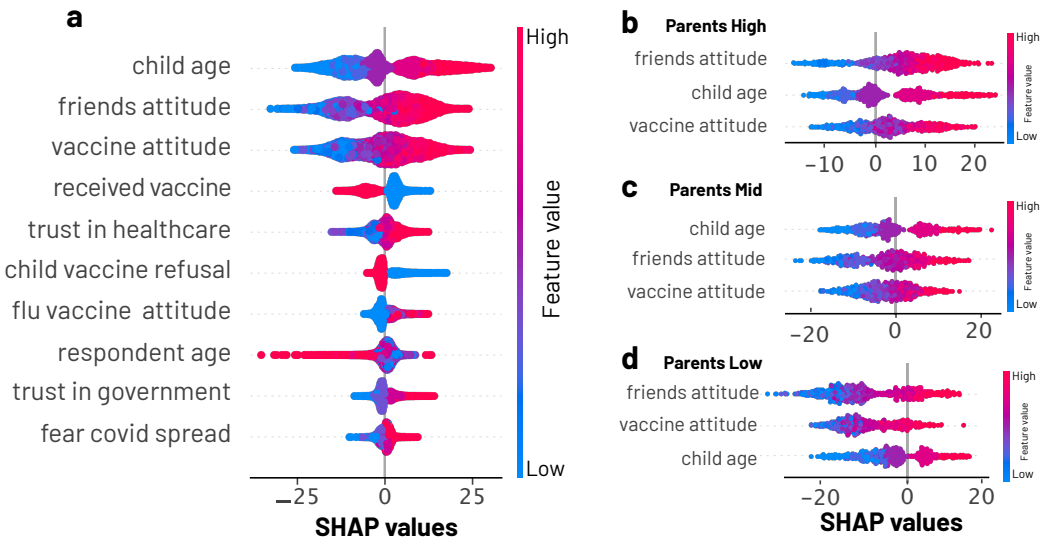

Figure 1: *Determinants of paediatric vaccination attitudes.* SHAP values of the XGBoost regression model are compared for the top features. a) SHAP of the top 10 features for the entire dataset. b-d) SHAP of the top 3 features for parents with high-medium-low attitudes toward paediatric COVID-19 vaccination.

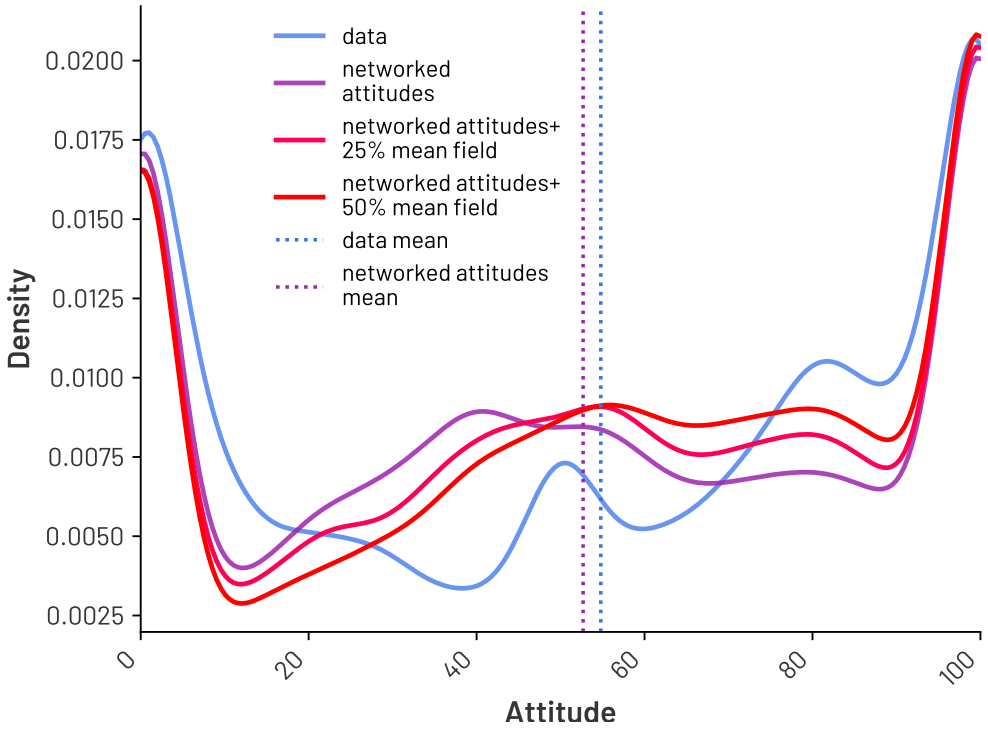

Figure 2: *Attitudes distributions.*