

Evolution of Public Opinion on COVID-19 Vaccination in Japan

Keywords: COVID-19; vaccination; Twitter; public opinion; longitudinal study

Extended Abstract

Japan stands out among developed economies as having one of the lowest vaccine confidence levels in the population. Such low public confidence delayed the start of mass vaccination against COVID-19, and Japan was two months behind the United States, China, and European countries. Although mass vaccination began late in Japan, this country achieved high vaccination coverage in a short time and had one of the highest vaccination rates in the world (ranking 14th among 229 countries).

The aim of this study was to understand the dynamics of public opinion during the vaccination campaign in Japan, which achieved a high vaccination rate more rapidly than other high-income countries. Classic survey studies are expensive, relatively slow, and can hardly trace changes in public opinion in real time. In addition, individuals tend to underreport behaviors that go against prevalent social norms [1]. In recent years, several aspects of human activities have become increasingly mediated by digital services, leaving electronic footprints that can be exploited to assess population health and opinions [2]. The pervasiveness of Twitter in Japan provides a unique source of data for monitoring the evolution of public opinion.

We hypothesized that major social disruptions could lead the population to focus the debate on a few topics directly related to their daily experience, particularly individuals' personal experiences with vaccines. To examine this hypothesis, we collected more than 100 million vaccine-related tweets written in Japanese and from 8 million users (approximately 6.4% of the Japanese population) from January 1 to October 31, 2021. We identified 15 main topics from a subset of the tweets using the Latent Dirichlet Allocation (LDA) model [3]. Here we sampled 1 million tweets (100,000 tweets per month) to remove the non-stationarity of the tweet activity due to the imbalance in the number of vaccine-related tweets during the study period. The LDA model automatically classifies the tweets based on word distribution; however, it cannot show us the interpretation of each topic. Thus, we manually grouped these topics into the following four general themes using typical tweets on each topic: (1) personal issues, (2) breaking news, (3) politics, and (4) conspiracy, humor.

The most popular theme in the tweets was *personal issues* (50%), formed by 2 topics concerning personal issues before being vaccinated and 4 topics on personal experiences after being vaccinated, which consists of 1 topic of live reporting of the experience of vaccination and 3 topics on individual vaccination experiences, including 1) complaints about discomfort, and side effects and personal life after vaccination; 2) reporting body temperature after taking the vaccine; and 3) advice to overcome side effects. The second most popular theme was *breaking news* (21%), consisting of 2 topics about news on COVID-19 vaccines and a topic on booking an appointment for vaccination, in particular, concerning the availability and whether a user could successfully book a time slot. The third most common theme was *politics* (17%) with 3 topics, namely, 1) opinions on the government, 2) opinions on mass media, and 3) vaccination policy, including casual chats. The least popular theme was *conspiracy and humor* (12%) with 3 topics: 1) population control, 2) effects on the body, and 3) internet memes. The percentage

of topics related to conspiracy theories (topics 1 and 2) was small (7%), even though it also includes the jokes on conspiracy theories. We also confirmed that the popularity of the tweets related to conspiracy theories was rare (6%) by extracting the corresponding tweets using a subset of keywords from the original data set (24 million tweets).

Previous research has shown that the number of tweets on a particular topic reflects Twitter users' attention [2]. We calculated the percentage of tweets on each theme to monitor temporal changes in the interest of users (Figure 1A). The percentage of personal issues increased dramatically after June, reaching more than 70% of all the vaccine-related tweets in October 2021. By contrast, breaking news and politics tweets declined steadily from nearly 30% and 25% (in January), respectively, to around 10% (in October). This result implies that while Twitter users split their attention across various themes before the vaccination campaign, they focused on personal issues after June 2021, including the journal of their vaccination experience and its side effect. Again, we validated this result by creating a subset of keywords for each theme and extracting all tweets of each theme from the original data set.

Finally, we performed the interrupted time series regression [4] to estimate the impact of critical social events on the popularity of the themes. We focused on four events during the vaccination campaign: 1) vaccination start for health workers (February 17th), 2) vaccination start for older people (April 12th), 3) vaccination start for the general population under 65 years old (June 21st), and 4) the start of the Olympic Games in Tokyo (July 23rd). This analysis showed that the impacts of the vaccination rollout to the general population and the Tokyo Olympic Games on public opinion were significant for all the themes. The vaccination rollout in the general population increased the rate of tweets containing practical advice and personal experience (Figure 1B).

This study is, to the best of our knowledge, the first work to track the evolution of public opinion on COVID-19 vaccination in a single country during most of the vaccination campaign period. We found a striking shift in public interest over the course of the vaccination campaign in Japan. While users split their attention over various themes early in the campaign, they focused on personal issues, as trust in vaccines grew over the course of the effective vaccination campaign. In addition, our analysis showed that the vaccination rollout to the general population (aged under 65 years) increased the popularity of tweets about practical advice and personal vaccination experience. The associations between the campaign stages and the tweet themes suggest that public engagement in a social platform contributed to speedup vaccine uptake by reducing anxiety via social learning and support.

References

- [1] Gnambs T, Kaspar K. (2015). "Disclosure of sensitive behaviors across self-administered survey modes: a meta-analysis", *Behav Res Methods* 47: pp.1237-1259.
- [2] Kwak H, Lee C, Park H, Moon S. (2010). "What is Twitter, a social network or a news media?" In: *WWW '10: Proceedings of the 19th International Conference on World Wide Web*.
- [3] Blei DM, Ng AY, Jordan MI. (2003). "Latent dirichlet allocation", *J Mach Learn Res* 3: pp. 993-1022.
- [4] Bernal JL, Cummins S, Gasparrini A. (2017). "Interrupted time series regression for the evaluation of public health interventions: a tutorial", *Int J Epidemiol* 46: pp. 348-355.

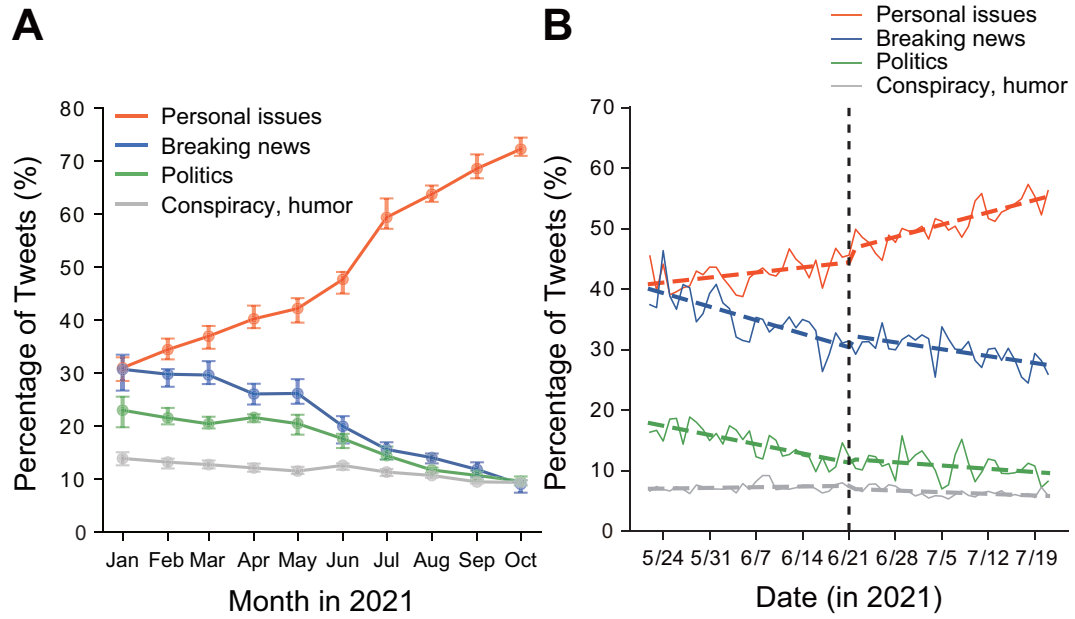


Figure 1: Evolution of public opinion on COVID-19 vaccination in Japan.

(A) Evolution of the popularity of the themes. Each line represents the percentage of tweets for each theme over time.

(B) Impact of social events on the theme popularity. We applied the interrupted time series regression to the popularity time series for each theme to examine the impact of the vaccination start for the general population aged under 65 years on the time series.