



# Anti-vaccine rabbit hole leads to political representation: the case of Twitter in Japan

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## Abstract

Anti-vaccine attitudes pose a threat to public health by impeding the development of herd immunity. However, the proliferation and politicization of anti-vaccine discourse, exacerbated by the pandemic and the rise of social media, have not been fully elucidated. This study, using Japanese Twitter data, revealed that (a) anti-vaxxers are characterized by high political interest, (b) persistent anti-vaxxers were more ideologically left-leaning and had stronger ties to existing political parties, and (c) pandemic-induced new anti-vaxxers displayed low political engagement but a greater affinity for conspiracy theories, spirituality, naturalism, and alternative health practices, which served as gateways to anti-vaccination views. Furthermore, those who turned anti-vaccine after the pandemic also exhibited an increased tendency to follow the newly emerged anti-vaccine party, potentially contributing to their political representation at the national level. These analyses show that the anti-vaccine discourse has expanded and reached a politically representative scale, strengthening its discursive network with conspiracy theories, spirituality, naturalism, and alternative health practices.

**Keywords** Anti-vaccination · Conspiracy theory · Political representation · Social media · Japan

## Introduction

The global spread of COVID-19 has highlighted the challenge posed by anti-vaccine attitudes. Despite scientific evidence that supports the effectiveness of vaccines in reducing the severity and mortality rates of COVID-19 infections, a significant segment of the population remains hesitant about or completely resistant to vaccination. This vocal minority presents a significant obstacle to public health efforts to achieve herd immunity [1, 2]. Although anti-vaccine attitudes are not

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new [3], social media has amplified their scale and velocity, making containment efforts increasingly difficult [4]. The onset of COVID-19 in early 2020 coincided with an era of heightened social media use, further increasing the prevalence and relevance of anti-vaccine narratives.

During the COVID-19 pandemic, anti-vaccine attitudes have become further complicated by their politicization. The most notable example is the relationship between anti-vax beliefs and former US President Donald Trump. Despite boasting about his administration's support for vaccine development, Trump expressed reluctance to take a booster shot. These mixed messages have resulted in Trump supporters, who often harbor distrust toward government and experts, displaying a tendency to eschew preventive measures like vaccination and mask-wearing, in contrast to liberal citizens. In Europe, anti-vaccine sentiments have been linked to support for populist parties that express skepticism toward elites and experts [5, 6]. The intersection of anti-vaccine attitudes with support for specific political parties and their influence on policymaking can have profound implications for public health.

Hence, there is an urgent need to elucidate the mechanisms of the spread of anti-vaccine narratives on social media and their political ramifications. Nonetheless, the existing literature suffers from two critical limitations. First, the prevailing research has focused on describing the characteristics of individuals holding anti-vaccine attitudes, utilizing cross-sectional data (e.g., ref. [7]), whereas there is a dearth of research on the mechanisms behind the transformation of individuals into anti-vaxxers (however, see ref. [8]). A static analysis of demographic and psychological features of anti-vaxxers will not reveal the underlying triggers of the development of such attitudes. Second, while the existing literature has demonstrated how established political parties, particularly populist parties, have utilized anti-vaccine sentiments to garner support in the US and Europe, analysis of the political forces that have emerged due to anti-vaccine sentiments is lacking. The proliferation of anti-vaccine attitudes through social media has enabled emerging political forces to attract voters who feel alienated by established parties by making opposition to vaccines a primary agenda.

The primary objective of this study is to address the abovementioned gaps in the literature by examining Twitter data from Japan during the pandemic. First, we aim to describe the characteristics of individuals who hold anti-vaccine attitudes on Twitter. We then investigate the triggers of anti-vaccine attitudes by analyzing the social influences they encounter on Twitter. Second, we aim to shed light on the political consequences of anti-vaccine attitudes by examining the emergence of the Sanseito party, which has gained momentum by advocating anti-vaccine policies. Sanseito, formed in March 2020, has attracted individuals who believe in anti-vaccine narratives, conspiracy theories, and spiritual discourses while espousing right-wing, revisionist historical views. Despite being a newcomer, Sanseito won one seat in the July 2020 House of Councillors election with over 2% of the popular vote. We aim to articulate the link between the rise of Sanseito and anti-vaccine attitudes to demonstrate that the anti-vaccine segment of the public can quickly gain a foothold in national politics.

## Social media and anti-vaccination

Previous studies found that while pro-vaccine sites draw on scientific research and statistical evidence provided by experts, anti-vaccine sites tend to reject scientific knowledge and instead employ postmodern narratives that relativize scientific truth [9, 10]. Anti-vaccine websites also promote health behaviors lacking medical evidence, such as alternative medicine and homeopathy [9]. These anti-vaccine discourses have persisted into the COVID-19 pandemic, with the rapid spread of anti-vaccine sentiments through social media having significant political consequences [4].

Anti-vaxxers create insular online communities on Facebook [11] and are more closely connected to those with moderate views on vaccines than to pro-vaccine communities. This facilitates their recruitment of new members [12]. On Twitter, Germani and Biller-Andorno [7] identified pro- and anti-vaccine users by analyzing hashtags. They found that anti-vaccine users are less active in sending messages but more engaged in retweeting and replying to them, particularly to those from a small number of influencers, including Donald Trump. Mitra et al. [8] collected over three million tweets from 2012 to 2016 and categorized users into three groups: those with long-standing pro-vaccination attitudes, those with long-standing anti-vaccination attitudes, and those who had recently adopted anti-vaccination attitudes. Individuals with entrenched anti-vaccination attitudes tend to exhibit high degrees of conspiratorial thinking in relation to the government, including references to the “Deep State.” Conversely, those who developed anti-vaccine attitudes after August 2014 did so in response to the widely publicized “vaccine fraud” incident, without initially holding broad conspiracy beliefs. However, once an anti-vaccine attitude is adopted, it tends to reinforce other conspiratorial beliefs, as individuals who subscribe to one conspiracy theory are more likely to embrace others [13].

Anti-vaccine beliefs are not isolated but rather closely linked to alternative medical practices, conspiracy theories, spiritual discourses, naturalism, and other beliefs [14–20]. Survey data from multiple countries also confirm the association between anti-vaccine attitudes and conspiratorial thinking [21]. These associations suggest that individuals may adopt anti-vaccine beliefs via various gateways, such as health consciousness, conspiracy theories, spirituality, and naturalism.

## Political consequences of anti-vaccination attitudes

As anti-vaccine attitudes became prevalent on social media, their link with political affiliation grew more prominent. In the United States, conservative Republicans exhibit stronger anti-vaccine attitudes than liberal Democrats [22–24] owing to their more prevalent anti-expert sentiment. Among conservatives, support for Donald Trump is associated with particularly strong anti-vaccine attitudes, primarily owing to the prevalence of conspiratorial thinking rather than to political conservatism [25]. Communities coalesce around political leaders who perpetuate conspiratorial thinking and uphold conservative values, shaping the identity of those with

anti-vaccine attitudes [26]. Anti-vaccine attitudes in Europe have become politicized and are closely linked to populism, which pits “the people” against “corrupt elites.” Consequently, those who advocate for vaccination from a public health perspective, including governments, politicians, scientists, and experts, are often viewed as “enemies” of the people. As a result, individuals who distrust these groups are more likely to support populist parties [5, 6, 27].

An analysis of anti-vaccine and political attitudes suggests that populist parties, framing their message as “the people vs. corrupt elites,” exploit antipathy toward experts who advocate for vaccines to co-opt those with anti-vaccine views. However, COVID-19 is unique in that the number of individuals with anti-vaccine attitudes has reached unprecedented levels owing to the vaccine’s availability to all. The significant distrust of and aversion to COVID-19 vaccines has made it easier for new organizations to seek political representation by promoting conspiratorial anti-vaccine campaigns. While Donald Trump and European populist parties were already influential political actors prior to the pandemic, their attempts to expand their power through anti-vaccine sentiment have been well documented. However, few studies have examined the parties that enter national politics during a pandemic to represent anti-vaxxers by exploiting anti-vaccine attitudes as a single issue. This study addresses this gap in the literature.

## Research context

Although not the majority, a significant portion of the Japanese population holds anti-vaccine attitudes [28]. While the vaccination process proceeded smoothly, anti-vaccine beliefs are prevalent in Japan, as seen in the spread of misinformation about the cervical cancer vaccine, which resulted in an anti-vaccine campaign [29]. Indeed, misinformation about vaccines is widespread in Japan. For instance, data from a nonprobability online sample collected in 2022 revealed that 23.5% of people had encountered false information that “COVID-19 vaccines can cause infertility in women” [30]. In April 2022, members of the anti-vaccine conspiracist group Yamato Q were apprehended for trespassing in a clinic where COVID-19 vaccines were being administered and attempting to disrupt the vaccination process. Yamato Q was formed as a Japanese branch of the US-based conspiracy theory QAnon movement, which claims on its website that “COVID-19 does not exist,” “the vaccine contains disease-causing agents,” and “vaccination is part of a plan to reduce the population” [31].

Although only a handful of individuals engage in extremist anti-vaccine conspiracy theories, a substantial number in Japan exhibit anti-vaccine sentiments in more moderate forms. This sentiment was expressed through support for the political party, Sanseito, which was formed in March 2020. Sanseito’s platform incorporates conspiracy theories, spirituality, and naturalism, including anti-global capitalist and anti-Semitic conspiratorial views, and its strong commitment to organic food aligns with its opposition to introducing artificial substances into the body, including vaccines. Sanseito successfully campaigned on these policies by relying heavily on social media, including Twitter and YouTube. Consequently, in the House of

Councillors election in July 2022, Sanseito secured one seat less than two years after its inception, granting it a national political voice.

## Method

We define accounts spreading anti-vaccine information as those that post or retweet anti-vaccine tweets and accounts that disproportionately follow them as anti-vaccine accounts. This definition serves two purposes. First, retweeting a tweet does not necessarily indicate agreement with its content [32, 33], making it difficult to infer anti-vaccine attitudes from retweet behavior. However, selective exposure has been observed in the following behavior [34], indicating that information about “friends” (i.e., the accounts followed by focal accounts) can be useful in estimating user attitudes. For example, it has been shown that users’ ideology can be accurately estimated using information about their friend lists (e.g., ref. [35]).

### Identification of accounts spreading anti-vaccine information

We retrieved tweets in Japanese containing “ワクチン” (the Japanese word for vaccine) or “vaccine” using the Twitter Public API between January 1 and December 31, 2021. We refer to these as “vaccine-referencing tweets” ( $N=98,805,971$ ). A total of 6,777,598 accounts posted or retweeted vaccine-referencing tweets.

Subsequently, we clustered the tweet network to categorize vaccine-referencing tweets. To do this, we adopted the methodology outlined by Uchida et al. [36] by selecting vaccine-referencing tweets that were retweeted at least twice and calculating the Simpson coefficient for all pairs of tweets to measure user overlap. We constructed a tweet network by establishing edges between pairs of tweets with Simpson coefficients surpassing 0.2. Finally, the Louvain method was employed to extract tweet clusters from the network. This clustering method was applied to each of 12 sets of monthly data. Then, in any two clusters among all detected clusters, the pairs were merged in order of the highest overlap rate of retweeters, and merging was stopped when the overlap rate of any pair no longer exceeded 50%.

This clustering resulted in 20 tweet clusters with more than two tweets. However, the majority of tweets (more than 99%) were concentrated in the three largest clusters, which also accounted for 98% of the total number of retweets. Consequently, we focused our analysis on these three largest clusters. Upon manual inspection of tweets within the clusters, we observed that the largest cluster contained pro-vaccine tweets, the second largest expressed opposition to the government’s vaccine policy, and the third largest consisted of anti-vaccine tweets. Examples of typical tweets from each cluster are presented in Table S1 in the Supplementary Materials. Table 1 shows the number of original tweets, the total number of retweets, and the number of unique accounts that tweeted or retweeted for each cluster. We labeled the first cluster “pro-vaccine information spreading accounts” ( $N=1,382,065$ ), the second cluster as “policy criticism spreading accounts” ( $N=248,699$ ), and the third cluster as “anti-vaccine information spreading accounts” ( $N=196,936$ ).

**Table 1** Clustering of vaccine-referencing tweets

Cluster	Original tweet	Total # of RTs	# of accounts that tweeted/retweeted
Pro-vaccine	5136	13,224,735	1,382,065
Policy criticism	1958	2,861,335	248,699
Anti-vaccine	2782	3,064,989	196,936

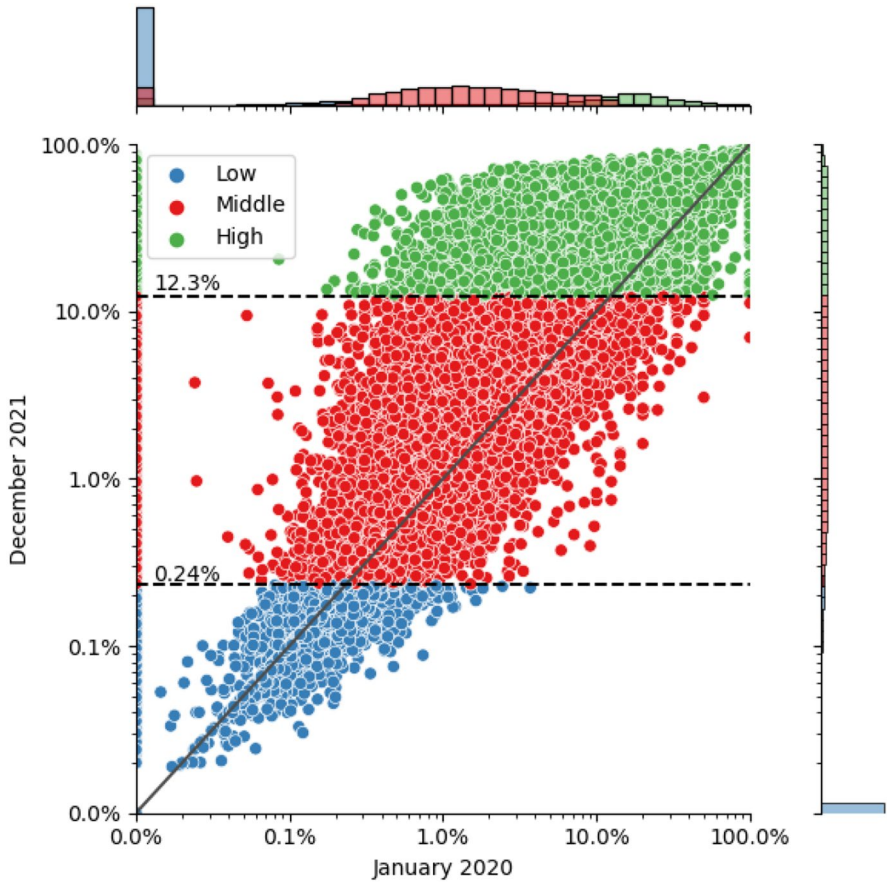
## Identification of anti-vaccine accounts

In this study, anti-vaccine accounts are defined as those that follow a significantly large number of “anti-vaccine information spreading accounts.” The following procedures were used to identify these accounts. First, 50,000 accounts were randomly selected from each of the three clusters in Table 1 as of December 31, 2021, resulting in a total of 150,000 accounts. Given the high costs associated with collecting extensive network data through API, random sampling was necessary. From these 150,000 accounts, we included only those for which we could obtain friend lists from January 2020 to December 2021 as of March 2022, when the analysis was conducted, to enable longitudinal analyses.

The friend list of each account was estimated in January 2020 and December 2021 based on the order of friend additions and the creation date of the friend’s account. For each account, we calculated the proportion of anti-vaccine information-spreading accounts in the friend list. The level of anti-vaccine sentiment, as determined by the percentage of accounts in the friend list that disseminate anti-vaccine information, enabled us to classify account attitudes into three categories. The Low anti-vaccine group was comprised of accounts in the bottom 25% (i.e., percentage < 0.24%) in terms of the proportion of anti-vaccine spreading accounts in the friend list. The Moderate anti-vaccine group included accounts between the bottom 25% and the top 25% (i.e.,  $0.24\% \leq \text{percentage} < 12.3\%$ ). The High anti-vaccine group consisted of accounts in the top 25% (i.e., percentage  $\geq 12.3\%$ ). The initial and final counts of accounts in each group are presented in Table 2. Please note that the number of accounts decreased from 150,000 to 115,335 in January 2020 because of the requirement for continuous availability of friend lists from 2020 to December 2021, as of March 2022. The resulting distribution of the percentage of anti-vaccine information spreading accounts in the friend list is shown in Fig. 1 for both the start (January 2020) and end (December 2021) of the analysis period.

**Table 2** Distributions of accounts by anti-vaccine sentiment

	Jan 2020	Dec 2021
Anti-vaccine sentiment: low	31.30%	25.00%
Anti-vaccine sentiment: moderate	56.80%	50.00%
Anti-vaccine sentiment: high	11.80%	25.00%
Total number of accounts	115,335	150,000



**Fig. 1** Distribution of the percentage of anti-vaccine information spreading accounts in the friend list

Figure 1 illustrates the proportion of accounts spreading anti-vaccine information within the friend lists of each account at two-time points: January 2020 and December 2021. Each dot in the figure represents an individual account, with the color indicating the level of anti-vaccine attitudes as of December 2021, namely High, Middle, and Low. The X-axis represents the proportion of accounts as of January 2020, while the Y-axis represents the proportion as of December 2021. Since the three categories were determined based on the proportions as of December 2021, the Y-axis shows the proportions of High (25%), Middle (50%), and Low (25%) categories. Note that the histograms at the top and right of the graph show that many of the accounts tweeting and retweeting about vaccines did not follow a single anti-vaccine information-spreading account (i.e., 0%). This suggests that while many anti-vaccine tweets were spread during the pandemic, many of them circulated among a small number of people with anti-vaccine attitudes.



In January 2020, the High anti-vaccine group represented 11.8% of the sample. By December 2021, this percentage had increased to 25%, indicating a rise in anti-vaccine attitudes. Table 3 displays the changes in affiliation categories from January 2020 to December 2021, among 115,335 accounts for which data were available at both time points. None of the accounts moved from the High group to the Low group, but 1921 accounts moved from the Low group to the High group. In addition, 6466 accounts transitioned from the Moderate group to the High group, while only 1,030 accounts moved from the Moderate group to the Low group. Overall, more accounts strengthened their anti-vaccine stances than weakened them during the pandemic.

## Analysis

First, we compared the characteristics of the High and Low groups as of December 2021 to illustrate the characteristics of anti-vaxxers. Subsequently, we partitioned the High group into two subgroups: those who continuously belonged to the High group from January 2020, and those who had shifted from the Low group to the High group by December 2021. We analyzed the differences between these groups to identify the characteristics of users who develop new anti-vaccine attitudes. Finally, we compared the following rates of political party accounts from March to September 2022 to demonstrate that the meteoric rise of the anti-vaccine party, Sanseito, in the Upper House election is associated with an increased tendency of those who moved from the Low group to the High group to follow Sanseito's account, rather than those who had always been in the High group.

## Descriptive characteristics of anti-vaccine users

To begin, we analyzed the descriptive characteristics of anti-vaccine users. We compared the Low and High groups as of December 31, 2021, to identify the characteristics of those with strong anti-vaccine attitudes. To accomplish this, we trained a classifier that uses two features—following anti-vaccine influencers during the early days of Twitter use and profile language features—to distinguish between the High and Low groups. We extracted features that significantly contributed to this classification, enabling us to characterize each group.

**Table 3** Movement between categories between Jan 2020 and Dec 2021

		Dec 2021			
		Low	Middle	High	Total
Jan 2020	Low	28,831	5395	1921	36,147
	Moderate	1030	58,025	6466	65,521
	High	0	668	12,999	13,667
	Total	29,861	64,088	21,386	115,335



The first feature we considered was the proportion of anti-vaccine influencers followed during the earliest days of Twitter use. We calculated the percentage of anti-vaccine influencers among the friend list during five distinct time slots: 1st–10th, 11th–20th, 21st–30th, 31st–40th, and 41st–50th, based on the order of followership in the friend list. For this analysis, anti-vaccine influencers were defined as accounts that spread anti-vaccine information and had over 10,000 followers, with posts that were retweeted more than 1000 times. The second feature is profile language, which consists of nouns, verbs, and adjectives used in the Twitter profile texts as of March 2022. Table 4 shows the top 20 predictive features for classification, sorted based on their weights, using linear support vector machine for the binary classification of the High and Low groups (see Fig. S1 in the Supplementary Materials for the rationale behind adopting the linear support vector machine). As shown, there are characteristic features and their corresponding weights that are predictive of classification into either the High or the Low group.

Table 4 shows that features that measure the following anti-vaccine influencers in the early phases of Twitter use come at the top of the list of the characteristic features of the High group. That is, those who follow anti-vaccine influencers soon after starting to use Twitter were more likely to maintain anti-vaccine attitudes until December 2021. These features arguably represent two effects. One is that those who first started using Twitter with the aim of gathering anti-vaccine information tend to be consistently anti-vaccine. The other is that by following anti-vaccine influencers for whatever reason in the early stages of use, they are persuaded by the influencers to hold persistent anti-vaccine attitudes. The High group is also distinguished by features related to politics, including terms such as “politics,” “Japan,” “Japan Communist Party,” “nuclear power plant,” and “democracy.” This heightened interest in politics aligns with prior research indicating that the global pandemic has politicized anti-vaccine attitudes [6, 25, 37].

In contrast, the most prevalent features for classification into the Low group pertain to cultural artifacts like games and anime, encompassing terms such as “adult” (mature content), daily life, TRPGs (table talk role-playing games), and *Uma Musume* (name of a game). No political keywords are present. Although these accounts also mention vaccines through posts or retweets, they exhibit a predominantly personal interest in games and anime, indicating that Twitter serves as a platform for their hobbies. Individuals using Twitter for personal hobbies are less likely to hold anti-vaccine attitudes.

### Comparison of continuing and new anti-vaccine users

Next, based on Table 3, we classified individuals who were in the High group in January 2020 and retained this classification in December 2021 ( $N=12,999$ ) as the HH group. Similarly, we designated individuals who were in the Low group in January 2020 but shifted to the High group in December 2021 ( $N=1921$ ) as the LH group. Our objective was to outline the attributes of those who switched to an anti-vaccine stance after the pandemic onset.

**Table 4** Profile features characterizing High and Low anti-vaccine sentiment groups

Rank	Features of High group		Features of Low group	
	Feature	Weight	Feature	Weight
1	% of anti-vaccine influencers among 1–10 oldest friends	16.46	Adult	-2.16
2	% of anti-vaccine influencers among 11–20 oldest friends	10.91	Games	-1.07
3	% of anti-vaccine influencers among 41–50 oldest friends	10.25	Sorry	-1.04
4	% of anti-vaccine influencers among 31–40 oldest friends	10.06	Married couple	-1.03
5	% of anti-vaccine influencers among 21–30 oldest friends	9.75	Omnivore	-1.01
6	Politics	4.27	Daily life	-1.01
7	Japanese Communist Party	4.00	TRPG (tabletop role-playing game)	-1.00
8	Japan	2.62	FGO (game)	-0.99
9	Opposition	2.57	Unauthorized reproduction	-0.98
10	Nuclear power plant	2.48	Uma Musume (game)	-0.92
11	Nuclear Power Plant Free	2.26	Somewhere	-0.86
12	World	2.14	30 s	-0.86
13	Peace	2.08	Hako-oshi (supporting entire idolized groups)	-0.84
14	Reiwa Shinsengumi	1.98	Icon	-0.84
15	Online right-wing	1.97	Career change	-0.83
16	Children	1.92	Professional	-0.83
17	Society	1.91	NEWS	-0.82
18	Empathy	1.87	Creation	-0.82
19	Democracy	1.78	Newbie	-0.82
20	Calm	1.76	Infertility	-0.81

We constructed a network comprising 14,920 accounts (comprising both HH and LH groups) as nodes, with their follow/follower relationships serving as edges. Subsequently, we utilized the Louvain method to identify 12 clusters within the network. Regarding the profile texts of all accounts within each cluster as its documents, we then retrieved the words with high TF-IDF (term frequency–inversed document frequency) scores as its feature words. Specifically, words with a frequency of occurrence less than 10 times across the entire corpus are omitted, and words that appear in 80% or more of the documents across the entire corpus are excluded. See Fig. S2 in the Supplementary Materials for sensitivity analyses on these two parameters. Because the four largest clusters accounted for 91.3% of all accounts, we manually labeled each cluster based on its respective feature words (Table 5). The upper row for each cluster in Table 5 lists the feature words using profile texts from January 2020, while the lower row lists those from March 2022. However, the substantive conclusion remains consistent regardless of which row is interpreted.

The largest clusters, which represent 43.1% of the HH and LH groups, are characterized by feature words related to conspiracy theories, health concerns, spiritual discourse, and naturalist discourse. For example, “group stalking” refers to surveillance and harassment by an unspecified number of people, while those who claim victimization are characterized by paranoia and conspiracy theories such as “electromagnetic wave attacks” and “thought eavesdropping.” “Technology” is often used in profile texts to mean “technology crime,” which refers to organized crime that exploits harassment, electromagnetic waves, and ultrasound, and is also part of conspiracist discourse. This cluster also exhibits a high level of health consciousness, as indicated by terms such as “health,” “immunity,” and “diet.” Similarly, “fabric softeners” are strongly believed by some health-conscious naturalists to cause chemical sensitivity, including headaches, nausea, and dizziness owing to their scent. Furthermore, Haruma Miura is the actor who committed suicide during the pandemic, and conspiracy theorists believe that the truth of his death was covered up. “Wave” and “Universe” are keywords often mentioned in spiritual discourse. Therefore, the first cluster can be interpreted as a health-conscious cluster with a preference for conspiracy theories, spiritual discourse, and naturalist orientation. It is also noteworthy that no political discourse appears in this cluster.

The second cluster exhibits strong leftist characteristics, as profile texts frequently mention the leftist party Reiwa and its leader Taro Yamamoto, expressing criticism and condemnation of former Prime Minister Shinzo Abe and his administration, as well as hostility toward rightist parties such as Ishin. The third cluster demonstrates a high level of interest in issues typically supported by leftist parties, such as opposition to nuclear power plants, concern over radiation contamination in Fukushima, anti-war sentiment, the Okinawa US military base issue, and support for the Japanese Communist Party. While the second cluster references political parties and leaders, the third cluster focuses more on issues that align with leftist ideology. The fourth cluster, in contrast, expresses hostility toward “anti-Japanese” forces, conservatism, the emperor, the Japanese flag, and rightist politicians, reflecting a rightist cluster with conservative ideology.

How do cluster membership patterns differ between the HH and LH groups? Table 5 indicates that the LH group is overwhelmingly represented in the first cluster

**Table 5** Clusters among the HH and LH groups

Cluster	# of accounts	Share	Share among HH	Share among LH	Feature words
Conspiracy theory/ Spirital/ Naturalist	5856	43.1%	37.8%	82.7%	Group stalking Haruma Miura (an actor who committed suicide) Technology Account Fabric softener Mask Health Spiritual Around 30 (age) Immunity Diet Group stalking Animals Waku (a slang for vaccine) Recently Wave (buzz word for spiritualists) Start Important Information gathering Universe
Leftist	3915	28.8%	31.5%	10.0%	Taro Yamamoto (liberal politician) Reiwa Government Ishin (Conservative party) Taro Yamamoto Nuclear power plant free War Japanese Communist Party Nuclear Power Free TPP 3.11 (the day when Fukushima was hit by the earthquake) Japan [Icon of Japanese flag] Anti-Japanese [Icon of Japanese flag]
Leftist issues	1533	11.3%	12.7%	0.8%	War Japanese Communist Party Nuclear Power Free TPP 3.11 (the day when Fukushima was hit by the earthquake) Japan [Icon of Japanese flag] Anti-Japanese [Icon of Japanese flag]
Rightist	1098	8.1%	8.5%	4.9%	Anti-Japanese [Icon of Japanese flag] Anti-Japanese [Icon of Japanese flag]
					Neto-tyo (Online right-wing) Smartphone Ignorance Government Worst Komei (LDP's coalition partner) Abe (Shinzo) Democracy Opposition parties Cat paw War Powers Act Okinawa Abolition NO Anti-war Fukushima Radiation exposure Relocation Radiation Impartial Emperor Ancestors Block Immigration Smae Takachi (Rightist politician) I like Japan Biased media Japan First Party (Naiton- alist party) Japan Pride Conservative Biased media Japan Pretdecessor Diet member Immigrants

at 82.7% and in the leftist cluster at 10%. This suggests that the new anti-vaxxers who emerged after the pandemic have a strong inclination toward conspiracy theories, spirituality, and naturalism. In contrast, the HH group, which held anti-vaccine views before the pandemic, has the largest membership in the conspiracy theory/spiritual/naturalist cluster at 37.8%, with 31.3% in the leftist cluster and 11.3% in the leftist issue cluster. This suggests a clear leftist political ideology in the HH group, with a minor rightist inclination at 8.5%. Thus, the HH group's political stance is clearer than that of the LH group, but it also displays a significant inclination toward conspiracy theory and spiritual/naturalist discourses.

### Entry of anti-vaccine parties into national politics

Finally, we investigate the potential link between major political parties or their leaders and anti-vaccine attitudes at two-time points: March 2022, when the anti-vaccine party Sanseito was established, and September 2022, following the House of Councillors election. Specifically, we examine whether the prevalence of anti-vaccine attitudes on Twitter contributed to Sanseito's success.

To this end, we examine the extent to which accounts following the official Twitter accounts of major political parties or their leaders were included in the HH and LH groups, respectively, as an indication of association with a particular political party. The proportions of anti-vaccine accounts (i.e., the HH and LH groups) that follow these official accounts are presented in Fig. 2.

Figure 2 demonstrates that the HH group, persistently opposed to vaccinations, exhibited a greater inclination to support leftist parties such as the Constitutional Democratic Party, Reiwa, and the Japanese Communist Party during the pandemic. This observation aligns with the findings presented in Table 5, which indicate that the HH group had more profile texts associated with leftist parties and their agendas. Additionally, the following pattern of the HH group remained relatively consistent, with a slight upsurge in their support for Sanseito from March to September 2022. In contrast, the LH group, who developed anti-vaccine sentiments following the pandemic, displayed a weaker tendency to follow prominent political figures and major parties. Nevertheless, the LH group demonstrated an exception in their support for Sanseito, with 13% of members already following Sanseito or its leader in March 2022, which rose to 24% by September. This increase surpassed that of the HH group.

Sanseito made anti-vaccine discourse a central part of its election campaign. This campaign was partially successful in gaining the support of the existing anti-vaccine voters (the HH group), but it was more successful in quickly gaining the support of new anti-vaccine accounts (the LH group) whose anti-vaccine attitudes were triggered by health and side-effect concerns, spiritual discourse, and conspiracy theories in the wake of the pandemic. Persistent anti-vaxxers, owing to their established affiliations with established liberal and—to a lesser extent—conservative parties, exhibited a limited propensity to transition to the nascent Sanseito movement. Conversely, individuals with minimal political involvement and weak ties to established parties

prior to the pandemic but a preexisting interest in health, spirituality, and conspiracy theories are likely to have been receptive to Sanseito's electioneering efforts.

## Discussion

The global COVID-19 pandemic and the widespread push for vaccination have hastened the spread of anti-vaccine sentiments, which the extensive use of social media has facilitated. Although previous research has shed light on the characteristics of those who oppose vaccines, few studies have explored the factors that lead people to adopt such views. Therefore, this study employs a longitudinal analysis of anti-vaccine discourse on Japanese Twitter to examine the drivers of the transformation into anti-vaccine advocates. Moreover, we examine the emergence of the anti-vaccine party in the context of the politicization of anti-vaccination and elucidate the process by which anti-vaccine advocates gain political representation.

The analysis shows that anti-vaxxers are more politically involved than other Twitter users interested in vaccines. They include both rightists and leftists, but leftists are dominant. Anti-vaxxers' strong interest in politics contrasts with non-anti-vaxxers, who, while tweeting/retweeting about vaccines, are primarily concerned with the realm of private interests, such as gaming and anime. A comparison of users who were consistently anti-vaccine before the pandemic with those who turned anti-vaccine afterwards indicates that the former followed anti-vaccine influencers in the early stages of their Twitter use, suggesting they originally had an interest in

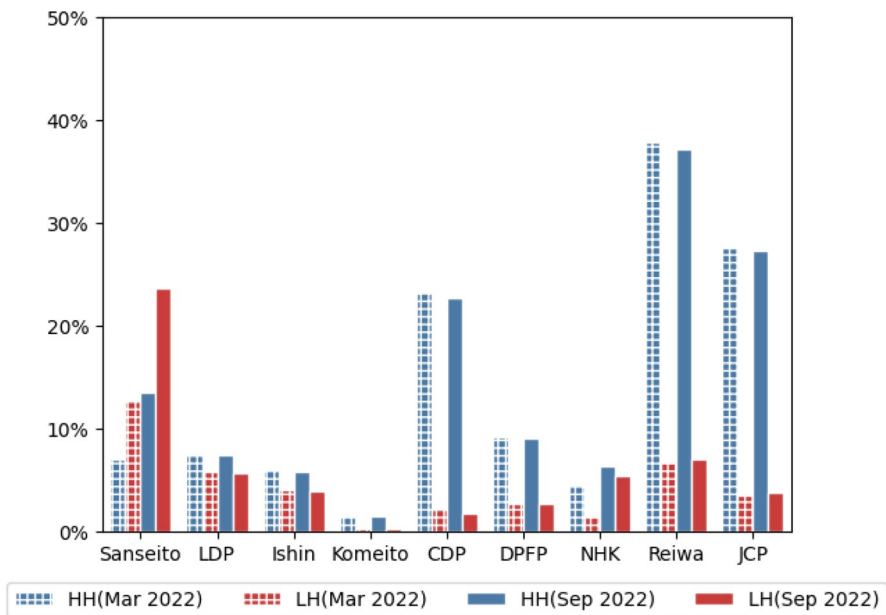


Fig. 2 Associations between major political parties/leaders and anti-vaccine accounts

vaccines and a social influence on Twitter. They were also more politically interested than new anti-vaxxers, leaning more to the left than to the right. In contrast, new anti-vaxxers are less politically engaged but have a particular interest in health, spiritual and naturalist discourses, and conspiracy theories.

The study suggests that the emergence of new anti-vaxxers was not primarily driven by political concerns. Rather, their preexisting interests in conspiracy theories, spiritual discourse, and health acted as a gateway to their adoption of anti-vaccine attitudes during the pandemic. Owing to the high congruence between anti-vaccine sentiment and conspiracy theories and alternative health practices [14–20], these individuals incorporated their anti-vaccine beliefs into their original belief systems, resulting in their identification as anti-vaxxers. While persistent anti-vaxxers tended to follow established left-leaning political parties and leaders, such as the Constitutional Democratic Party, Reiwa, and the Japanese Communist Party, new anti-vaxxers rarely followed existing political parties. However, the number of new anti-vaxxers following the anti-vaccine Sanseito increased sharply from March to September 2022, suggesting that Sanseito has successfully appealed to those who became anti-vaccine during the pandemic, resulting in its seat in the Diet.

To summarize, our findings suggest that individuals without anti-vaccine beliefs can be exposed to anti-vaccine tweets if they possess a strong focus on health or spirituality and are driven by pandemic-related anxiety. As a result, they may be inclined to support a political party that combines anti-vaccine mixed conspiracy theories with spiritual discourses. For instance, Yumi Akao, the unsuccessful co-chair of the Sanseito Party in the Upper House election, has expressed her intention to establish politics that aligns with the “era of the wind,” a term of significance in spiritual discourse. Sanseito’s representative, Sohei Kamiya, likewise referenced this term in a speech, stating that “it appears that we are currently in the ‘era of the wind.’” Additionally, the party often invokes conspiracy theories regarding international Jewish capital, which attracts individuals who subscribe to such beliefs. By weaving these spiritual and conspiratorial narratives together with explicit or implicit anti-vaccine rhetoric, Sanseito rapidly gained the support of those who became vaccine-hesitant during the pandemic.

This study has several limitations that remain to be addressed. First, since this study focuses solely on the case of Japan, it is unclear which aspects of the findings are specific to Japan and which can be generalized globally. Similar findings to this study, which suggest that spirituality serves as a gateway to anti-vaccine attitudes, have been reported in the Czech Republic [38] and the United Kingdom [39]. Therefore, the relationship between spirituality and anti-vaccine attitudes may have generalizability beyond Japan. On the other hand, whether anti-vaxxers are politically represented heavily depends on the influence of supply-side factors, which can vary significantly from country to country. While Japan witnessed the emergence of an anti-vaccine Sanseito during the pandemic, countries where such parties did not emerge would likely see anti-vaccine individuals supporting existing right-wing or populist parties. Thus, it is believed that there are significant factors specific to Japan when it comes to the political representation of anti-vaccine individuals.

Second, we defined those who disproportionately follow accounts spreading anti-vaccine information as “anti-vaxxers.” Still, there is room for debate regarding the



assumption that the act of following represents users' attitudes. For instance, if 30% of the friend list consists of accounts spreading anti-vaccine information, according to our study's definition, they would be identified as the "High group." However, simultaneously, 40% of the friend list may consist of accounts spreading pro-vaccine information. In cases where users follow both types of accounts spreading anti- and pro-vaccine information, their follow behavior may reflect information-seeking strategies rather than their attitudes. However, it should be noted that there were not many accounts that followed both accounts spreading anti-vaccine information and accounts spreading pro-vaccine information (see Fig. S3 in the Supplementary Materials). Future research is called for to refine the estimation of anti-vaccine attitudes.

Finally, this study demonstrated that individuals who became anti-vaccine after the onset of pandemic exhibited a higher increase in following rates of Sanseito compared to those who were already anti-vaccine prior to the pandemic. However, a causal relationship with voting in elections has not been established. While following behavior on Twitter is associated with support for political parties, obtaining evidence that individuals who became anti-vaccine after the pandemic were strongly mobilized to vote for Sanseito requires future analysis that combines Twitter data with survey data on voting behavior.

When individuals adopt anti-vaccine discourses, they develop a belief system that aligns with other spiritual discourses and conspiracy theories, making them resistant to persuasion. Therefore, preventing the adoption of anti-vaccine beliefs is crucial in reducing the overall number of anti-vaxxers. This requires investigating how anti-vaccine discourses intersect with non-scientific health practices, alternative medicine, spiritual discourse, and conspiracy theories, as these serve as gateways to anti-vaccine beliefs. Failure to do so increases the risk to public health policies, allowing political parties that prioritize opposition to vaccines as their signature issue to gain entry into the national political arena.

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**Data availability** Upon request, we can provide the complete IDs of the tweets used in the analysis, as long as they comply with the terms and conditions of Twitter (currently X). However, we are unable to disclose user IDs or information regarding the followers of the individuals analyzed, as it violates Twitter's terms and conditions. This limitation exists to prevent the identification of individuals' attitudes towards vaccines.

## Declarations

**Conflict of interest** The authors have declared that no competing interests exist.

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