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'It's a shot, not a vaccine like MMR': A new type of vaccine-specific scepticism on Twitter/X during the COVID-19 pandemic

Elena Semino [a,*], Tara Coltman-Patel [a], William Dance [a], Zsófia Demjén [b], Richard Gleave [c], Alison Mackey [d]

[a] Department of Linguistics and English Language, Lancaster University, Lancaster LA1 4YL, United Kingdom
[b] Centre for Applied Linguistics, University College London, United Kingdom
[c] UK Health Security Agency, United Kingdom
[d] Department of Linguistics, Georgetown University, USA

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ABSTRACT

Background: While it is well-known that vaccine hesitancy can be vaccine-specific, little is known about how people spontaneously evaluate different vaccines in comparison with one another, or the implications of such comparisons for vaccine attitudes. This paper first investigates how people posting on Twitter/X in 2020–2022 discussed the MMR vaccine and the COVID-19 vaccines in relation to each other. Next it reveals a new manifestation of vaccine scepticism, namely the claim that some vaccines, notably those against COVID-19, are in fact not vaccines.

Methods: A 9-million-word 'corpus' was created, consisting of tweets containing references to the MMR vaccine posted in 2008–2022. First, tweets posted in 2020–2022 and also containing references to COVID-19 were coded for: (1) vaccine-specific evaluation, and (2) vaccine-related topic. Then, the whole corpus was analysed for tweets that contain expressions that challenge the status of a vaccine as a vaccine (e.g. 'not a vaccine', and the use of 'shot' in contrast with 'vaccine').

Results: In 2020–2022, tweets mentioning COVID-19 alongside MMR show an increasing tendency to compare the COVID-19 vaccines unfavourably with MMR, based on perceived low effectiveness against infection. A further analysis of the whole corpus reveals:

- A tendency in 2020–2022 to challenge the status of COVID-19 vaccines, as well as flu vaccines, as vaccines;
- A perceived contrast in 2020–2022 between 'shot' and 'vaccine', with the former being described as an inferior medical intervention.
- Very little evidence of similar arguments being made about any vaccines in 2008–2019.

Conclusion: Data from Twitter/X suggests that perceptions about low effectiveness of the COVID-19 vaccines against infection have led to a belief that they are inferior to MMR and other vaccines, or are not vaccines at all. It is important to address this new form of scepticism about vaccines that primarily prevent serious illness.

1. Introduction

Vaccine hesitancy – defined as 'a delay in acceptance or refusal of vaccines despite availability of vaccination services' – was identified in 2019 by the World Health Organization (WHO) as one of the top 10 global health threats [1]. The threat has become even more urgent since the COVID-19 pandemic [2], with, for example, confidence in the effectiveness of vaccines declining in the UK between 2019 and 2023 (https://www.vaccineconfidence.org/vci/country/gb/). Although the WHO's definition of vaccine hesitancy is predicated on behaviour, in this paper we focus on attitudes towards vaccinations that are best captured by a psychological definition of vaccine hesitancy, specifically 'a state of indecisiveness regarding a vaccination decision' [3,4]. We are interested in differences in attitudes towards different vaccines on the part of the same individuals, and in the consequences of such differences in perceptions.

* Corresponding author.

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The importance of vaccine-specific concerns is well-documented in relation to vaccine hesitancy. 'Vaccine/vaccination-specific issues' is one of three categories of determinants of vaccine hesitancy in a 2014 report by a WHO Strategic Advisory Group of Experts on Immunization [5]. Included in this category are risk/benefit considerations, the introduction of new vaccines, the strength of health professionals' recommendation, etc.. Similarly, typologies of anti-vaccination arguments include some concerns and objections that apply to some vaccines more than others [6,7]. For example, people may argue that particular vaccines are too new to have been proven safe [8], or that vaccines prevent an illness that is not dangerous [9], or that vaccines do not provide enough protection to be worth accepting [6]. However, currently, little is known about how people express views and evaluations about one vaccine in comparison with another, and how this may be relevant to understanding the different manifestations of vaccine hesitancy. Therefore, the current paper explores how people posting on Twitter discussed, compared and evaluated two vaccines that are both controversial and currently relevant: the MMR vaccine and the COVID-19 vaccine.

As is well documented, the MMR vaccine became the focus of concerns about a link with autism in children following a 1998 study published and then retracted by The Lancet (Wakefield et al., 1998, retracted). Despite surveys showing high levels of confidence in the MMR vaccine [10], concerns persisted in various forms and among specific communities long after the retraction of the original problematic study, and survived the publication of multiple, larger studies contradicting its findings [11,12]. Since the start of the COVID-19 pandemic, a combination of factors, including difficulties of access, have resulted in reduced uptake [13], leading to the resurgence of measles outbreaks in many countries, including the UK [14]. With regard to COVID-19, it was found that, during May–June 2021, the proportion of survey respondents ($n = 5434$) from the USA who reported hesitancy towards the COVID-19 vaccines was six percentage points higher than the proportion who reported hesitancy towards vaccines in general (42.2% vs. 35.7%) [15]. Additionally, the results of a global survey involving 23 countries showed that in 2021, on average, approximately 25% of respondents were hesitant in relation to vaccination against COVID-19, with perceptions of low efficacy as one of the drivers of the reluctance [16]. In 2022, results from the same survey showed an increase in the proportion of respondents willing to accept vaccination (from 75.2% to 79.1) but also revealed a substantial minority of vaccinated respondents (12.1% on average overall) who expressed hesitancy about booster doses [17]. On the other hand, it has been estimated that, between 2020 and 2023, the COVID-19 vaccines saved approximately 1.6 million lives in adults aged 25 or over in 34 European countries, with first boosters saving 51% of lives [18].

Responding to the current relevance of both the MMR and the COVID-19 vaccines, we created a 9.6 million-word dataset, or 'corpus', consisting of tweets that mention the MMR vaccine over the 15-year period from 2008 to 2022. We focused on Twitter because, alongside other social media platforms, it has been widely discussed as a source of data for studying vaccine attitudes [19] and as a tool both for disseminating vaccination-related public health messages [20], as well as for spreading mis/disinformation regarding vaccination [21–23] (NB: our data was collected prior to Twitter being renamed X, and we therefore employ the previous label).

We begin by analysing tweets that mention COVID-19 alongside the MMR vaccine in the period 2020–2022. We show differences in perceptions and judgements between MMR and the COVID-19 vaccines, and specifically a tendency to evaluate the COVID-19 vaccines negatively compared with MMR, based on a contrast in perceived effectiveness against infection. Within this contrast, we discovered a form of vaccine-specific hesitancy, or, more precisely, scepticism that has not, to our knowledge, been previously documented. This is the challenging of the status of the COVID-19 vaccines as vaccines, e.g.:

> It's not even a real vaccine. You can catch covid and also spread it if you are vaccinated. You don't catch polio or MMR after you are vaccinated. (2021-07-26).

We therefore go on to investigate systematically a set of linguistic expressions that convey this specific form of vaccine scepticism in the 2020–2022 section of the corpus, in comparison with the 2008–2019 section. We show that scepticism about the status of any vaccine being a real vaccine was very rarely expressed on Twitter before 2020.

We suggest that this seemingly new belief reflects potential public misunderstanding of what counts as a vaccine in relation to COVID-19 specifically. We show that such confusion may now be generalized to public beliefs about other vaccines, such as those for influenza. We finish with some reflections on the role of linguistic and policy framing in this new attitude towards some vaccines.

2. Data: The twitter MMR corpus

Using Twitter's Academic Access API, we used the query below to collect every tweet in English that contains a reference to MMR and variations of the words 'vaccine', 'vaccinate', 'vaccination' and 'vax' between January 2008 and December 2022 (NB: Twitter data was available from 2006 but only 16 relevant tweets were found before 2008):

> lang:en (mmr) (vaccine OR vaccines OR vaccinate OR vaccinates OR vaccinated OR vaccinating OR vaccination OR vaccinations OR vaxx OR vax OR vaxxed OR vaxed OR vaxxer OR vaxer OR vaxxing OR vaxing OR vaxxes OR vaxes)

The resulting dataset was de-duplicated and retweets were removed. The remaining data was used to create a digitally searchable corpus—the Twitter MMR corpus—consisting of a total of 261,203 tweets and 9,650,253 word tokens, divided as follows with reference to the COVID-19 pandemic:

- Pre-pandemic sub-corpus: 1st January 2008 to 31st December 2019; 136,076 tweets, 4,117,012 words;
- Pandemic sub-corpus: 1st January 2020 to 31st December 2022; 125,127 tweets, 5,533,241 words.

NB: Despite covering a shorter time span (3 years versus 12 years) the Pandemic sub-corpus is 34% larger in terms of word count than the Pre-pandemic sub-corpus (approx. 5.5 million tokens versus 4.1 million).

3. Research questions and methods

While a number of previous studies have investigated attitudes to individual vaccines [13,24,25], there is currently a relative lack of research on how people compare one vaccine to another, and on the implications of such comparisons. To address this issue by means of the Twitter MMR corpus, we combined manual thematic coding of selected samples from the data with the tools associated with Corpus Linguistics, defined as the computer-aided analysis of large language datasets [25].

The first stage of the analysis focused on the Pandemic sub-corpus, and addressed the following research question:

> RQ1. What vaccine-related evaluations and topics characterize tweets that mention both COVID-19 and the MMR vaccine in the period 2020–2022?

To answer RQ1, the Pandemic sub-corpus was uploaded to the online corpus analysis tool CQPweb (https://cqpweb.lancs.ac.uk) and searched for the string 'covid*'. The wildcard * stands for any character or series of characters, thus retrieving 'covid', 'covid-19', etc. regardless of capitalization. 26,061 instances of the search string were identified, in

22,792 different tweets. A random sample of 12% of such tweets (no = 2794) was examined manually to establish how MMR and COVID-19 are discussed together.

First, Coder 1 carried out a preliminary analysis of 1000 tweets using a codebook developed iteratively via whole-team based discussions. These discussions included analysis of concordance lines between Coder 1 and Coder 2 as part of the codebook development process. Next, Coder 1 and Coder 2 independently coded 300 randomly selected tweets from the 2794 sample tweets (50 from each six-month section). This initial coding did not reach sufficiently high levels of reliability, which, after further examination and discussion, was attributed to Coder 2's being less familiar with the codebook than Coder 1 resulting in additional training for Coder 2. Finally, each of the two coders was assigned three sections from the six-month samples to code independently. A randomly selected 150 tweets from each of their assigned sections (50 per section) were coded by the second coder to assess inter-rater reliability The results of this coding were compiled into a spreadsheet. Each tweet was coded for:

1) Vaccine-specific evaluation regarding MMR and the COVID-19 vaccines, i.e., positive/negative for both MMR and COVID-19 vaccines; positive/negative for MMR or for COVID-19 vaccines; positive for MMR and negative for COVID-19 vaccines; negative for MMR and positive for COVID-19 vaccines; Neutral (i.e. no evaluation); and Unclear. Inter-Rater Reliability (IRR) was calculated in SPSS: the percentage agreement between two raters was 93.3%, and Cohen's Kappa, to account for agreement occurring by chance, was 84.0%. These were considered sufficiently high.
2) Vaccine-related topic(s), i.e., Civil Liberties/Personal Freedom,; Doses; Effectiveness; Ingredients/Technology; Mandates; Necessity; Religious Exemptions; Research/Testing; Safety/Side effects; Vaccine Hesitancy; Vaccine Uptake; and Miscellaneous (the latter including, for example, personal narratives). IRR percentage agreement between two raters was 87.67% and Cohen's Kappa was 83.2%. These were considered sufficiently high.

The first stage of the analysis revealed that, overall, positive evaluations outnumbered negative evaluations, but that the COVID-19 vaccines attract more negative evaluations, especially with regard to effectiveness in comparison with the MMR vaccine. In addition, the analysis revealed the presence of tweets that challenged the status of the COVID-19 vaccines as vaccines, as part of an unfavourable comparison with MMR and other vaccines, e.g.:

> That's why it shouldn't be called a vaccine, but a shot like the flu shot, yearly. MMR were actual vaccines to prevent measles and rubella. So was the polio vaccine. (2020-10-19).

An examination of the tweets expressing this belief led to the identification of seven linguistic structures that were repeatedly used to challenge the COVID-19 vaccines as vaccines:

i. *n't/not a vaccine*: negation of the applicability of the term 'vaccine'
ii. *"vaccine"*: use of 'vaccine' within scare quotes, to challenge the applicability of the term
iii. *actual* + *vaccine*: use of the adjective 'actual' preceding 'vaccine' to suggest a contrast with something that cannot be described in those terms:
iv. *proper* + *vaccine*: as above
v. *real* + *vaccine*: as above
vi. *true* + *vaccine*: as above
vii. *defin(ition|itions|e|ed|es|ing)* + *vaccine*: use of the noun 'definition' or the verb 'define' to question the applicability of the term 'vaccine'.

In addition to these potential expressions of vaccine-specific scepticism, we observed that the term 'shot' could be used in contrast with 'vaccine', as in the example above.

These findings led to the second stage of the analysis which aimed to investigate the extent of the use of these expressions to challenge the status of *any* vaccine in both the Pre-pandemic and Pandemic sub-corpora, by answering the following research questions:

RQ2. How often are:

a. the seven potential expressions of vaccine-specific scepticism, and
b. the term 'shot'

used to challenge the status of a vaccine as a vaccine in the Pre-pandemic and Pandemic sub-corpora?

RQ3. Which vaccines have their status as vaccines challenged via the seven expressions or the term 'shot' in the Pre-Pandemic and Pandemic sub-corpora?

NB: Our approach to what counts as a vaccine relies on the WHO's list of vaccine-preventable diseases: https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases.

To address RQ2.a, we uploaded the whole of the Twitter MMR corpus to CQPWeb and extracted all instances of each of the seven linguistic structures in context via CQPWeb's 'concordance' tool. We analysed each concordance line to establish whether, in context, the relevant structure was used to challenge the status of a vaccine as a vaccine (what we call 'vaccine challenging' uses). This involved the coding of 4455 concordance lines – 192 from the Pre-pandemic sub-corpus and 4263 in the Pandemic sub-corpus.

A different approach was taken to answering RQ2.b, since the number of occurrences of the word 'shot' (10,794 in total) made an analysis of all concordance lines unviable. We observed that 'shot' occurs twice as frequently, in relative terms, in the Pandemic vs. the Pre-pandemic sub-corpora. We then used the collocation tool in CQPweb to establish which words tended to co-occur with 'shot' in each sub-corpus. Collocates were calculated based on the MI3 statistic, which is well established in Corpus Linguistics as a way of considering both the frequency and exclusivity of co-occurrences between words. This revealed that 'flu', 'MMR', and 'vaccine' were among the top 20 collocates of 'shot' in the Pre-pandemic sub-corpus, while 'flu', 'MMR', 'covid' and 'vaccine' were among the top 20 collocates of 'shot' in the Pandemic sub-corpus.

For each collocational pair (e.g. 'shot' and MMR, 'shot' and 'vaccine', etc.), a random sample of 10% concordance lines from each sub-corpus was initially analysed to establish whether a substantial proportion of instances did in fact involve challenging the status of a vaccine as a vaccine (e.g., 'it's just a shot').

For the collocational pair 'shot' and 'MMR', no instances were identified in the random sample of a contrast being made between 'shot' and 'vaccine'. Therefore, this collocational pair was not examined any further. In contrast, for co-occurrences of 'shot' with, respectively, 'flu' (agreement: 98.3%; Cohen's Kappa: 96.9%), 'vaccine' (agreement: 97.1%; Cohen's Kappa: 94.2%) and 'covid' (agreement: 90.36%; Cohen's Kappa: 80.3%, all considered sufficiently high), a substantial proportion of instances were found to indicate such a contrast in the sample. Therefore, all instances of co-occurrence with the latter three words were examined to identify cases where 'shot' was used to suggest that a vaccine was not a vaccine.

To answer RQ3, we considered the frequencies of the co-occurrence of 'shot' with 'flu' in the Pre-pandemic sub-corpus, and with both 'flu' and 'covid' in the Pandemic sub-corpus. In addition, all 'challenging' uses of co-occurrences between 'shot' and 'vaccine' and of each of the seven expressions of vaccine-specific scepticism were coded for the vaccine or vaccines involved, and IRR analysis yielded a Cohen's Kappa coefficient of 93.9%, indicating a strong level of agreement. This was in order to establish whether and to what extent any vaccines in addition to

COVID-19 had their status as vaccines challenged in our Twitter data.

4. Results

Results part 1: Tweets that mention COVID-19 alongside MMR in 2020–2022.

The first stage of the analysis aimed to answer RQ1 above.

Vaccine-related evaluations and topics in tweets that mention both COVID-19 and the MMR vaccine.

The overall frequencies of vaccine-specific evaluations and vaccine-related topics in the sample from tweets that mention COVID-19 in the Pandemic sub-corpus are provided in, respectively, Figs. 1 and 2 (NB: the total number of occurrences for topics is higher than the number of tweets in the sample because some tweets received more than one topic code).

In the data, positive evaluations outnumber negative evaluations. Out of 2794 tweets in our sample, we have 1934 cases where at least one vaccine is evaluated positively vs. 1002 cases where at least one vaccine is evaluated negatively. Negative evaluations are most relevant to this paper.

Overall, the COVID-19 vaccines are evaluated negatively more often than the MMR vaccine (972 instances vs. 130). More specifically, the most frequent vaccine-specific evaluation that involves a negative element is *Positive for MMR, negative for COVID-19 vaccines* (698 instances, i.e. 70% of all tweets involving a negative evaluation).

In the rest of this paper we therefore focus on the interaction between the evaluation code *Positive for MMR, negative for COVID-19 vaccines* and the most frequent vaccine-related topic, *Effectiveness* (994 instances). We should note, however, that there are negative evaluations of MMR, alone or alongside the COVID-19 vaccines, and these feature a variety of concerns about side effects, ingredients, effectiveness and mandates, but, interestingly, little evidence of belief in the scientifically discredited link with autism.

Positive evaluation of MMR alongside negative evaluation of COVID-19 vaccines based on effectiveness (2020–2022).

The evaluation *Positive for MMR, negative for COVID-19 vaccines* is over four times as frequent as the second most frequent evaluation with a negative element, *Negative for COVID-19 vaccines* (698 vs. 144 instances). *Effectiveness* is twice as frequent overall as the next most frequent topic, *Mandates* (994 vs. 487 instances). In addition, as shown in Fig. 3, *Effectiveness* is by far the most frequent topic in tweets that involve the evaluation *Positive for MMR, negative for COVID-19 vaccines*: it is present in 66.5% of tweets with this particular evaluation (464 tweets), while all other topics are present in less than 10% of such tweets.

The period covered by the 5.5-million-word Pandemic sub-corpus saw rapid and significant changes with regard to the existence and availability of COVID-19 vaccines, with implications for associated attitudes and behaviours. In Fig. 4, we therefore divide the sub-corpus into six 6-month sections, and show the prevalence of the top five most frequent vaccine-specific evaluations, respectively, from the most to the least frequent. This shows how, not surprisingly, the *Positive for MMR, negative for COVID-19 vaccines* evaluation emerges in a small number of tweets in the second part of 2020 (at 3.2% of tweets in the sample) and then grows steadily from 16% of tweets in the sample in the first part of 2021 to 40.8% in the second part of 2022.

Characteristics of tweets that evaluate MMR positively and COVID-19 vaccines negatively on the basis of effectiveness (2020–2022).

The examples below are representative of tweets that were coded as *Effectiveness* for topic and as *Positive for MMR, negative for COVID-19 vaccines* for evaluation (NB: we remove usernames or any identifying information, but preserve original spellings):

1. Yes because the covid vaccine is just like the MMR vaccine. NOT. MMR vaccine provides 99.8% protection from catching measles, mumps or rubella. Covid vaccine does NOT stop you from catching covid. Vaccinate away but it's not going to stop covid. (2021−02−11)
2. I've never worried about someone's MMR status nor would I segregate away from someone that had measles/mumps/rubella because I trust my vaccine to protect me, as it has. CV19 vaxxed can still transmit & get Covid which makes them no dif then unvaxxed. (2022-04-09)

In both cases, the COVID-19 vaccines are compared unfavourably to MMR because the latter is highly effective at preventing infection while the COVID-19 vaccines are not. In some cases, other vaccines, such as

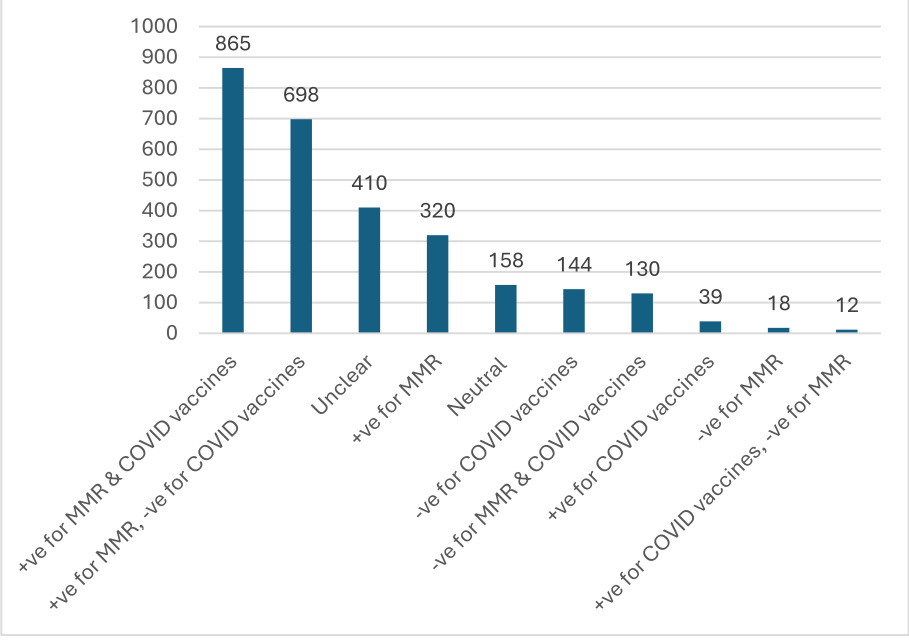

Fig. 1. Frequencies of vaccine-specific evaluations in sample from Pandemic sub-corpus.

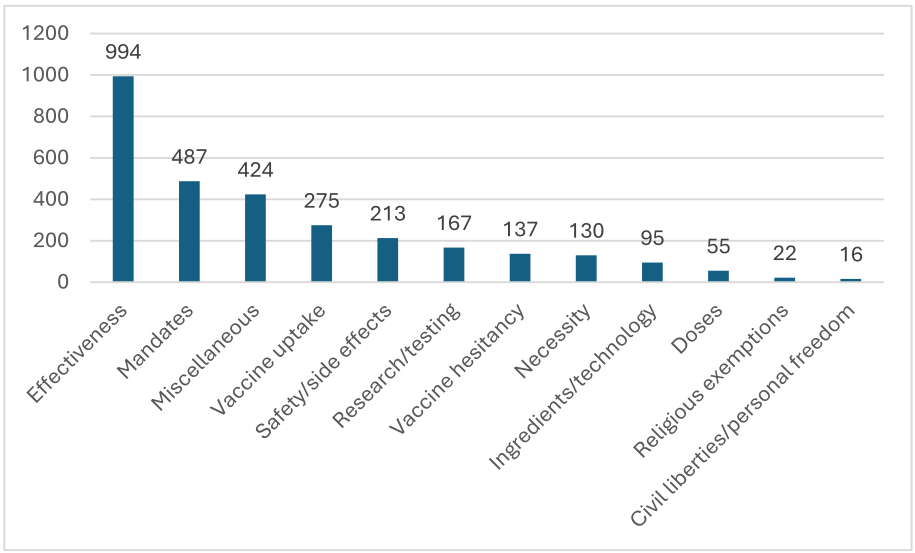

Fig. 2. Frequencies of vaccine-related topics in sample from Pandemic sub-corpus.

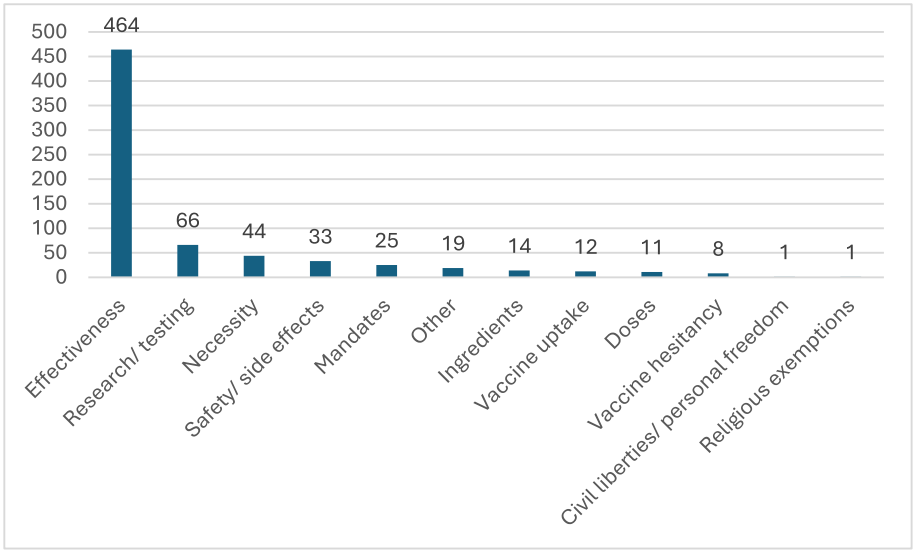

Fig. 3. Topics of tweets in the sample with **Positive for MMR, negative for COVID-19 vaccines** Evaluation.

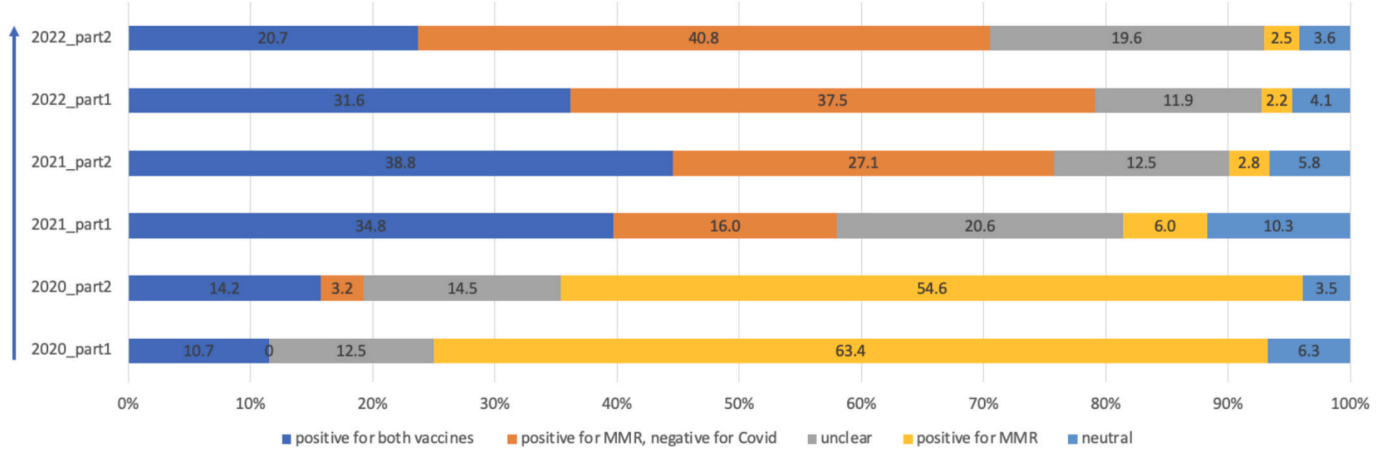

Fig. 4. Proportions (%) of five most frequent vaccine-specific evaluation by six-month period in sample the pandemic sub-corpus (NB: For each year, Part 1 covers January to June, and Part 2 covers July to December).

the one against polio, are mentioned alongside MMR as examples of highly effective vaccines.

Moreover, and most importantly, in some cases posters conclude that, because of their alleged low (or lack of) effectiveness against infection, the COVID-19 vaccines are in fact not vaccines (our underlining below):

3. How about we start with the fact that it's not a vaccine, it's a therapeutic. True vaccines immunize you from the virus. The COVID "vaccine" still allows you to catch COVID just with lesser symptoms. Not the same with polio, MMR, etc. (2021-06-21)
4. Agreed, the definition of a vaccine is lifetime protection like the MMR vax. This is more like a flu shot that needs to be taken yearly when they try to guess which strain will be out (2021-04-08)

This particular form of vaccine-specific scepticism goes beyond an unfavourable comparison of one type of vaccine in relation to another, and has not, to our knowledge, been observed before. We therefore explored systematically in the whole Twitter MMR corpus (2008–2022) the seven potential expressions of vaccine-specific scepticism mentioned in section 3, and the use of 'shot' in contrast with 'vaccine' (cf. underlining in examples 3–4), in order to establish the extent of this form of vaccine-specific scepticism in relation to the COVID-19 vaccines and any other vaccines, both before and during the pandemic.

Results part 2: Tweets that challenge the status of a vaccine as a vaccine in the whole Twitter MMR corpus (2008–2022).

The second stage of the analysis aimed to answer RQ2 and RQ3.

Table 1 provides, for the seven linguistic structures introduced in section 3, the frequencies of uses that were coded as challenging the status of a vaccine as a vaccine, in the Pre-pandemic and Pandemic sub-corpora.

The seven linguistic structures appeared in very low frequencies in the Pre-pandemic sub-corpus (no = 192, 0.5 instances per 10,000 words), in contrast with the post-pandemic corpus (no = 4263, 7.7 instances pr 10,000 words). Only 16 vaccine-challenging instances were identified in total in the Pre-pandemic sub-corpus, i.e., 0.04 instances of challenging uses per 10,000 words. In contrast, the Pandemic sub-corpus contains 3512 vaccine-challenging uses of these structures (6.3 instances per 10,000 words). Overall, therefore, in the MMR Twitter corpus, claims that some vaccines are not in fact vaccines, expressed via the linguistic structures in question, are a pandemic phenomenon.

Fig. 5 illustrates which vaccines have their status challenged via the seven linguistic structures in the Pandemic sub-corpus. The COVID-19 vaccines are involved in 86% of cases (no = 3013). In a further 8% of cases (no = 272), the flu vaccines are challenged alongside the COVID-19 vaccines. In 2% of cases (no = 66), the flu vaccines alone are challenged. In the case of flu, the same objection applies as for COVID-19, i.e. that what is officially described as a vaccine has low effectiveness against infection:

5. Can you tell me more about this "vaccine" for the flu that allows tens of thousands of deaths? That's not a vaccine, it's a flu shot. Much different than say a polio vaccine or MMR vaccine. I would argue that we do NOT have a flu vaccine. (2020-04-13)

Table 1
Frequencies of linguistic structures that can be used to challenge the status of a vaccine in the Pre-pandemic and Pandemic sub-corpora.

Pre-pandemic sub-corpus		Pandemic sub-corpus	
Non-challenging uses	Challenging uses	Non-challenging uses	Challenging uses
176 (92%)	16 (8%)	751 (18%)	3512 (82%)

The other cases – MMR, the HPV vaccine, and vaccines in general – apply to 1% of the cases or fewer (50 or fewer instances).

Overall, therefore, in our data the view that a vaccine is not, in fact, a vaccine, based primarily on perceived low effectiveness against infection, is a pandemic phenomenon that overwhelmingly applies to the COVID-19 vaccines, but also extends, to a lesser extent, to the flu vaccines.

With only 16 instances of vaccine-challenging uses of the seven expressions in the Pre-pandemic sub-corpus, no comments can be made about patterns. However, we only found one instance in which the flu vaccine was involved, in contrast with 338 in the pandemic sub-corpus. This may suggest that a perception that was mainly motivated by experience with the COVID-19 vaccines is resulting in a greater focus on a similar perceived shortcoming of the flu vaccines in 2020–2022. Future research will be needed to establish the persistence of this perception from 2023 onwards.

'Shot' in contrast to 'vaccine'.

The first stage of the analysis revealed that 'shot' was sometimes used in contrast to 'vaccine':

6. Vaccine: Polio, MMR, smallpox. You don't have to get them again and you won't get the disease. Shot: Tetanus, flu, Covid. You have to keep getting them because they are n't a cure because there is no cure, especially for a coronavirus. Stop calling it a vaccine. It's a shot. (2021−03−20)

We therefore investigated the overall frequencies of the noun 'shot' and the extent to which it was used in contrast with 'vaccine' in the Pre-pandemic vs. the Pandemic sub-corpora.

'Shot' occurs 2733 times in the Pre-pandemic sub-corpus (6.6 instances per 10,000 words) and 8061 times in the Pandemic sub-corpus (14.6 instances per 10,000 words). As mentioned in section 3, the top 20 collocates of 'shot' in both sub-corpora include 'MMR', 'flu' and 'vaccine'. In the Pandemic sub-corpus, 'covid' is also among the top 20 collocates. As explained in section 3, we examined the concordance lines for all instances of 'shot' collocating with 'vaccine', 'flu' and 'covid', to identify uses that challenged the status of a vaccine.

Table 2 provides the frequencies of vaccine-challenging uses in the Pre-pandemic and Pandemic sub-corpora, as compared with other 'non-challenging' uses of 'shot' in combination with each of the three collocates (NB: the collocate pairs are not mutually exclusive, so that the same stretch of text can be counted under more than one row in Table 2).

In the Pre-pandemic sub-corpus, we identified 13 vaccine-challenging instances of the collocate pair 'shot' plus 'flu', amounting to 3% of the occurrences of the collocate pair. This was never the case when 'shot' collocated with 'vaccine'. In the Pandemic sub-corpus, between 30% and 52% of occurrences of each of the three collocate pairs involves the use of 'shot' in contrast to 'vaccine', to challenge the status of a vaccine. Specifically, the flu vaccine is challenged in 870 cases, and the COVID-19 vaccines in 429 cases.

These findings confirm that, in our data, scepticism about the status of some official vaccines as vaccines is a pandemic phenomenon, and reveals a greater presence of the flu vaccine as the target of this scepticism than we observed in the previous sections.

5. Discussion

Attitudes towards particular vaccines have been amply investigated, e.g., regarding MMR [13], the HPV vaccine [25], and the COVID-19 vaccines [16]. However, to our knowledge, ours is the first study to look at how individuals evaluate vaccines in relation to each other in spontaneous discourse. We investigated a corpus of tweets mentioning the MMR vaccine between 2008 and 2022, which we divided into a Pre-pandemic sub-corpus (2008–2019) and a Pandemic sub-corpus (2020–2022).

We initially focused on tweets mentioning both the MMR vaccine

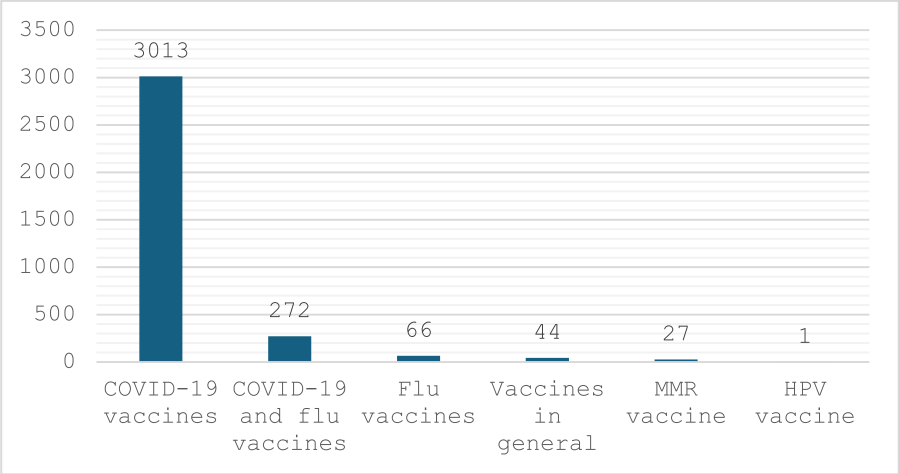

Fig. 5. Vaccines whose status is challenged in Pandemic sub-corpus.

Table 2
Frequencies of vaccine-challenging and non-challenging uses of 'shot' collocating with 'vaccine', 'flu' and 'covid' in the pre-pandemic and pandemic sub-corpora.

Collocate	Pre-pandemic sub-corpus		Pandemic sub-corpus	
	Non-challenging uses	Challenging uses	Non-challenging uses	Challenging uses
vaccine	384 (100%)	0 (0%)	642 (61%)	409 (39%)
flu	389 (97%)	13 (3%)	2036 (70%)	870 (30%)
covid	n/a	n/a	397 (48%)	429 (52%)

and COVID-19 in the Pandemic sub-corpus. Both MMR and the COVID-19 vaccines are proven to be highly effective from a public health perspective and both have a high level of uptake overall. Nonetheless, both have been the focus of vaccine-hesitant sentiment, which has potentially affected uptake, in combination with other factors [12,14,17,18].

In the Pandemic sub-corpus, the most frequent evaluation with a negative element involves a negative assessment of the COVID-19 vaccines when compared with MMR (and, in some cases, other childhood vaccines) based on a perceived contrast in effectiveness against infection. While vaccine hesitancy around the MMR vaccine has historically involved safety rather than effectiveness, it is nonetheless noteworthy that, for some, MMR constitutes a paradigm case of a highly effective vaccine against which the COVID-19 vaccines are perceived to fall short.

Some Twitter posters making this comparison additionally state that, due to not being effective at preventing infection, COVID-19 vaccines are not in fact vaccines. In some cases, this involves describing the COVID-19 vaccines as 'shots' in contrast with a 'proper'/'real'/'true' vaccine like MMR. This specific type of scepticism bears some similarity with an anti-vaccination argument that has been noted before, e.g., 'All or nothing' theme in Fasce et al.'s taxonomy of anti-vaccination arguments [6]: 'Impossible expectations: We should not accept anything that is less than 100% effective'. However, the challenging of the status of a vaccine as a vaccine has not been noted before, and seems to reflect confusion regarding the definition of vaccines and the goals of vaccination programmes. Based on our analysis of vaccine-challenging expressions in the Pandemic vs. Pre-pandemic sub-corpora, this confusion seems to be a pandemic phenomenon that, in the period 2020–2022, was also extended to the flu vaccines, in a way that does not apply prior to 2020.

From a public health perspective, there are two broad purposes for vaccination: to prevent infection or reduce severity of illness (i.e., modify the course of disease), which are benefits to the individual being vaccinated; and to reduce transmission, which is a collective/public benefit. The benefits of COVID-19 vaccination campaigns in particular are expressed in terms of reductions in deaths rather than infections [18], which is consistent with the goal to modify the course of the disease, especially in the most vulnerable populations, where transmission has not been prevented. In contrast, our findings reflect a public focus on the prevention of infection at the individual level as the basis for assessing the value of a vaccine, or, in some cases, the status of an intervention as a vaccine in the first place.

On the one hand, this folk perspective arguably involves a limited understanding on the part of the tweeting public of the individual benefits of vaccination, and concomitantly, a likely lack of appreciation for its public benefits. On the other hand, it is understandable how this perspective may have arisen, particularly during the pandemic. Prevailing definitions of vaccination tend to focus on disease prevention. For example, the WHO begins its explanation of vaccines with 'Vaccines reduce risks of getting a disease…' (https://www.who.int/health-topics/vaccines-and-immunization#tab=tab_1). The UK Health Security Agency states 'Immunisation means both receiving a vaccine and then becoming immune to a disease' (https://www.gov.uk/government/publications/health-protection-in-schools-and-other-childcare-facilities/supporting-immunisation-programmes), and up to 2021, the US Centre for Disease Control also focused its definition on immunity from infection. In addition, during a large-scale disease outbreak individual benefits of vaccination become more visible because the disease is all around. If, therefore, a vaccine fails to prevent illness, i.e., fails to deliver the most obvious individual benefit, it can increase scepticism. The public health benefit of vaccination (which is altruistic) is less apparent in such context. With COVID-19 it has also become possible for individuals to discover through often easily available lateral flow tests that they have contracted the very disease that they had been vaccinated against, while it is not usually easy to test for other diseases, for example, influenza. Indeed, as the pandemic progressed, people expressed increased hesitancy towards boosters [16], and, in the UK, decreased confidence in the effectiveness of vaccinations generally (https://www.vaccineconfidence.org/vci/country/gb/).

While our findings are limited to Twitter data on MMR and focus on the consequences of the COVID-19 pandemic, their potential relevance is broader. We have shown that a negative perception that was mainly motivated by experience with the COVID-19 vaccines resulted in a greater focus on a similar perceived shortcoming of the flu vaccines in 2020–2022. This provides a small insight into the ways in which vaccine specific hesitancy might emerge and shift: what begins as concerns about one specific vaccine can affect individual attitudes to others.

Moreover, the use of 'shot' to suggest an inferior and qualitatively different intervention from 'vaccine' is concerning, particularly for contexts where 'shot' may be used as an informal alternative to 'vaccine' in public health communication.

Overall, the new form of vaccine specific scepticism we have identified is relevant for any current or future vaccines that primarily modify disease rather than prevent infection. For the expert, it was not surprising that, like flu, COVID-19 was primarily a vaccine-modifiable disease, rather than a vaccine-preventable one, like measles. However, this crucial difference was likely missed by most lay people, and not unreasonably, given prevailing definitions of vaccination. It is also possible that, during the pandemic, widely advertised data on the efficacy of vaccines in clinical trials led to expectations about real-world effectiveness that were subsequently not perceived to be met, leading to disappointment and suspicion.

How can this be addressed? Public health campaigns could explain how vaccines function differently for different illnesses, along with differences between viruses (the emergence of new variants, waning immunity, etc.), rather than focusing on the 'quality' of vaccines themselves. *Re*-evaluating the use of informal terms like 'shot' should similarly form part of these considerations in public health campaigns about vaccinations.

CRediT authorship contribution statement

Elena Semino: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. **Tara Coltman-Patel:** Data curation, Formal analysis, Methodology, Writing – review & editing. **William Dance:** Data curation, Formal analysis, Funding acquisition, Methodology, Writing – original draft. **Zsófia Demjén:** Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. **Richard Gleave:** Conceptualization, Funding acquisition, Writing – review & editing. **Alison Mackey:** Conceptualization, Methodology, Resources, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Elena Semino reports financial support was provided by UK Research and Innovation Economic and Social Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The authors do not have permission to share data.

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