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Does Local Context Matter? - Content Analysis of COVID-19 Vaccine-Related Online Comments in Hungary

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The COVID-19 situation brought novelties into discourses on anti-vaccination and vaccine hesitancy on social media—both in logic and concerning topics. The complexity of vaccine production and distribution parallel to constant political negotiations on a global level created an opaque and confusing system seedbed for misinformation, which decreased the trust in public management and authorities as the vaccination discussions became embedded in both local and global politics. In this study, we contrast the anti-vaxxers and the vaccine-hesitant people's attitudes toward the local aspects of vaccination. We compare these groups' main narratives in two key vaccine-related topics – locality and authority. Based on our analysis, anti-vaxxer comments are nonpolitical or differentiate national politics from global aspects of COVID-19 vaccination. On the contrary, vaccine-hesitant discourses are highly contextual and dependent on the continuous changing of the conditions. The east-west political narrative has severely impacted both non-anti-vaxxer and vaccine-hesitant groups and contributed to increased vaccination hesitancy in Hungary.

KEYWORDS

COVID-19, vaccine-hesitant narratives, anti-vaccination narratives, 'eastern' and 'western' vaccines, word embedding, discourse analysis, mixed methods

Several authors and research groups have investigated opinions and anti-vaccination attitudes toward vaccination (Kata, 2010, 2012; Martin & Petrie, 2017; N. Smith & Graham, 2019). Vaccine hesitancy has been listed as one of the top global threats by the World Health Organization (WHO) in 2019 (Nuwarda et al., 2022). Studies demonstrated that besides sociodemographic factors and personal experiences (Larson et al., 2014; Luo et al., 2021; MacDonald, 2015), the spread of misinformation (Jolley et al., 2014; Verger & Dubé, 2020) and the decreasing trust in authorities and expertise (Kata, 2010; Pluviano et al., 2020; Stecula et al., 2020) are key factors shaping the attitude toward vaccination. Previous research shows that pro-vaccine websites, or websites sharing natural information, focusing on posting evidence-based scientific research about vaccines and accepted vaccination-related practices, while in contrast, vaccine-skeptical or anti-vaccination websites emphasize creating communities of people affected negatively by vaccines (Grant et al., 2015).

During COVID-19, the time spent collecting and sharing vaccine-related information on social media has increased (Enders et al., 2021; Ngai et al., 2020). Some shared vaccine-related information was misinformation by groups supporting anti-vaccination attitudes (Durach et al., 2022; Sanford et al., 2023; Scannell et al., 2021; Skafle et al., 2022). The spread of misinformation is a cause for concern, as it could significantly increase vaccine hesitancy (Loomba et al., 2021).

By looking at the dominant discourses, vaccine hesitancy appears in several discourses independent of national contexts and spread globally on the internet, principally in social media (Durach et al., 2022; Sanford et al., 2023). The discourses concerning vaccination were various even before COVID-19 (Johnson et al., 2020). The main anti-vaccination discourses included fear of side effects (safety) and unforeseen future effects (Gunaratne et al., 2019; Ligeti et al., 2024; Martin & Petrie, 2017), mistrust in the vaccine's effectiveness, the mistrust of people or institutions being in power position like pharmaceutical companies, researchers and politicians

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(Hofmann et al., 2006; Jamison et al., 2019; Sturgis et al., 2021; Yaqub et al., 2014), the natural immunity discourse (Ligeti et al., 2024; Martin & Petrie, 2017; Price, 2020) or the limitation of personal freedom discourse (Gunaratne et al., 2019; Ruiz & Bell, 2021; T. C. Smith & Reiss, 2020). However, results also showed that personal or close-life experience of COVID-19 infection can mitigate the effect of conspiracy beliefs on vaccine hesitancy (Stefkovics et al., 2024).

The COVID-19 situation also brought novelties into discourses on anti-vaccination and vaccine hesitancy on social media—both in logic and concerning topics. New vaccine hesitancy narratives have emerged around topics such as the too-quick vaccine development process (Ligeti et al., 2024), the unknown duration of protection, and the new mRNA technology (Wong et al., 2021). The politicization of the pandemic changed the discussion on trust in authorities (Abbas, 2022). The complexity of vaccine production and distribution parallel to constant political negotiations on a global level created an opaque and confusing system seedbed for misinformation, which decreased the trust in public management and authorities (Prada et al., 2023) as the vaccination discussions became embedded in both local and global politics.

The politicization of vaccine development and distribution shed light on previously less significant factors behind anti-vaccination and vaccine hesitancy narratives, such as political ideologies or trust in local politics (Baumgaertner et al., 2018; Jiang et al., 2021; Ligeti et al., 2024) or the credibility of the author of any vaccine-related content (Savolainen, 2023). The opinion toward vaccines is thus shaped by the dominant discourses of vaccine diplomacy based on international relations (Manfredi-Sánchez, 2023), parallel to the local cultural and historical context (Streefland et al., 1999).

This study uses online textual data, advanced text mining methods, and discourse analysis to analyze specific aspects of vaccination discourse during the second and third waves of the COVID-19 pandemic in Hungary. An important originality of our analysis is that we could follow the birth and the development of new narratives concerning vaccine hesitancy in a country where one of the broadest ranges of vaccine types became available quite soon, including western and eastern manufactured vaccines (Kutasi et al., 2022). We focus our research on local attitudes toward vaccination and how these vaccination attitudes are built on the locality's structural, sociological, and political characteristics. In this paper, we contrast the anti-vaxxers and the vaccine-hesitant people's main narratives in two key vaccine-related topics – locality and authority.

Our analysis could help better understand vaccine-hesitant and anti-vaccination narratives, essential in developing health communication strategies to prevent vaccine denial.

Data and Methodology

Our current study is part of a large research project in which we studied vaccine-related narratives in the online sphere in Hungary during the COVID-19 pandemic. This research project includes the analysis of media frames, expert narratives, and vaccine-related discourse in the comment section. In this paper, we focus on the latter aspect, as our goal is to understand people's attitudes toward vaccination, not the narrative frames around vaccination of media outlets or experts.

In the larger project we collected online articles, posts, and comments about vaccination between 1 September 2020 and 15 April 2021 from Hungary using a social listening platform - Sentione.[1] The Sentione tool made the content of all major Hungarian news portals, major blog sites, public Facebook pages, and YouTube channels accessible. This access covers the online spaces where public interactions on the vaccination could have taken place. Sentione has been used in several similar studies recently (Burzyńska et al., 2020; Neag & Healy, 2023; M. K. Smith et al., 2021; Szabo et al., 2021).

The selected period covers the country's second and third waves of the COVID-19 pandemic. We set the start date to September 2020, as the vaccine debate started around that period in Hungary. The general vaccination program started in January 2021, so we can observe how this affected the prevalence of anti-vaccination and vaccine-hesitant discourse online.

We collected vaccine-related comments with two approaches. One source was comments that directly mentioned vaccination or vaccines. The other sources were comments written under articles, blogs, and social media posts about vaccines and vaccination. We used vaccination-related keywords to select the initial corpus. We used a mixture of stop-words and topic-modeling approaches to narrow the corpus of articles and posts to relevant content. There were several out-of-focus articles in the initial corpus, such as articles related to animal vaccination. The stop-words and the topic modeling helped us delete out-of-focus articles and keep those articles and posts linked to the COVID-19 vaccination. The cleaned corpus consisted of around 198 816 articles. In this paper, we use the comment section of this corpus, and comments which are not in this pool but contain vaccination or vaccine-related keywords (see the first approach above). Combining these two sources in a final dataset gave us 4 485 878 million comments. In this paper, we analyze these 4.5 million comments. For the analysis, we had to find the anti-vaxxer and vaccine-hesitant comments. We developed a classification model for this task.

The first step of this classifier development was annotating 10.000 comments from the 4.5 million pool.[2] We annotated these comments with double annotators by applying a three-

[1] SentiOne (www.sentione.hu) is an international social listening software, a content-based web analytics platform that covers and recognizes 30 languages all across Europe. It gathers, indexes and analyses public online contents published anywhere on the web starting with social media channels through blogs, forums and websites.

[2] As the first step, the researchers in the project coded a random sample of 1,000 comments to anti-vax and non-anti-vax or not related to vaccination category. Based on this initial classification, we defined a set of keywords that covered well (over 98 percent recall) the anti-vax comments. In this step, we wanted to remove those comments from the classification where we did not expect to find any anti-vax content. This method filtered out 27.5 percent of the comments. After filtering the comments with the keywords, we randomly selected 10,000 comments from the remaining pool.

category classification: anti-vaxxer, vaccine-hesitant, and pro-vaccine or neutral comments.

If the comment was against vaccination by showing an intent not to get vaccinated, we categorized it as anti-vaxxer content. Vaccine-hesitant content was more challenging to grab; they were the ones who did not reject vaccination completely but had specific concerns about different matters. Comments expressing uncertainty toward vaccination due to the lack of transparency and necessary information regarding vaccination were categorized as vaccine-hesitant content. Moreover, discussions on unpredictability regarding the efficacy or the side effects of the vaccine among different age groups or those criticizing the vaccination process and the whole establishment in this context, which have an explicitly expressed effect on vaccination attitudes, were also categorized as vaccine-hesitant comments. Comments expressing cherry-picking attitudes by choosing certain vaccines over other types - typically promoting "Western" vaccines against "Eastern" products - were also put into the vaccine-hesitant category.

The third category contains comments showing neutral and pro-vaccination attitudes. These manually classified 10,000 comments were the input for categorizing the 4.5 million comment. For the comment categorization, we used a Hungarian version of BERT (huBERT) (Nemeskey, 2021). The train dataset was the 10,000 classified comments. The average macro precision of the classification was 0.66, the recall and the F1 score were 0.65. The weighted average precision and F1 score were 0.85, and the recall was 0.86 (Kmetty et al., 2025). After this classification process, all the 4.5 million comments were categorized into one of the three vaccination-related categories. In this study we use the 4.5 million comments to analyze the prevalence of anti-vaccination and vaccine-hesitant discourse.

In analyzing the comments, we have combined two approaches. In the quantitative analysis, we used keywords to identify the volume of each aspect of content (e.g., the prevalence of certain vaccines) and word embedding models (GloVe model by Pennington et al., 2014) to identify the primary word context of keywords and topics. **Four** word embedding models are used in the analysis. The position of the vaccines in the narrative was analyzed using a model fitted to the total corpus (1). Separate word embedding models were fitted to the anti-vaccine (2), vaccine-hesitant (3), and neutral/pro-vaccine (4) comments. The separate word embedding models allow us to compare how vaccines or specific topics are contextualized in the different comment groups.

The analysis focuses on two unique COVID-19-related aspects of vaccine denial/hesitancy – locality (Jiang et al., 2021; Ligeti et al., 2024) and authority (Savolainen, 2023). We covered the topics of locality and authority with keywords. We only selected keywords with a reasonable frequency (1000 +). The locality was explored using the names of the central vaccine-producing countries (America, Russia, China) and the words Eastern and Western. For authority, we examined the discourse position of the major international organizations (WHO, EMA) in addition to the word context of the Hungarian Prime Minister (Viktor Orbán) and Foreign Minister (Péter Szijjártó). The third actor type here were the researchers and (medical) experts., We identified them in the corpus with the words doctor/scientist/expert.

We used cosine similarity in the word embedding models to measure the word distances. We start with our keywords (see above) and calculate the closest words based on this metric.[3]

In addition to the quantitative analysis, we also conducted a qualitative discourse analysis. Based on the keywords and context words (see above), we could narrow down the comments in each analysis to topic-specific content. We then extended our quantitative results by systematically analyzing the selected comments.

Results

We classified 6.4 percent of the 4.5 million comments as anti-vaxxers and another 9 percent as vaccine-hesitant. 5.5 percent of the comments mentioned one of the vaccines (Pfizer, Moderna, AstraZeneca, Sinopharm, Sputnik-V). The anti-vaccination voices were much louder in the comments that mentioned vaccines; meanwhile, many of them were vaccine-hesitant comments, not anti-vaxxers.

As shown in Table 1, Pfizer was the most mentioned, and Moderna was the least mentioned vaccine in the comment section. The highest anti-vaccination level (57%, including vaccine-hesitant and anti-vaxxer comments) was measured in the case of the Russian vaccine - Sputnik V and the Chinese vaccine Sinopharm (62 percent). It is striking how differently people commented about the eastern and western vaccines. Strong anti-vaxxer comments were missing when people discussed the eastern vaccines (Sinopharm, Sputnik-V) but more common when discussing western vaccines (Pfizer, Moderna, AstraZeneca.) One possible explanation for this lower vaccine mention in anti-vaxxer comments is that the type of vaccine is less relevant in this case since people critics mostly target the small amount of time for the development, testing, and getting enough information about the possible long-term side effects.

Table 1. Vaccine mentions and anti-vaccination ratio within comments

	Vaccine mentioned in comments	Vaccine-hesitant ratio within comments mentioned the vaccine	Anti-vaxxer ratio within comments mentioned the vaccine
Pfizer	78303	32.9%	7.3%
Moderna	29333	33.5%	6.1%
Astrazeneca	40724	31.3%	8.9%
Sinopharm	71280	61.1%	0.8%
Sputnik-V	68216	56.9%	1.5%

[3]Only the first of the synonymous words was kept. The analysis was narrowed down to nouns, verbs, and adjectives, as the other word types did not contribute to interpreting the discourse.

We used word-embedding models to explore the context in which the vaccines are mentioned. We listed the 20 closest words for each vaccine type (see Table S1 in the supplementary).

Sputnik-V, Sinopharm, and Pfizer were the most mentioned vaccines in the comments (see Table 1). However, while the origins of the first two - by country or just called easter vaccines - are in the center of the discourses, Pfizer is mentioned in the context of these, co-mentioned with the "Chinese" and the "Russian" vaccine, but with much less references to its origin. The cosine similarity was higher for the words Chinese and Russian than American for Pfizer, and we got the same results for Moderna and AstraZeneca. The western vaccines' closest word context contains many words about technical details of the vaccination process, like numbers – thousand/million – referring to the number of doses or words like delivered, ordered, and shipment referring to the transportation process. The type of the vaccines (MNRS, vector) also appeared in the closest word context of Western vaccines – that context is missing in the case of Eastern vaccines (see Table S1 in the supplementary).

The Chinese Sinopharm and the Russian Sputnik V vaccines were mentioned in a strongly politicized context, co-mentioned with political actors like Viktor Orbán and Péter Szijjártó. In the case of Sputnik, Putin and Merkel were also among the 20 closest words. No politicians were in the close context for the Western vaccines based on the word embeddings. The qualitative discourse analysis showed that most of these political mentions were rather negative for the eastern vaccines. These politized comments displayed critical opinions toward the government and its actions during the pandemic. The comments questioned the efficacy of eastern vaccines and criticized the whole process of how these vaccines were retrieved. It seems that the massive political campaign toward the Chinese and the Russian vaccines in Hungary (Bíró-Nagy & Szászi, 2023) backfired and strengthened the "cherry picking" attitudes concerning vaccinations, namely the rejection of these "eastern" vaccines, which was possible due to the various types of vaccines available in the country.

Reflecting on the existing literature concerning unique COVID-19-related anti-vaccination and vaccine-hesitant narratives and discourses (Jiang et al., 2021; Ligeti et al., 2024; Savolainen, 2023), the next part of the paper analyzes two narrative frames around COVID-19 vaccination. These narratives were about **locality** and **authority.**

Where Does it Come From?

The country of the vaccine manufacturers and the east/west distinction were mentioned in 6.6 percent of the comments. However, when vaccines were mentioned in the comment, it was more common − 29 percent - to mention geography. The country and the east/west division were especially important for the eastern vaccines; origin was mentioned in 40.9 percent of Sputnik-V-related comments and 38.5 percent of Sinopharm comments. This number was "just" 24.5 percent for AstraZeneca and 29.1 percent for Pfizer.

We found significant differences regarding the mention of the origin and the vaccination-related label of the comment. The vaccine-hesitant comments frequently mention manufacturer countries and the east/west dimension. Thirty-two percent of these comments contained origin-related words, while this number in anti-vax comments was just 2.5 percent. The qualitative assessment of anti-vaxxer comments also confirms that people writing these comments reject all of them no matter where they come from, although with slightly different explanations. For eastern vaccines, the core of doubts was connected to the efficacy of the vaccines that linked to the lack of transparency of its development. In the case of Western vaccines, the immediate side effects were the focus, but the role of politics and business actors (pharmaceutical companies) were also mentioned.

In vaccine-hesitant comments, the origin of the vaccines and the east/west distinction played a crucial role in the perception of the vaccines (see Table 2 for the result of the word embedding) - mainly in the case of the "eastern" vaccines, Sinopharm and Sputnik-V. The negative opinion on these vaccines and countries has much more to do with the existing stereotypes of these countries due to shared past or present confusing relations. The negative stereotypes of the Eastern vaccines have common points, such as the critical view on the existing political system or the intensification of relations between these countries and Hungary, but differ in their past relations with Hungary. In the comment sections, the Russian Sputnik-V vaccine is often called "ruszki" a pejorative and strongly critical expressions embedded in the Hungarian language. In the case of the Chinese vaccine, Sinopharm, the negative preconceptions of people about the "fake" Chinese products are present. And the word "'crappy" was also within the top 10-word context both for Russia and Chinese (Table 2.).

In contrast, the word American appeared in a completely neutral context in the vaccine-hesitant group. The first 10 words for American all refer to vaccines or other countries.

The East-West distinction was examined using a specific method. Word embedding allows us to examine the context of a word "cleansed" of the impact of another word.[4] This is similar logic to the control of confounding variables in statistical models. This logic has been applied in this case. We examined the context of the Eastern word without the Western and vice versa.

In the Western (controlled by Eastern) dimension, we see vaccine names, countries, and positive terms such as modern or significant. In contrast, the Eastern (controlled by the Western) dimension presents a completely politicized picture. The closest context word is the name of a Hungarian opposition party (DK), but the word "opposition" also appears separately, as does the campaign, which also has a political overtone. Other strongly critical words, like untested, uncontrolled, and human experimentation, also appear in the close context of Eastern. These terms show that in this group, a highly politicized and very negative context surrounded the Eastern vaccines.

The qualitative analysis of the comments also showed that Eastern vaccines are often compared to Pfizer by referring to

[4]Technically, this can be done by subtracting the vector values of one word from the vector values of another word and examining the cosine closeness of this difference vector to other words (Németh & Koltai, 2021).

Table 2. Context of countries and eastern and western word- word embedding model. Vaccine-hesitant corpus

Russian		Chinese		American		Eastern (controlled Western)		Western (controlled Eastern)	
Words	Cosine similarity	Words	Cosine similarity	Words	Cosine similarity	Words	Cosine similarity	Words	Cosine similarity
Sputnik-V	0.81	russian	0.81	german	0.71	DK (Hungarian anti-gov party)	0.36	american	0.41
chinese	0.81	Sinopharm	0.78	english	0.59	untested	0.32	Pfizer	0.39
ruszki' (pejorative formulation of Russian)	0.74	ruszki' (pejorative formulation of Russian)	0.71	Pfizer	0.57	campaign	0.31	Moderna	0.38
Sinopharm	0.65	Sputnik-V	0.62	Moderna	0.53	opposition	0.29	vaccine	0.36
vaccine	0.61	good	0.62	western	0.53	petition	0.29	modern	0.34
western	0.58	crappy	0.62	russian	0.52	unverified	0.27	significant	0.32
eastern	0.55	fake	0.57	british	0.51	human experiment	0.25	german	0.28
crappy	0.55	vaccine	0.56	hungarian	0.46	distrust	0.25	company	0.28
hungarian	0.54	stuff	0.56	USA	0.46	opening	0.25	MNRS	0.27
bad	0.53	eastern	0.54	From Israel	0.46	protest	0.25	deliver	0.27

the authorization processes and their availability in the country. The authorization of the vaccines was relatively fast in Hungary, but the European Medicines Agency did not accept the eastern vaccines. These discussions appear in a broader "western-eastern" narrative, which involves not only the quality but also the questions of authority and the lack of transparency in decision-making processes.

Whose Authority? - Chain of Authorities

As we showed in the previous section, the authorization process is an important aspect of how people evaluate the vaccines and the whole vaccination. In the case of COVID-19, we could distinguish between three main types of authority – the authority of politicians, the authority of health organizations, and the authority of scientific people and medical experts. These authorities could have local and global roles and responsibilities. There is a close relationship between the location and the role of authorities. In the case of the Chinese, but mostly Russia, the negative opinion toward the political regime may question the scientific standards and scientific authority over the political authority. It gives the floor for doubts about whether the urgency of vaccine approval is rather a political tool (Michlin-Shapir, 2023). However, the scientific community authority is also questioned in the Western vaccine development process, as the research done by pharmaceutical companies and their integrity can be doubted due to being controlled by business actors. Thus, scientific results are already questioned in developing vaccines against COVID-19 (Ligeti et al., 2024).

This complex **authorization process** - which we call the chain of authorities - should be examined and clarified by international organizations such as the European Medicines Agency or WHO, but the trust in these actors is weakening (Ntini, 2023).

National-level authorities are the last link in the chain since they are responsible for the final decision concerning authorization. However, contradictions between political and scientific statements could undermine the credibility of these decisions.

The massive information flow concerning vaccines could make these chains of authorities unclear and could question the scientific credibility on a national level. Extensive governmental communication could reinforce these existing doubts, which could create distrust toward vaccines among anti-governmental communities. The complexity of the chain of authorities makes the process less transparent, but the distrust in even one of the elements in the chain can result in skepticism toward the whole process.

At the comment level, not all types of authority are mentioned regularly; some, like national-level authorities, are nearly entirely missing from the comment section of vaccine-related content. In contrast to the local authorities, local politicians were more frequently mentioned. The two most mentioned politicians were the prime minister Viktor Orbán and the foreign minister Péter Szijjártó. The latter's main task was to secure as many vaccines as possible for the country. The two leading local politicians were mentioned in 2.8 percent of all the comments and 3.6 percent in the vaccine-hesitant comments. International organizations (WHO, EMA) were mentioned less in the discourse − 0.5 percent, but this ratio went up to 1.7 percent within the vaccine-hesitant comment. Medical experts, doctors, and researchers, on a general basis, were

Table 3. Main differences between vaccination related narratives

	Anti-vaxxer	Vaccine-hesitant
Location	no real importance	high importance of east-west narratives, and strongly interrelated to authority
Authority	No/Low trust in scientific authority, political authority is less important and detached from scientific authority.	low trust in local political authority -> decreasing trust in professional(scientific) authority The evaluation of authorities is strongly interrelated

mentioned more frequently in the comments (4.6 percent), especially within the anti-vaxxer (7.2 percent) and vaccine-hesitant (7.3 percent) comments.

When we look at the word context of the three categories of comments (see table S2A in the supplementary), criticism toward the government and leading governmental politicians can be seen in all the comments regardless of what they say about vaccination. Words like "gang" and "idiot" appear in the top antivax context words of leading politicians, and we can see negative name-calling phrases like "kakadu" or "petike" - both terms are derogatory references to the foreign minister - in the vaccine-hesitant and even in the neutral/pro-wax comments. Among vaccine-hesitant and neutral/pro-wax comments, we can find words like Putin, comrade, Sinopharm, and Sputnik-V - linking the leading Hungarian politicians to the eastern vaccines and eastern political regimes.

On the contextual level, the evaluation of international authorities (Table S2B) is neutral and instrumental in both comment types. We could also see similar contexts for medical experts, who were mentioned in a respectful and neutral context. In the case of anti-vax and vaccine-hesitant comments, we saw political-related words, which shows how these two dimensions intercorrelate in the discourse field.

Qualitative discourse analysis, however, shades much of the neutral/positive picture of organizations and experts presented above. In all vaccination groups, international organizations are mentioned in the context of what they have said about specific vaccines and what authorizations and reports they have issued. In the anti-vaccine discourse, people mainly refer to various fake WHO reports, or extract half-sentences from WHO reports and build the anti-vaccine narratives on these. In the vaccine-hesitant group, the EMA is mentioned more often in the context of vaccine licensing. EMA approved vaccines are contrasted with Russian vaccines approved only by the Hungarian authority (OGYEI). Such comments illustrate how the authority of local (politically supported) institutions clashes with the authority of international organizations. In the third group - neutral or pro-vaccine - we find the most neutral comments on the WHO and EMA, where they do not distort the communication of international organizations and are not used as a counterpoint.

The neutral perception of health professionals and researchers is mainly because they typically appear as passive actors in the comments. Doctors - as a general category - are the most mentioned expert type in these texts. Their role is limited to passively carrying out their part in the chain of authority - administering vaccines. The exception to this is in some anti-vaccine commentaries, where doctors are portrayed as not recommending vaccination - but this is the exception rather than the typical comment. Negative comments about leading Hungarian doctors who are close to politics (e.g., Béla Merkely) are frequent, especially in the vaccine-hesitant group. The latter result also suggests that when an actor enters the political field, (s)he can quickly lose its expert status in the eyes of certain groups.

Discussion and Limitation

We have witnessed the birth of a vaccine-hesitant attitude whose opinion on vaccination is firmly embedded in the political context. They seem strongly critical of the establishment and thus distrust their decisions. In case these decisions are interlocked with scientific and medical authority, those are also questioned. In Table 3, we highlighted the differences and similarities between the two groups.

Anti-vaxxer attitudes and discourses are as old as vaccination itself; they embrace a unique, inherent logic and reasoning that is long-lasting and can be well detected in "classical" anti-vaccination narratives. Even if they must reflect on the actual circumstances, in this case, COVID-19, they keep their main recurring narratives. Anti-vaxxer comments are nonpolitical or differentiate national politics from global aspects of COVID-19 vaccination. On the contrary, vaccine-hesitant discourses are highly contextual and dependent on the continuous changing of the conditions. The confusing and inconsistent communication concerning vaccination and the complexity of authorities responsible for acting creates vaccine-hesitant narratives that express doubts, lack of trust, and problems with missing information. Vaccine-hesitant comments are filled with emotions, hatred toward the government, and fear of possible side effects. The east-west political narrative has severely impacted the vaccine-hesitant group and contributed to increased vaccination hesitancy. Our results suggest that individuals with vaccine-hesitant attitudes exhibit decreased trust in local political authorities, which also affects trust in scientific authorities on both local and global levels.

Our study is not without limitations. Analyzing Hungarian comments provides a good framework for understanding how people thought about Eastern and Western vaccines. Hungary was one of the countries where a broad range of vaccine types became available quite soon. However, one country is one

context, and how locality works could differ greatly from other countries. Previous and current relations with vaccine-developer countries like China, Russia, and the US strongly impact how people react to specific vaccines. So, the locality aspect and the politicization of vaccine distribution are firmly embedded in the context of the particular country, which makes the generalization of results challenging.

Another limitation comes from our methodological approach. The tool selected for collecting comments gives a pretty good coverage of public comments. However, during data collection, the tool did not cover comments behind paywalls or comments on specific social media channels (TikTok, Reddit). Comments in Facebook groups are also missing. So, even with more than 4.5 million comments, we can not be sure that we could capture all aspects of the discourse. Also, the BERT model used for the classification and the word embedding GLoVE models bring some uncertainty in the analysis, as they come with their own limitations. However, mixing quantitative and qualitative approaches makes our results more robust.

The communication about COVID-19 vaccines has been done by many actors in Hungary. Politicians and local and global authorities had their own communication agenda. We don't know what authorities people accepted when they decided about vaccination, but in the vaccine-related comments, politicians were mentioned more frequently than health authorities.

When politicians mentioned the context of comments, they were strongly negative. When people mentioned health authorities in the discourse, the context was mixed. Previous research found that health authorities need to communicate clearly and use messages with statistical evidence (Hwang et al., 2022). In Hungary, the commenters see the Hungarian health authorities as political actors, not scientific ones. It also raised questions about why local and global authorities evaluated Eastern vaccines differently. Evidence-based communication is becoming challenging when a discourse gets into a politicized context. Our finding underscores the importance of public health agencies in clearly detaching scientific authorities from the political sphere. Health agencies must consider everyday local experiences and clearly communicate responsibilities to create effective communication strategies for disseminating reliable health information.

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Data Availability Statement

Raw data is not available because of copyright issues, but access can be asked from the authors.

Ethics Approval

As we did not include human subject in our research no ethical approval was needed.

Supplementary material

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