European Journal of Health Communication

ISSN 2673-5903
ejhc.org

Article

Exploring Public Health Agencies' Communication on Social Media in the Early Stages of the Covid-19 Pandemic

An International Perspective

DOI: 10.47368/ejhc.2025.101
2025, Vol. 6(1) 1-26

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Abstract

The Covid-19 pandemic created a significant challenge for public health agencies worldwide. Many have turned to social media as a tool for pandemic-related information dissemination. However, research on the effectiveness of social media for pandemic communication is still limited. This study explores social media communication by health agencies during the early stages of the pandemic in four countries which differ in their pandemic dynamics, cultural and geopolitical factors: the Netherlands, Poland, South Korea, and the United States. We focus on Twitter and identify themes present in the health agencies' communication, as well as their relationship with the publics' engagement. We find that the health agencies' communication was mostly neutral and focused on providing sources for more information about the virus and basic information about the virus, however, there are differences between the countries.

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Keywords
Covid-19, social media, health communication, thematic analysis, Twitter.

Communication during a health crisis like a global pandemic poses a challenge for health agencies and governments as it requires a quick and reliable communication infrastructure, which needs to be built within complex communication ecologies (Tagliacozzo et al., 2021). The Covid-19 pandemic motivated many public health agencies to add digital channels, such as social media, as part of their strategy for disseminating health-related communication (e.g., Chu et al., 2020). This shift calls for more research into the effectiveness of using social media to communicate with citizens in a time of a health crisis. While research looking into the effectiveness of social media (health) communication exists, research investigating such communication in the context of a global pandemic is still limited. Such research is important, because consistent and properly managed communication during a pandemic may help public health agencies introduce necessary measures and explain their importance to citizens.

Managing communication during the Covid-19 pandemic proved difficult: The pandemic was unfolding very quickly, forcing public health agencies to develop and adjust their communication in real time. Furthermore, pandemic communication lies at the intersection of health, science, risk, and crisis communication, and due to the politicisation of the issue (e.g., Hart et al., 2020), it also involves political communication and communication about misinformation, challenging health agencies to not only provide reliable health information but also fend off attacks. Also, the way health agencies communicate may affect news coverage of pandemics (Lee & Basnyat, 2013). Finally, while different countries were adopting different strategies to deal with and communicate about the pandemic, in the interconnected and globalised world, the communication of health agencies reaches across borders, making the design of messages even more important.

Since our knowledge about effective pandemic communication is still limited, we aim to explore and compare the pandemic communication strategies and themes applied by public health agencies in different countries. We focus on the Netherlands, Poland, South Korea, and the United States. These countries differ with respect to their pandemic dynamics, cultural characteristics, and the ways they have been dealing with the pandemic. We analyse the communication of public health agencies on Twitter (now known as X) during the early stages of the pandemic to identify the themes used in communication and their effectiveness in triggering the publics' engagement. We chose Twitter, because it is a popular social media platform, and it has been playing an important role in disseminating health-related information, even before the pandemic (e.g., Allem et al., 2017; Broniatowski et al. 2018; Harris et al., 2014).

By analysing the posts from public health agencies in several countries, our results provide insights into the early pandemic communication, improving our understanding of Covid-19 communication and providing implications for public health agencies regarding the effectiveness of their efforts and the role of platforms like Twitter in disseminating health communication during the pandemic. As such this study provides a unique contribution to the ongoing academic debate about communication during the Covid-19 pandemic. First, the study identifies communication themes and draws the connections between the themes in social media communication and message engagement. Second, it provides an international comparison perspective of health crisis communication.

Theoretical Background

Health Communication on Social Media

During a time of a health crisis, individuals often seek out information that will help them understand the severity of the crisis and make behavioural decisions. In line with the risk information seeking and processing model (RISP; Griffin et al., 1999), individuals turn to the media to alleviate ambiguity in the time of crisis with the internet being an important source of health information (e.g., Jacobs et al., 2017). According to the health information acquisition model, individuals seeking information are mostly driven by uncertainty (Freimuth et al., 1989). As discussed by McKinley and Lauby (2021), seeking information can fill in gaps in knowledge (Brashers et al., 2022) and alleviate cognitive and emotional discomfort caused by uncertainty.

One online source of information that is becoming increasingly popular is social media (e.g., WHO, 2017). Hence, research has paid attention to social media in the context of health communication. Hale et al. (2022) employed the RISP model (Griffin et al., 1999) to discuss why and how individuals use a social media platform Reddit as a source of information about Covid-19. They analysed posts and comments by the users of r/coronavirus subreddit and found that information about Covid-19 spread, public health, the pandemic's political and economic consequences, and the experiences of medical workers were particularly relevant. The authors also noticed that the discourse was collectivistic and of negative valence and users' engagement with the subreddit decreased over time (Hale et al., 2022).

From the perspective of information dissemination, social media platforms are an easily available tool to spread health-related information in a language understandable to the general audience (Ferguson et al., 2021). Social media also allow health agencies to disseminate their messages broadly and immediately, especially targeting communities at risk. In the context of the Covid-19 pandemic, Chan et al. (2020) argue that if social media are used in a professional, transparent, rapid, and efficient way, they can provide effective dissemination routes for key information. Furthermore, social media platforms enable interactions with communication (e.g., likes, shares, comments) and can therefore provide a connection between healthcare providers and the public (Diddi & Lundy, 2017), shortening the physical and psychological distance and presumably making access to health information easier for the public. Social media communication has been shown to have a significant impact on factual and subjective knowledge (Lee et al., 2022), again illustrating its importance for health communication. It is not clear, however, how health communication on social media should look like during a pandemic for it to have beneficial–and not counterproductive–effects.

Themes in Communication about Covid-19

We are interested in (1) the themes that public health agencies used to communicate about the Covid-19 pandemic on Twitter and (2) what their effectiveness in attracting the audience's engagement was. Previous research has shed some light on these issues.

A study by Ye et al. (2021) found that between Jan 1, 2020, and November 12, 2020, government agencies (@CDCgov, @US_FDA, @NIH) communicated about Covid-19 preventive behaviours, latest updates, new treatments and vaccines, risk factors, testing, risk reduction, cases, and hospitalisations. Chu et al. (2020) analysed Facebook posts from 13 academic medical centres between December 1, 2019, and April 30, 2020 and found that

initially most of the Covid-19 posts were about National Health Command Center news and regulations (40%), and as the outbreak continued in February and March, hospital-released news and policy announcements became the main focus of posts (52% and 36%, respectively). In April, the majority of Covid-19-related posts expressed gratitude (42%). Tagliacozzo et al. (2021) analysed online communication of Italy, Sweden, and the U.S. and found that agencies relied heavily on their internal departments and experts. While they also provided some tailored information, information tailored to vulnerable groups (e.g., pregnant women) was mostly absent (Tagliacozzo et al., 2021). Research by Kligler-Vilenchik et al. (2020) suggests that Twitter use during the pandemic can be characterised by three themes: information goal (trying to stay up to date on the pandemic), maintaining social connection (dealing with psychological difficulties), and use habits (some increased their usage of Twitter while others decreased it). Guidry et al. (2017) analysed Ebola-related Twitter and Instagram posts by three major health organisations (CDC, WHO, MSF), focusing on seven risk perception variables. All these results seem to suggest that there has been little consistency in themes used by various health-related agencies and organisations.

According to crisis communication approaches, communication should convey language of openness, compassion, and acceptance of uncertainty (Veil et al., 2011) and should provide credible sources and actionable directives (see the IDEA–Internalisation, Distribution, Explanation, Action–model; Sellnow et al., 2017). Based on the IDEA model, communication during a crisis should help individuals internalise the potential risks, use appropriate distribution strategies, offer informative and concise information, and introduce specific coping instructions (Sellnow et al., 2017). This is in line with health communication perspective, where the Health Belief Model (HBM; Rosenstock et al., 1988), for instance, stresses the importance of explaining susceptibility, severity, benefits, and barriers, strengthening self-efficacy, and providing cues to action (e.g., Diddi & Lundy, 2017).

While existing crisis, risk, and health communication models and theories can help us develop and evaluate communication efforts during a pandemic, as Backer et al. (1992) note: "no one theory and no one model is totally adequate for designing public communication campaigns" (p. 82). Also, while health agencies may be aware of the different models and best practices, we cannot be sure which ones they follow in their communication. Hence, it is unclear what themes health agencies delivered in the early stages of the Covid-19 pandemic, and whether these themes were in line with theoretical recommendations. Our goal is not only to build on the developed models but also review and categorise health agencies' communication (here tweets) related to the pandemic based on the themes present.

Furthermore, the themes employed by health agencies may have been less or more successful in terms of triggering engagement with communication and affecting citizens' health behaviours. In this project, we focus on social media engagement among the users. By engagement we mean Twitter users' interactions with the content published by health agencies, such as retweets and comments. Social media can serve as gateways to scientific information about health crises (e.g., Hagen et al., 2018), but as Van Dijck and Alinejad (2020) discuss, Twitter may be a double-edge sword: While it allows for effective dissemination of information about the pandemic, it can be used for misinformation also, making health authorities vulnerable to attacks. Hence, engagement created by health agencies does not have to be positive. Moreover, even if health agencies can create engagement, it does not have to translate into an increase in health behaviours. Usher et al. (2023) found that more followers on local public health social media pages was associated with fewer vaccinations. Still, engagement can

provide insights into the audiences' interest in the topic and willingness to propagate communication. We aim to determine how the themes used by public health agencies were related to the audience's engagement with communication.

Cultural Differences

Tagliacozzo et al. (2021) suggest that health agencies in different countries may use different strategies with different effectiveness. Also, we may expect people in different countries to seek out and engage with different types of communication. We selected four countries for our analysis: the Netherlands, Poland, South Korea, and the U.S. These countries differ in geopolitical contexts (e.g., different neighbouring countries and proximity to the pandemic, governments with different political leaning, different stages in the election cycle, etc.), their Covid-19 pandemic timelines, social media and Twitter use, risk perception, and culture. Also, the countries differ in how often they are studied and published about, with the U.S. being very well represented in the academic literature, while e.g., Poland has been less studied.

Cultural theorists suggest that social relations and culture shape how individuals perceive and respond to risk (Douglas & Wildavsky, 1982). Individuals' attention to risk and preference for risk taking vs avoiding correspond to cultural worldviews, which represent values and beliefs related to patterns of interpersonal relationships (Wildavsky & Dake, 1990). Previous research has investigated differences in risk perception in different countries, but we lack a comprehensive overview of such differences. Furthermore, risk perceptions can be influenced by multiple factors, including social, political, and cultural factors, particularly hierarchy–egalitarianism and individualism–communitarianism (Savadori & Lauriola, 2021), and uncertainty avoidance (e.g., Bontempo et al., 1997). We know from previous research that risk perceptions are also context dependent. For example, those who come from collectivistic cultures may feel like they have someone to rely on, which may result in lower risk perceptions and them being more likely to make more risky individual financial decisions. In contrast, when it comes to an epidemic, they may focus more on their responsibility towards others, which may result in higher risk perceptions. Savadori and Lauriola (2021) showed that a more individualistic worldview was related to a lower perceived probability of becoming infected with Covid-19 than a more collectivist worldview. This may affect risk behaviours but also information seeking. Risk communication models, such as RISP, often assume that people seek communication to overcome uncertainty, but if they do not perceive the risk, their information seeking behaviours will likely differ.

Relatedly, countries also differ on Hofstede's cultural dimensions: power distance (attitude towards inequalities between individuals in societies), individualism (interdependence), masculinity (competition, achievement, and success vs caring for others and quality of life), uncertainty avoidance (the unknown nature of the future), long-term orientation (maintaining memories of the past while dealing with the present and the future), and indulgence (controlling one's desires and impulses) (Figure 1). In our study, the U.S. and the Netherlands have the lowest power distance and the highest individualism and indulgence. Poland and the U.S. share the highest masculinity. South Korea and Poland score the highest on uncertainty avoidance. Finally, South Korea shows the highest long-term orientation. These cultural dimensions may be associated with responses to the pandemic. Several studies have correlated cultural dimensions with Covid-19 cases and shown effects. For example, countries with higher

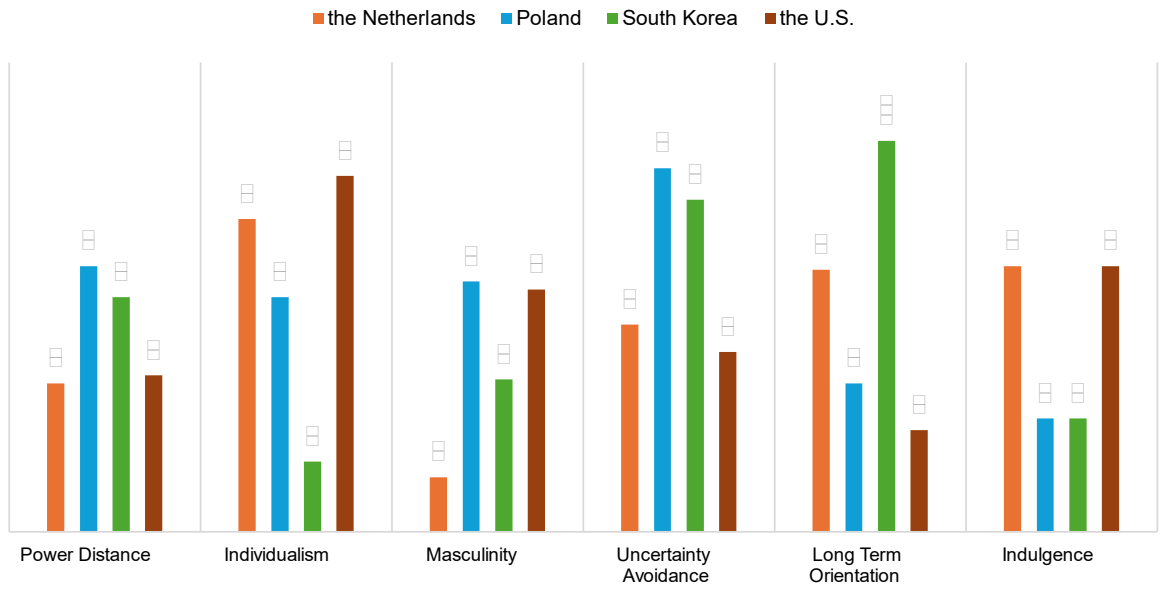


Figure 1. Cultural Differences Between the Studied Countries

Note. Recreated from: www.hofstede-insights.com/country-comparison/the-netherlands,poland,south-korea,the-usa/

uncertainty avoidance and indulgence had significantly higher rates of Covid-19 cases (Voegel & Wachsman, 2022).

Countries also differ in their engagement with social media, and Twitter popularity and usage differ in the four countries we study. It was estimated that in 2020 about 2.8 million internet users were on Twitter in the Netherlands (Newcom, 2023), 6.55 million in South Korea (Statista 2024a), and 56.1 million in the U.S. (Statista 2024b). In Poland, the number of people that Twitter reported could be reached by adverts was 1.25 million (Kemp, 2020). Taking population into account, Twitter seems to be the most popular in the U.S., followed by the Netherlands, South Korea, and Poland.

Users' characteristics and motives for Twitter use may differ too, driven by the differences in individualism-collectivism, which may affect the need for self-promotion, something which may be higher in more individualistic societies. For example, Jackson and Wang (2013) found that U.S. participants (higher individualism) tend to spend more time using social media, find them more important and have more connections than Chinese participants (higher collectivism). Sheldon et al. (2017) compared motives for Instagram use in the U.S. (higher individualism) vs Croatia (higher collectivism) and found that while motivations behind Instagram use do not vary across cultures, the way Instagram is used does: Croatian participants' use reflects more collectivist tendencies (i.e., social interaction), while U.S. participants are more motivated by self-promotion and documentation. Finally, Kim et al. (2010) compared the U.S. (higher individualism) and South Korea (higher collectivism) and found that the two countries share the major motives for using social media (like seeking friends, social support, entertainment, information, and convenience) but the weights of these motives and the networks they create differ. While the cited studies have not dealt with the same countries as this study, the countries we selected also differ on the individualism vs collectivism dimension.[1]

Finally, the pandemic had a different timeline in these countries with South Korea being the first to report cases and the U.S. being the last one of the four. The four countries implemented different preventive measures as well. For example, South Korea had strict testing and isolation

policies including mobile tracking, while the U.S. never implemented such strict measures. We do not know how the public health agencies in the four countries communicated or how the countries' citizens reacted to the agencies' communication. Therefore, we ask:

> *RQ1:* What were the themes used by public health agencies in the studied countries in their communication about Covid-19 on Twitter?
>
> *RQ2:* What was the relationship between the identified themes and the audiences' engagement with public health agencies' communication in the studied countries?

Methods

We focused on Twitter as the communication channel, since it was one of the most popular social media platforms involved in the discussion of a dynamic public sphere and many public health organisations use it to disseminate information. All tweets from national public health agencies were extracted using Crimson Hexagon (currently Brandwatch) between Jan 21 (when the first case of the Covid-19 disease was confirmed) and May 11, 2020 (we decided to finish the data collection after 3 months), in four countries: the Netherlands (@rivm, N = 1,336), Poland (@GIS_gov, N = 1,224), South Korea (@KoreaCDC, N = 1,187), and the United States (@CDCgov, N = 877). We used total engagement as our main outcome of interest. Total engagement is calculated by Brandwatch and includes a sum of retweets and replies.

Coding Procedures

In our approach, we built, to some extent, on thematic analysis, similarly to Naeem and Ozuem's (2022) who utilised both deductive and inductive approaches to thematic analysis. We decided to combine an inductive and deductive approach in our analysis. We did that for several reasons. First, we did not aim to test any theory, but rather to analyse what health agencies communicated on social media and what resonated with social media users. Previous research, especially in the context of the Covid-19 pandemic, suggests that there were various themes used by various health-related agencies and organisations. Second, we wanted to compare several countries, where health agencies may have relied on different theoretical frameworks. Therefore, we decided to take a more data-driven and exploratory approach. In the analysis of Twitter posts, Powell (2021) took a similar approach in that the author conducted an open coding to identify the most prevalent themes and ideas, which helped establish concepts or phrases that initially emerged from the data, followed by second-level coding, when umbrella themes were extracted.

A codebook for content analysis was developed in a several-step process. First, the authors reviewed relevant literature and came up with a list of thematic categories (deductive approach). Next, all the authors coded a random sample of 10% of the tweets from the U.S. and identified more categories (inductive approach). After that, the authors coded 10% of the tweets from the remaining countries in their native languages to confirm the categories identified in the U.S. tweets and to come up with new categories. After each round, the authors met to discuss the themes appearing from the analysed messages, and to reach consensus on how to proceed. The identified themes can be found in Table 1.

Subsequently, the authors hired two coders per country, who were trained by the authors. The coders conducted two rounds of codebook testing using two 20% sub-samples of tweets from each of the four countries (random samplings without replacement). Each thematic

category was coded using a dichotomous (0 = absent vs 1 = present) response. Thematic categories were not mutually exclusive in that one tweet could be for example positive, about prevention behaviours, and about trust. However, a tweet had to be deemed *relevant* (i.e., deal with the Covid-19 pandemic) to be coded. Krippendorff's alpha and other measures of intercoder reliability were calculated using ReCal (Freelon, 2022), followed by discussions among coders to resolve disagreements and finalise the codebook. In the first round of coding, the coders did not achieve satisfactory intercoder reliability. In the second round, coders achieved sufficient intercoder reliability for the relevance category: The Netherlands 92.1% agreement & Krippendorff's $\alpha = .81$, Poland 90.1% agreement, Krippendorff's $\alpha = .76$, South Korea 100% agreement, U.S. 98.9% agreement & Krippendorff's $\alpha = .98$.

Table 1. Short Description of the Coded Themes

Coded Category	Short Description
Relevance	The message deals with issues related to the pandemic.
Sentiment	
Positive	The message expresses overall positive sentiment.
Neutral	The message expresses overall neutral sentiment.
Negative	The message expresses overall negative sentiment.
Themes	
Statistics	The message focuses on presenting numerical information related to the pandemic.
Basic information	The message discusses information about the virus like transmission, symptoms, treatment and recovery, vaccine, and therapeutics.
Regulations	Efforts and measures undertaken by the government and other governmental agencies: rules, school regulations, travel regulations.
Financial information	Information about stimulus packages, financial support for organizations, businesses, etc.
Clarifying misinformation	Reference to dis and misinformation is made, information is clarified.
Research	Academic findings and research are referred to.
Testing information	Available testing, types of testing, where one can get tested, who should test and when, etc.
Preventive behaviours (virus)	Recommended preventive behaviours (e.g., masks, social distancing, staying home, etc.).
Preventive behaviours (other)	Tips that focus more on mental health, creating a healthy working environment, etc. Also, animal care during the pandemic.
Where to find information	The tweet directs readers to additional materials, such as websites, webinars, etc.
Empathy	Expressions of gratitude, effort acknowledgment, reassurance, togetherness, etc.
Trust building	Stressing the expertise and preparedness of agencies, governments, public institutions, etc.
Limited knowledge	Admitting that the current knowledge about the pandemic is limited.
Rationale	Rationale for the discussed measures is provided, e.g., why certain behaviours should be undertaken.

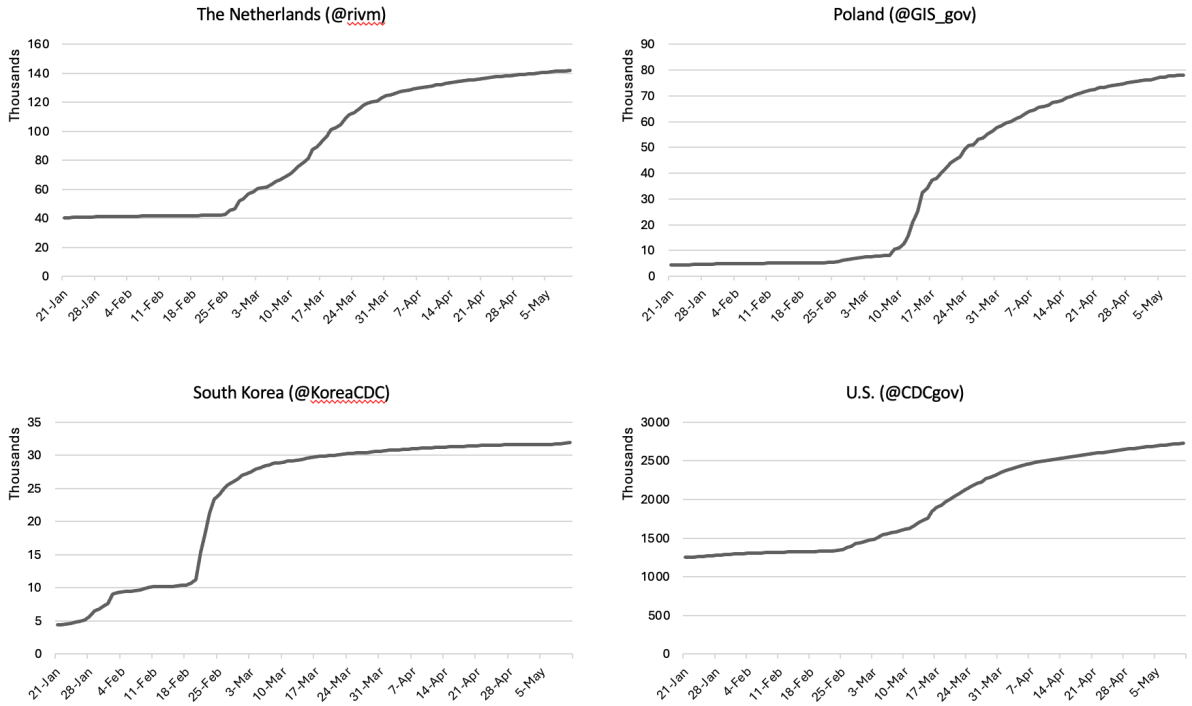
Note. The actual codebook was more detailed and can be found in Appendix 1.

Regarding other categories, the results were more mixed. Looking at all tweets (i.e., both relevant and irrelevant), for the Netherlands, the agreement between coders ranged between 83.1% and 100%, for Poland it was between 80.2% to 99.6%, for South Korea it was between 73.9% and 100%, and for the U.S. it was between 78% and 99.4%. While the percent agreement was satisfactory, Krippendorff's alphas sometimes were not and even produced negative values. We think that was caused by a small sample size, zero-inflated data, rare categories, and big variance. Because of this issue, we organised another discussion with the coders and authors. When everyone was finally satisfied with the categories and agreed on their definitions, we finalised the codebook (Table 1 presents final coding categories and themes, and the full codebook can be found in Appendix 1). One coder per country coded the final sample of tweets (i.e., the remaining 60%): the Netherlands $n = 802$, Poland $n = 738$, South Korea $n = 712$, and the U.S. $n = 527$. We coded only tweets that were deemed relevant, that is, tweets that dealt with Covid-19: the Netherlands $n = 633$, Poland $n = 402$, South Korea $n = 696$, and the U.S. $n = 368$.

Results

We first looked at descriptive differences between the countries. Figure 2 shows the change in the number of account followers over time. Unsurprisingly, the emergence of the pandemic attracted people to the health agencies' Twitter accounts in all countries. Though the increase starts at different points in time in different countries (in the Netherlands, it is beginning to mid-March, in Poland it is mid-March, in South Korea it is the end of February, and in the U.S., we see a steep uptake around the beginning of April). This illustrates that people turned to Twitter as the pandemic became more evident in each specific country.

Figure 2. Numbers of Twitter Followers per Country Over Time



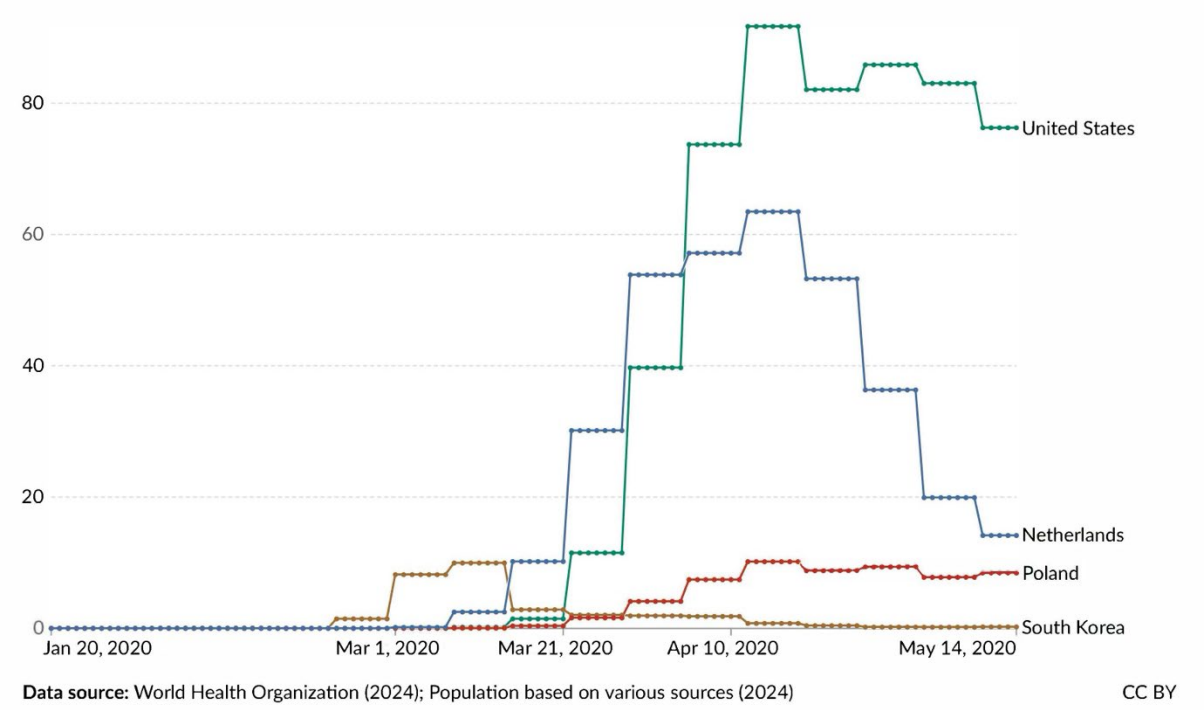


Figure 3. Daily New Confirmed Covid-19 Cases per Million People (7-day rolling average)
Note: This graph is from Our World in Data (https://ourworldindata.org/covid-cases?country=USA~NLD~POL~KOR). Downloaded on November 10, 2024

Figure 3 shows that in the Netherlands the cases increased in late March, in Poland it was late March/beginning of April, in South Korea it was in late February/early March, and in the U.S., the spike in cases started in late March/early April. Again, these descriptive data suggest that the publics in different countries tend to turn to social media to get information about the pandemic.

Figure 4 illustrates the publics' engagement with the communication from the agencies' Twitter accounts and how it changed over time but following a slightly different pattern than the accounts' popularity. Also, the ways the publics in different countries engaged with communication differed by country. In the Netherlands, Poland, and the U.S., people mostly mentioned the agencies, while in South Korea, we see many more retweets. We can also see that while people did reply to health agencies, so engaged in conversations with them, the replies constituted just a tiny percent of all interactions. We again see that the peak of engagement follows the evolution of the pandemic in each country with the highest engagement in the Netherlands taking place in mid-March and again in early April, in Poland it was mid-March, in South Korea the end of February, and in the U.S. around the end of March.

The Themes Present in Communication

The results of coding (Table 2) show that the tweets were mostly of neutral sentiment (90.1%). Public health agencies mainly focused on (1) providing resources where people could find additional information (48.9%), (2) providing basic information about the virus (40.4%), and (3) expressing empathy (30.7%). Many tweets also discussed virus-related preventive behaviours (23%) and communicated statistics related to the virus (19.9%). To a lesser extent, public health agencies wanted to increase trust and credibility (11.7%). They sometimes

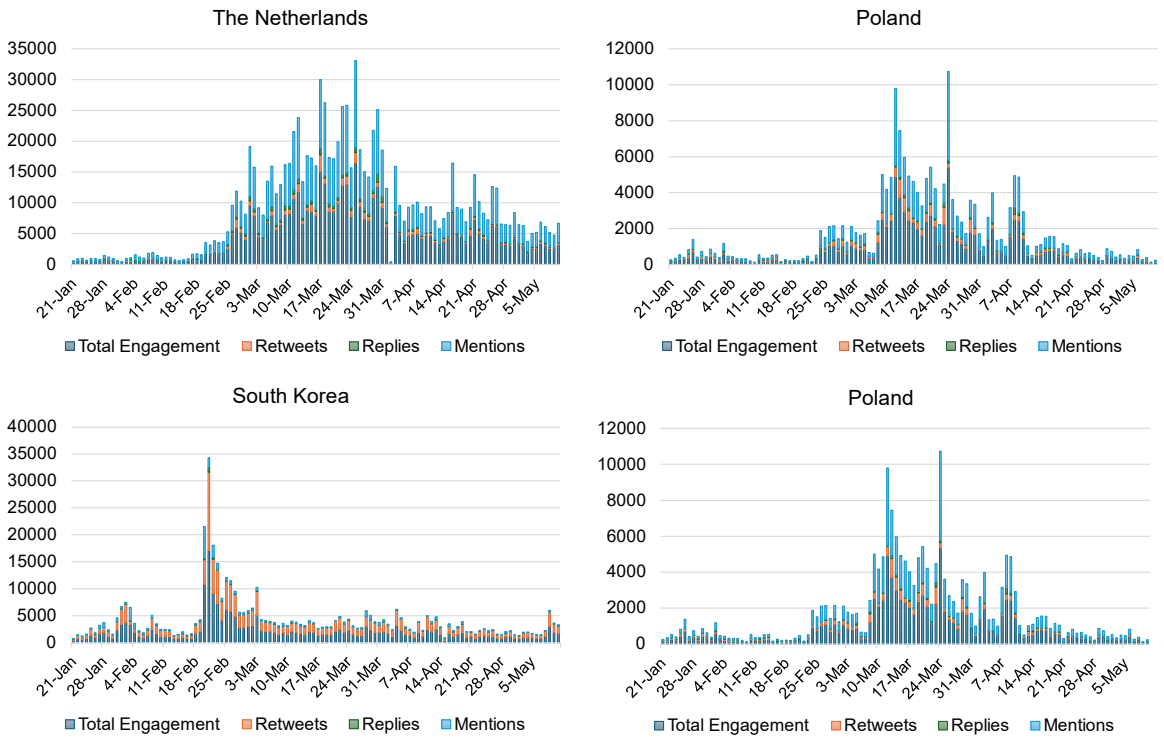


Figure 4. Retweets, Replies, and Mentions with Health Agencies' Twitter Messaging in The Netherlands, Poland, South Korea, and U.S.

Note. Mentions were not included in the total engagement measure and therefore were not included in the models.

provided rationale for their recommendations (11.10%). Some, though limited, information was provided when it comes to regulations being implemented (7.40%), testing (6.20%), or other preventive behaviours (e.g., concerning mental health, 5%). Public health agencies barely admitted that our knowledge about the virus was limited (3.20%). Very limited communication focused on correcting misinformation (2.8%), introducing newest research (2.6%), or providing financial information (1.4%).

Differences between Countries in the Discussed Themes

The studied countries differed in their communication approach. While the sentiment of the tweets was mostly neutral, South Korea was a country with the highest percentage of positive messages (21.60%). Also, South Korea reported statistics and data more than other countries (30.30%), while the U.S. reported them the least (4.30%). Messages with negative sentiment merely existed. When it comes to providing additional resources (code: "where to find information"), the Netherlands (42.20%), South Korea (67.40%,) and the U.S. (57.90%) did not differ much, but this theme was much less present in Poland (19.40%). Similarly, the Polish health agency less often focused on the basic information about the virus (15.70%) than the agencies in the other studied countries: the Netherlands 26.90%, South Korea 69.00%, the U.S. 36.70%. Other significant differences can be observed when it comes to South Korea's focus on empathy (73.10%) and statistics (30.30%). It seems that Poland (33.30%) and the U.S. (34%) focused on discussing how to prevent the spread of the virus more than the other two countries. Both Poland (18.90%) and the U.S. (18.50%) also focused more on building trust and credibility. The U.S. also provided rationale for presented recommendations more often than other countries (27.20%). South Korea did that the least (1.70%). The Netherlands

(10.10%) and South Korea (9.80%) focused more on discussing regulations. The Netherlands admitted significantly more often (8.40%) that the knowledge about the virus was limited than agencies from other countries. Finally, the Netherlands (5.50%) and Poland (4.50%) more often tried to address misinformation than the other countries.

Table 2. Occurrence of Communicated Themes in Public Health Agencies' Tweets and Differences Between Countries

Category	The Netherlands	Poland	South Korea	United States	Total
Negative	1_{a} 0.20%	7_{b} 1.70%	0_{a} 0.00%	$0_{a, b}$ 0.00%	8 0.40%
Neutral	612_{a} 96.70%	371_{b} 92.30%	546_{c} 78.40%	363_{a} 98.60%	1892 90.10%
Positive	$20_{a, b}$ 3.20%	24_{b} 6.00%	150_{c} 21.60%	5_{a} 1.40%	199 9.50%
Statistics	119_{a} 18.80%	71_{a} 17.70%	211_{b} 30.30%	16_{c} 4.30%	417 19.90%
Basic info.	170_{a} 26.90%	63_{b} 15.70%	480_{c} 69.00%	135_{d} 36.70%	848 40.40%
Regulations	64_{a} 10.10%	13_{b} 3.20%	68_{a} 9.80%	11_{b} 3.00%	156 7.40%
Financial information	0_{a} 0.00%	3_{a} 0.70%	24_{b} 3.40%	2_{a} 0.50%	29 1.40%
Research	17_{a} 2.70%	34_{b} 8.50%	0_{c} 0.00%	4_{a} 1.10%	55 2.60%
Misinformation	35_{a} 5.50%	$18_{a, b}$ 4.50%	0_{c} 0.00%	6_{b} 1.60%	59 2.80%
Testing	$45_{a, b}$ 7.10%	$20_{a, b}$ 5.00%	54_{b} 7.80%	12_{a} 3.30%	131 6.20%
Prevent. Virus	99_{a} 15.60%	134_{b} 33.30%	124_{a} 17.80%	125_{b} 34.00%	482 23.00%
Prevent. other	6_{a} 0.90%	6_{a} 1.50%	17_{a} 2.40%	75_{b} 20.40%	104 5.00%
Where info	267_{a} 42.20%	78_{b} 19.40%	469_{c} 67.40%	213_{d} 57.90%	1027 48.90%
Empathy	21_{a} 3.30%	27_{a} 6.70%	509_{b} 73.10%	87_{c} 23.60%	644 30.70%
Trust	59_{a} 9.30%	76_{b} 18.90%	43_{a} 6.20%	68_{b} 18.50%	246 11.70%
Limited	53_{a} 8.40%	6_{b} 1.50%	1_{c} 0.10%	7_{b} 1.90%	67 3.20%
Rationale	75_{a} 11.80%	47_{a} 11.70%	12_{b} 1.70%	100_{c} 27.20%	234 11.10%

Note. Subscript letters denote differences at the significance level of .05 within each row. If the letter is the same, there is no significant difference between cells; if the letter is different, there is a significant difference.

Communication Themes and Engagement

To investigate the relationships between the thematic categories and total engagement (i.e., retweets and comments), we ran zero-inflated negative binomial regression analyses on the whole sample and separately for each country. We used the 'pscl' package in R (Jackman et al., 2022). We decided that this was the most appropriate analytical approach, because our outcome variable (total engagement) included many 0s and was overdispersed (i.e., its variance was larger than its mean[2]). Furthermore, our sample size was rather small, there were many thematic categories, some of the categories were correlated, and many categories were sparse; therefore, we decided to select the most prevalent categories for this analysis (see Table 2): where to find more information (1,027 occurrences), basic information (848 occurrences), empathy (644 occurrences), preventive behaviours related to the virus (482 occurrences), and statistics (417 occurrences). We also included the age of a post in days as a control variable. The results are presented in Table 3.[3]

We can see that all the categories are significantly and positively related to engagement, except the category statistics, which is negatively related to engagement, suggesting that simply listing numbers, while may be informative, does not create engagement.

Next, we ran the same model but separately for each country to understand whether the same themes were equally important for each country's audiences. The results are presented in Table 4. In the Netherlands, basic information was related to engagement negatively, while empathy, preventive behaviours, and statistics were not significant. In the Polish sample, basic information was nonsignificant, but information on virus prevention and where to find more information were positively related to engagement. Interestingly, empathy was negatively related to engagement. In South Korea, basic information, where to find information, and empathy were negatively related to engagement, while statistics and preventive behaviours were positively related to engagement. Finally, in the U.S., basic information, information on virus prevention, and empathy were all positively related to engagement, but where to find

Table 3. The Effect of Thematic Categories on Engagement

Variable	*Est.*	*SE*	*z*	*p*
Count model coefficients				
Intercept	4.243	0.09	45.76	<.001
Where information	0.496	0.09	5.26	<.001
Basic information	0.731	0.09	8.00	<.001
Empathy	0.515	0.10	5.27	<.001
Prev. behaviours (virus)	0.367	0.11	3.34	<.001
Statistics	-0.371	0.12	-3.22	.001
Post age	-0.898	0.06	-16.11	<.001
Log(theta)	-1.269	0.04	-32.62	<.001
Zero-inflation model coefficients				
Intercept	-1.215	0.27	-4.50	<.001
Where information	-1.685	0.40	-4.25	<.001
Basic information	-2.248	1.03	-2.18	.029
Empathy	-0.367	0.36	-1.01	.312
Prev. behaviours (virus)	-0.594	0.39	-1.51	.132
Statistics	-16.048	822.21	-0.02	.984
Post age	-0.490	0.15	-3.18	.001

information was negatively related to engagement. These results suggest that individuals on Twitter in different countries do not respond to their public health agencies' communication about Covid-19 in the same way and that different strategies effectiveness may depend on the country.

Discussion

Social media platforms have become primary sources of information about Covid-19 and mitigation measures (Nielsen et al., 2020). Indeed, we noticed an increase in the number of account followers as well as in the followers' engagement with the health departments' accounts over the course of the pandemic. Especially as more cases were reported, people turned to Twitter for more information. As people became more used to the pandemic and the cases started decreasing, people's engagement with health communication on Twitter also decreased. However, it is worth noting that the number of followers did not decrease in our sample, suggesting that people stopped engaging but stayed connected to the health agencies (possibly in case the situation changes).

Themes Observed in Communication

Our findings show that pandemic communication was mostly neutral and focused on providing sources of additional information, basic information about the virus, empathy, behaviours to prevent the spread of the virus, and statistics. This is partially in line with the results by Dorantes-Gilardi et al. (2021) who found that early in the pandemic government agencies in the U.S. (@CDCgov, @US_FDA, @NIH) communicated about Covid-19 preventive behaviours, news, new treatments and vaccines, risk factors, testing, risk reduction, cases, and hospitalizations. We also found lots of communication about preventive behaviours but less so about treatments. Our time frame was however shorter, and little was known about treatments at that time. Crises pose serious threats to public health, but also psychological, emotional, and economic well-being (Seeger & Reynolds, 2007). It is surprising that we did not see more information about financial issues or the types of preventive behaviours that relate to psychological and physical well-being.

Other studies looked at themes in communication by other influential sources. For example, Rufai and Bunce (2020) conducted a content analysis of G7 leaders' viral posts on Twitter about the Covid-19 pandemic and identified three key themes: informative, morale-boosting, and political. Powell (2021) identified themes in Twitter messaging from New York State Governor, Andrew Cuomo, which included Covid-19 case number updates, precaution, reassurance and partnership efforts, best practices/safety measures, reassurance and gratitude, public restrictions, medical related content, public health content and case updates, practice content. Some of the results of our study are similar in that we also identified more informative themes like statistics, preventive behaviours, basic information about the virus, to be dominant. We did find empathy and trust but only in some countries and we did not really see gratitude or political information.

Table 4. The Effect of Thematic Categories on Engagement per Country

	The Netherlands				Poland				South Korea				United States			
Variable	*Est.*	*SE*	*z*	*p*	*Est.*	*SE*	*z*	*p*	*Est.*	*SE*	*z*	*p*	*Est.*	*SE*	*z*	*p*
Count model coefficients																
Intercept	2.920	0.12	24.31	<.001	2.562	0.19	14.20	<.001	5.865	0.14	42.17	<.001	6.371	0.16	39.30	<.001
Where information	1.285	0.16	7.84	<.001	0.562	0.26	2.16	.031	-0.568	0.09	-6.07	<.001	0.048	0.14	0.35	.727
Basic information	-0.427	0.17	-2.54	.011	0.255	0.37	0.69	.488	-0.347	0.10	-3.36	<.001	0.533	0.13	3.99	<.001
Empathy	0.621	0.52	1.20	.230	-1.230	0.41	-2.98	.003	-0.463	0.11	-4.41	<.001	0.661	0.17	3.92	<.001
Prev. Behaviours (virus)	0.021	0.21	0.10	.919	0.688	0.20	3.36	<.001	0.344	0.12	2.97	.003	0.452	0.14	3.20	.001
Statistics	-0.067	0.21	-0.32	.748	-0.628	0.26	-2.45	.014	0.395	0.11	3.53	<.001	0.722	0.31	2.35	.019
Post age	-1.516	0.01	-13.95	<.001	-0.490	0.19	-2.61	.009	0.334	0.09	3.67	<.001	0.214	0.08	2.79	.005
Log(theta)	-0.958	0.06	-16.53	<.001	-0.032	0.16	-0.20	.844	-0.111	0.05	-2.27	.023	-0.15	0.08	-1.60	.110
Zero-inflation model coefficients																
Intercept	-3.760	0.85	-4.40	<.001	0.213	0.27	0.78	.432	-6.523	1.87	-3.49	<.001	-0.266	0.25	-1.07	.286
Where information	1.688	0.90	1.88	.060	0.609	0.31	1.99	.047	0.181	0.99	-0.18	.856	-1.174	0.27	-4.30	<.001
Basic information	-2.242	2.42	-0.93	.354	1.452	0.39	3.69	<.001	-1.526	0.98	-1.56	.120	-0.860	0.30	-2.86	.004
Empathy	3.667	1.15	3.18	.001	0.018	0.54	0.03	.974	1.463	1.26	1.164	.244	0.958	0.29	3.31	<.001
Prev. behaviours (virus)	-3.630	1.49	-2.44	.015	-0.823	0.26	-3.22	.001	-17.509	9906.29	-0.002	.999	-0.563	0.30	-1.85	.064
Statistics	-9.205	36.78	-0.25	.802	-0.141	0.33	-0.42	.672	-17.789	7490.33	-0.002	.998	-0.964	0.80	-1.20	.231
Post age	-0.789	0.26	-3.05	.002	0.201	0.28	0.73	.466	3.717	1.30	2.851	.004	0.016	0.12	0.13	.896

The themes we found are not only in line with previous research but also partially supported by theoretical frameworks. While the timeline of the pandemic was different in the different countries, since we focused on the early stages of the pandemic, we can say that we are dealing mostly with the pre-crisis and the initial event stages, as categorised by the CERC model. Reynolds and Seeger (2005) provide a detailed overview of all the stages including what communication should aim to establish in each of them. While we saw that health agencies discussed basic information about the virus, how to protect oneself, and where to find reliable information, we did not see many empathy, reassurance, or emotional turmoil reduction messages (see our recommendations below).

Differences between Countries

Our results also show that different countries chose a slightly different focus. The Netherlands and the U.S. mostly discussed where people can find information about the virus, which may be linked to higher individualism in these countries. Poland focused on virus-related preventive behaviours. South Korea's communication was dominated by empathy, followed by basic information about the virus and sources of information. Also, South Korea reported statistics and data more than other countries, while the U.S. reported them the least. It may be because out of the four countries, South Korea experienced the pandemic first, while the U.S. was last to get its first case.

These differences may be partially explained by cultural differences, which we attempt to do below, but we acknowledge that we need more research that would link cultural differences to people's responses to information during a pandemic (see also Limitations and Future Research Avenues). South Korea may still be regarded as a collectivistic society, which may explain more focus on empathy, as being responsible for others is highly regarded in collectivistic societies. This is also in line with low masculinity scores implying more attention to caring for others in South Korea. The high score on uncertainty avoidance in Poland could translate to an increased risk perception and be the reason why the Polish health agency focused more on research and trust building than other countries. The U.S. stands out when it comes to providing tips on other preventive behaviours like mental and physical health, which may be driven by their high individualism. High individualism suggests more focus on one's well-being and development (even in the time of crisis). It may also be due to their low long-term orientation, suggesting less focus on perseverance and more on short-term achievements and gratifications. The U.S. also provided the rationale more often than other countries, which may be because of their lower need for rules and regulations driven by the low uncertainty avoidance–U.S. citizens may need more justification before they follow rules, unlike South Korea, which is characterised by high power distance and hence more respect for authority. However, the Netherlands also scores quite low on uncertainty avoidance and the Dutch health agency focused on rules and regulations much more than the agencies in other countries. The Netherlands, as a highly individualistic, but also egalitarian culture, focused more on providing citizens with information where they can learn more about the virus. They provided less information on how to prevent infections and much less about empathy. We can speculate that the purpose was for the Dutch citizens to decide on their own how to behave.

In the time of an infodemic, in which false or unverified information spreads quickly and widely across various media (Radu, 2020), it seems especially important for reliable sources to share correct information and explain misinformation also when it comes to health crises like

a pandemic. Although we did find that public health agencies share a lot of (evidence-based) information through Twitter, we did not find them to frequently correct or explain (the presence of) misinformation about Covid-19. This may be because our time frame covers the first few months of the pandemic, and a lot of misinformation was either not yet present at that time or we did not know enough to correct it. Only limited communication (especially visible in the Netherlands and Poland) addressed misinformation.

Moreover, public health agencies barely discussed the newest developments in research. It may again be because of the early stage of the pandemic when research on the virus and treatments was still very limited. However, as Besalú et al. (2021) discussed after Perez-Dasilva et al. (2020), the silence of health experts and scientists on misinformation has not helped stop the spread of misinformation about Covid-19. Therefore, health agencies may consider strengthening their efforts to combat misinformation and providing more insights into research, especially by providing credible sources and actionable directives, as the IDEA model suggests (Sellnow et al., 2017). This may be especially important on social media because people with stronger anti-vaccine sentiments rely more strongly on social media for Covid-19 information (McKinley & Lauby 2021), which may be true also for subjects prone to other types of misinformation. In addition, providing more credible resources could combat the lack of trust in social media. According to reports like The Reuters Institute Digital News Report (2021) individuals do not trust social media, but we did not observe many efforts directed at increasing trust and credibility.

The health agencies in our sample barely admitted that their knowledge about the virus was limited. We know that people seek information to gain knowledge in the time of uncertainty (Brashers et al., 2022). By not admitting how little we knew, the health agencies may have wanted to avoid creating even more uncertainty and increasing people's ambiguity aversion. However, the study by Han et al. (2022) showed that scientific uncertainty can be communicated without increasing ambiguity aversion when an uncertainty-normalising strategy is used. We may need further research to better understand how people react to uncertainty in the time of a pandemic and whether communicating uncertainty may have beneficial effects for strengthening preventive behaviours and diminishing misinformation.

Engagement with Communication

We observed that engagement with public health agencies increased in all countries. We observed some differences though. For example, in the Netherlands, Poland, and the U.S., people mostly mentioned the agencies, suggesting that they added their own opinions to the posts, while in South Korea, we see many more retweets, so propagation. This may be linked to the role of hierarchy and authority in these countries. We did not observe many replies, which would suggest more conversational interactions. Regarding the themes, overall providing basic information, information about preventive behaviours, sources additional information, and empathy were all positively associated with engagement, while including statistics was negatively associated with engagement.

We also saw that the countries differed in their engagement with Twitter content with the audiences in the U.S. engaging more than the audiences in the other countries. Engagement was similar in the Netherlands and South Korea, and the lowest in Poland. This suggests that Twitter may not be the most relevant channel for public health agencies everywhere and that

research conducted on Twitter may not be equally representative of publics in different countries.

Finally, the relationship of the themes with engagement varied by country. For example, empathy was positively related to engagement in the U.S., but not in Poland or South Korea. Sources of additional information were related to increased engagement in the Netherlands and Poland, but not the U.S. or South Korea. Basic information about Covid-19 positively correlated with engagement in the U.S. only. These examples illustrate that there are differences in the responses to the communication themes and the health agencies in the different countries should tailor their messages to what their audiences are most looking for. When interpreting these relationships, we would like to acknowledge that the data we worked with were zero-inflated and overdispersed, and our predictors were mostly dummies with unbalanced distribution, and relatively small sample sizes. We tried to address these issues, but working with such data is difficult and there are different statistical approaches (see e.g., Green, 2021). Therefore, we are cautious when interpreting the findings and suggest that future research replicates our findings, preferably with other social media platforms and bigger samples.

Implications for Public Health Agencies

Based on our research we can provide several practical implications. First, we believe that health agencies should provide clear and actionable insights about preventive behaviours as well as resources where citizens can learn more. As we discussed earlier, in line with the IDEA model, communication should provide credible sources and actionable directives (Sellnow et al., 2017). We did observe that the health agencies provided information about preventive behaviours and sources of information, which is in line with previously established models in crisis communication and health agencies should continue doing so. This recommendation is also in line with the study by te Poel et al. (2021) that showed that the Dutch public were most in need of information about prevention of contamination, and additionally needed information about (severity of) symptoms, treatment, and vaccination.

Next, citizens need to receive information not only about the virus but also about the consequences related to political, economic, social, and psychological aspects. We only found limited communication about the effects on the economy or advice on how to protect mental health. Also, our study showed that science and research were rarely discussed. According to the study by Kessler et al. (2022), respondents found public communication to not pay enough attention to vaccination and vaccination side effects, political measures, psychological and social aspects and consequences, science and research, political aspects in general, and information on the virus. Therefore, we suggest that communication includes broader consequences of the virus and builds on newest scientific developments.

Finally, communication should convey language of openness, compassion, and acceptance of uncertainty (Veil et al., 2011). It is also in line with the CERC model that communication should build trust and provide reassurance and emotional stability in a time of distress. We observed some empathy in communication, but that was mostly the case in South Korea. We would advise health agencies to consider using more compassion and empathy in their communication. We did not see much acceptance of uncertainty or lack of knowledge, but increasing transparency when it comes to what we know and do not know could benefit communication.

A few caveats to these recommendations should be noted. We know that basic information about the virus, information about preventive behaviours, sources of information, and empathy are generally important and are associated with more engagement with communication. However, there are differences between countries. For example, we find that providing additional information may work in the Netherlands, Poland, but not necessarily in South Korea or the U.S., where sharing statistics may be more helpful. Also, as the study by Link et al. (2022) shows, people differ in their information seeking and avoidance motivations with some people actively seeking in-depth information, while others monitor news, or get their information from influencers or their family and friends. Many of the health communication theories and models have been developed in a context of specific countries and cultures and may not work well for all the different populations. Therefore, our final recommendation is that health agencies try to understand their audiences' needs, motives, and cultural biases or worldviews, and tailor their communication to not only their own country but also specific audiences within the country.

Limitations and Future Research Avenues

While this study provides some interesting results, it also suffers from limitations. First, we focused on one social media platform. Many of the health departments were also present on other social media like Facebook or Instagram, which are less accessible for academic research. These different social media platforms may attract different populations across but also within countries, and their relevance for crisis health communication may vary in different countries, as our analysis of the differences in engagement between countries shows. Also, we did not analyse rich media content or conversations, but focused only on the text included in the tweets. Future research could get a fuller picture by analysing images and videos posted. Our measurement of engagement was based on replies and retweets, since the data were collected using a third-party tool (i.e., Brandwatch). These two types of reactions may be argued to constitute a higher level of engagement in comparison to likes/favourites. The latter however may be more often used. While we believe the debate on what engagement is (see e.g., Maslowska et al., 2016) or what these different types of reactions mean is beyond the scope of this paper, future research may want to replicate our results for different engagement measures.

Second, we used a combination of an inductive and deductive approach, because we did not want to evaluate communication from the perspective of any of the risk, crisis, or health communication models, but rather identify what the communication was about. However, a model that could be useful to actually evaluate communication is the Crisis and Emergency Risk Communication (CERC) model developed by the United States Center for Disease Control and Prevention (CDC, 2018). The model identifies five stages of crisis health communication, i.e., the pre-crisis, initial event, maintenance, revolutions and evaluation stages, and criteria communication should focus on in each of these stages (e.g., precautions, risk management, reassurance, etc. (Powell, 2021; Reynolds & Seeger, 2005). The model was informed by experience and different health, but also crisis and risk communication theories, but it was not developed to test any one theory, but to explain how health communication works in the contexts of risk and crisis and to be used a tool for practitioners (Powell, 2021; Veil et al., 2008). For example, Powell (2021) investigated Twitter messaging from New York State Governor, Andrew Cuomo, in the early stages of the Covid-19 pandemic, using the CERC

model. Future research could look at the whole pandemic period and use this model to evaluate communication and possibly validate its applicability for different sources of health communication and in different cultural contexts.

Third, our study focused on comparing several countries and assuming they represent somehow coherent cultures. However, future research may want to investigate the role of culture defined in terms of worldviews that may vary not only across cultures but also within cultures. For example, Kim and Kim (2019) investigated how cultural worldviews (i.e., hierarchy, individualism, egalitarianism, and fatalism) influence people's interpretation of an environmental risk, which may affect their information seeking and processing. They discussed an example of South Korea, a society traditionally influenced by Confucianism and collectivistic values, but strongly affected by economic development and Western capitalism, leading to adoption of non-traditional values like individualism and egalitarianism. Future research may want to focus on cultural diversity in societies and how health communication could address them. Also, we noticed differences in communication between the countries, but *why* we see differences in choices in health communication between organisations from different countries is still an open question. Future research may endeavour to understand how communication in different countries is being developed, what models (if any) are being followed and why to better understand the mechanism behind these differences. This could be done, for example, through in-depth interviews with representatives from public health departments.

Finally, we analysed text in different languages. We tried to find native speakers who would not only speak the language but also understand the cultural and political background of the tweets studied. We wanted to avoid translating the texts into one common language to preserve cultural understanding and language peculiarities like sarcasm, humour, abbreviations, etc. Because we decided to take that route, we were sure that our coders understood the intentions behind the messages. However, that also means that their understanding of the codebook may have differed to some extent. We did our best to prevent this from happening by following a several-step approach to the development of our codebook. It would be interesting to compare our approach with an automated text analysis approach for which the text could be translated and analysed by the same algorithm or original texts could be analysed by algorithms developed for specific languages.

Notes

1. We should also notice that the results of the previous research are likely unstable as social media platforms change, and so do their users.
2. Which we also checked with the check_overdispersion function from the 'performance' package (Lüdecke et al., 2021).
3. We checked for robustness of the results with a negative binomial generalised linear model using the glm.nb function from package 'MASS' in R (Ripley et al., 2024). The results were in line.

Ethical Approval

Ethics approval was not sought because publicly available data (Twitter posts) provided by public institutions were used for the analysis. No personally identifiable information (such as comments or names of followers) or privately shared information was collected. Next to public posts, only summary statistics were gathered (number of likes, shares, and followers). We did not collect any information about the followers.

Funding

The University of Illinois Urbana-Champaign and the University of Amsterdam provided the necessary funding for the research presented in this submission.

Conflict of Interest

There are no conflicts of interests associated with the manuscript. The project was not sponsored, and ethics approval was not sought because only publicly available data published by national health agencies were collected. No personal information about individuals was collected.

Supplementary Material

The appendix to this article can be accessed online: https://doi.org/10.47368/ejhc.2025.101.

References

Allem, J. P., Escobedo, P., Chu, K. H., Soto, D. W., Cruz, T. B., & Unger, J. B. (2017). Campaigns and counter campaigns: reactions on Twitter to e-cigarette education. *Tobacco Control*, *26*(2), 226-229. https://doi.org/10.1136/tobaccocontrol-2015-052757

Backer, T. E., Rogers, E., & Sopory, P. (1992). *Designing health communication campaigns: What works?* Sage Publications.

Basch, C. H., Kecojevic, A., & Wagner, V. H. (2020). Coverage of the COVID-19 pandemic in the online versions of highly circulated US daily newspapers. *Journal of Community Health, 45*(6), 1089-1097. https://doi.org/10.1007/s10900-020-00913-w

Besalú, R., Pont-Sorribes, C., & Martí, A. (2021). Perceived credibility of tweets by opinion leaders during the COVID-19 pandemic in Spain. *International Journal of Communication*, *15*, 5158-5185.

Brashers, D. E., Goldsmith, D. J., & Hsieh, E. (2002). Information seeking and avoiding in health contexts. *Human Communication Research*, *28*(2), 258-271. https://doi.org/10.1111/j.1468-2958.2002.tb00807.x

Broniatowski, D. A., Jamison, A. M., Qi, S., AlKulaib, L., Chen, T., Benton, A., Quinn, S. C., & Dredze, M. (2018). Weaponized health communication: Twitter bots and Russian trolls amplify the vaccine debate. *American Journal of Public Health*, *108*(10), 1378-1384.

Centers for Disease Control and Prevention (2018). *CERC manual.* https://emergency.cdc.gov/cerc/manual/index.asp

Chu, W. M., Shieh, G. J., Wu, S. L., & Sheu, W. H. H. (2020). Use of Facebook by academic medical centers in Taiwan during the COVID-19 pandemic: Observational study. *Journal of Medical Internet Research*, *22*(11), Article e21501. https://doi.org/10.2196/21501

Diddi, P., & Lundy, L. K. (2017). Organizational Twitter use: Content analysis of Tweets during breast cancer awareness month. *Journal of Health Communication*, *22*(3), 243-253. https://doi.org/10.1080/10810730.2016.1266716

Douglas, M., & Wildavsky, A. (1982). *Risk and culture: An essay on the selection of technical and environmental dangers*. University of California Press.

Ferguson, C., Merga, M., & Winn, S. (2021). Communications in the time of a pandemic: The readability of documents for public consumption. *Australian and New Zealand Journal of Public Health*, *45*(2), 116-121. https://doi.org/10.1111/1753-6405.13066

Freelon, D. (2022). ReCal: Reliability calculation for the masses. www.dfreelon.org/utils/recalfront/

Freimuth, V. S., Stein, J. A., & Kean, T. J. (2018). *Searching for health information: The cancer information service model*. University of Pennsylvania Press.

Green, J. A. (2021). Too many zeros and/or highly skewed? A tutorial on modelling health behaviour as count data with Poisson and negative binomial regression. *Health Psychology and Behavioral Medicine*, *9*(1), 436-455. https://doi.org/10.1080/21642850.2021.1920416

Griffin, R. J., Dunwoody, S., & Neuwirth, K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research*, *80*(2), S230-S245. https://doi.org/10.1006/enrs.1998.3940

Guidry, J. P. D., Jin, Y., Orr, C. A., Messner, M., & Meganck, S. (2017). Ebola on Instagram and Twitter: How health organizations address the health crisis in their social media engagement. *Public Relations Review, 43*(3), 477–486. https://doi.org/10.1016/j.pubrev.2017.04.009

Hagen, L., Keller, T., Neely, S., DePaula, N., & Robert-Cooperman, C. (2018). Crisis communications in the age of social media: A network analysis of Zika-related tweets. *Social Science Computer Review*, *36*(5), 523-541. https://doi.org/10.1177/0894439317721985

Hale, B. J., Alberta, M., & Chae, S. W. (2022). Reddit as a source of COVID-19 information: A content analysis of r/coronavirus during the early pandemic. *Journal of Communication Technology,* 5(1), 26-57. http://doi.org/10.51548/joctec-2022-002

Han, P. K., Scharnetzki, E., Scherer, A. M., Thorpe, A., Lary, C., Waterston, L. B., Fagerlin, A., & Dieckmann, N. F. (2021). Communicating scientific uncertainty about the COVID-19 pandemic: Online experimental study of an uncertainty-normalizing strategy. *Journal of Medical Internet Research*, *23*(4), Article e27832. http://doi.org/10.2196/27832

Harris, J. K., Mueller, N. L., & Snider, D. (2013). Social media adoption in local health departments nationwide. *American Journal of Public Health*, *103*(9), 1700-1707. http://doi.org/10.2105/AJPH.2012.301166

Hart, P. S., Chinn, S., & Soroka, S. (2020). Politicization and polarization in COVID-19 news coverage. *Science Communication*, 42(5), 679-697. http://doi.org/10.1177/1075547020950735

Hofsteede Insights (2022). *Country comparison tool.* www.hofstede-insights.com/country-comparison/the-netherlands,poland,south-korea,the-usa/

Jackman, S. Tahk, A., Zeileis, A., Maimone, C., Fearon, J., & Meers, Z. (2022). Package 'pscl'. https://cran.r-project.org/web/packages/pscl/pscl.pdf

Jackson, L. A., & Wang, J. L. (2013). Cultural differences in social networking site use: A comparative study of China and the United States. *Computers in Human Behavior, 29*(3), 910-921. https://doi.org/10.1016/j.chb.2012.11.024

Jacobs, W., Amuta, A. O., & Jeon, K. C. (2017). Health information seeking in the digital age: An analysis of health information seeking behavior among US adults. *Cogent Social Sciences*, *3*(1), Article 1302785. https://doi.org/10.1080/23311886.2017.1302785

Jones, S., & Fox, S. (2009). *Generations Online in 2009.* Pew Research Center. http://www.pewinternet.org/Reports/2009/Generations-Online-in-2009/

Kemp, S. (2022). *Digital 2020: Poland.* Datareportal. https://datareportal.com/reports/digital-2020-poland

Kessler, S. H., Cano Pardo, M. S., Jobin, A., & Georgi, F. (2022). How informed are the Swiss about Covid-19 and prevention measures? Results of a survey on information awareness, behaviour, and deficits. *European Journal of Health Communication*, *3*(3), 118-142. https://doi.org/10.47368/ejhc.2022.306

Kim, H. K., & Kim, Y. (2019). Risk information seeking and processing about particulate air pollution in South Korea: The roles of cultural worldview. *Risk Analysis, 39*(5), 1071-1087. https://doi.org/10.1111/risa.13231

Kligler-Vilenchik, N., Stoltenberg, D., De Vries Kedem, M., Gur-Ze'ev, H., Waldherr, A., & Pfetsch, B. (2020). Tweeting in the time of coronavirus: How social media use and academic research evolve during times of global uncertainty. *Social Media+ Society*, *6*(3). https://doi.org/10.1177/2056305120948258

Lee, S. T., & Basnyat, I. (2013). From press release to news: mapping the framing of the 2009 H1N1 A influenza pandemic. *Health Communication, 28*(2), 119-132. https://doi.org/10.1080/10410236.2012.658550

Lee, S., Yamamoto, M., & Tandoc, E. C., Jr. (2022). Why people who know less think they know about COVID-19: Evidence from US and Singapore. *Journalism & Mass Communication Quarterly*, *99*(1), 44-68. https://doi.org/10.1177/10776990211049460

Link, E., Rosset, M., & Freytag, A. (2022). Patterns of online information seeking and avoidance about SARS-CoV-2 and COVID-19. *European Journal of Health Communication*, *3*(1), 53-75. https://doi.org/10.47368/ejhc.2022.103

Lüdecke et al., (2021). performance: An R package for assessment, comparison and testing of statistical models. *Journal of Open Source Software*, *6*(60), 3139. https://doi.org/10.21105/joss.03139

Maslowska, E., Malthouse, E. C., & Collinger, T. (2016). The customer engagement ecosystem. *Journal of Marketing Management, 32*(5-6), 469-501. https://doi.org/10.1080/0267257X.2015.1134628

McKinley, C. J., & Lauby, F. (2021). Anti-vaccine beliefs and COVID-19 information seeking on social media: Examining processes influencing COVID-19 beliefs and preventative actions. *International Journal of Communication*, *15*, 4252–4274.

Naeem M., Ozuem W. (2022a). Understanding misinformation and rumors that generated panic buying as a social practice during COVID-19 pandemic: Evidence from Twitter, YouTube and focus group interviews. *Information Technology & People, 35*(7), 2140–2166. https://doi.org/10.1108/ITP-01-2021-0061

Newcom (January 28, 2023). *Number of Twitter users in the Netherlands from 2013 to 2023 (in millions)* [Graph]. In Statista. Retrieved October 01, 2024, from www.statista.com/statistics/880865/number-of-twitter-users-in-the-netherlands/

Nielsen, R., Fletcher, R., Newman, N., Brennen, J., & Howard, P. (2020). *Navigating the 'infodemic': How people in six countries access and rate news and information about coronavirus*. Reuters Institute for the Study of Journalism. https://reutersinstitute.politics.ox.ac.uk/infodemic-how-people-six-countries-access-and-rate-news-and-information-about-coronavirus

Pérez-Dasilva, J. A., Meso-Ayerdi, K., & Mendiguren-Galdospín, T. (2020). Fake news y coronavirus: Detección de los principales actores y tendencias a través del análisis de las conversaciones en Twitter [Fake news and coronavirus: Detecting key players and trends through analysis of Twitter conversations]. *El Profesional de la Información, 29*(3), Article e290308. https://doi.org/10.3145/epi.2020.may.08

Powell, A. (2021). COVID and Cuomo: Using the CERC model to evaluate strategic uses of Twitter on pandemic communications. In D. M. Berube (Ed.), *Pandemic communication and resilience* (pp. 107-124). Springer International Publishing.

Radu, R. (2020). Fighting the 'infodemic': Legal responses to COVID-19 disinformation. *Social Media+ Society*, *6*(3). https://doi.org/10.1177/2056305120948190

Ripley, B., Venables, B., Bates, D. M., Hornik, K., Gebhardt, A., Firth, D. (2024). *Support functions and datasets for Venables and Ripley's MASS*. https://cran.r-project.org/web/packages/MASS/MASS.pdf

Rufai, S. R., & Bunce, C. (2020). World leaders' usage of Twitter in response to the COVID-19 pandemic: A content analysis. *Journal of Public Health, 42*(3), 510-516. https://doi.org/10.1093/pubmed/fdaa049

Savadori, L., & Lauriola, M. (2021). Risk perception and protective behaviors during the rise of the COVID-19 outbreak in Italy. *Frontiers in Psychology, 11*, Article 577331. https://doi.org/10.3389/fpsyg.2020.577331

Sellnow, D. D., Lane, D. R., Sellnow, T. L., & Littlefield, R. S. (2017). The IDEA model as a best practice for effective instructional risk and crisis communication. *Communication Studies*, *68*(5), 552-567. https://doi.org/10.1080/10510974.2017.1375535

Sheldon, P., Rauschnabel, P. A., Antony, M. G., & Car, S. (2017). A cross-cultural comparison of Croatian and American social network sites: Exploring cultural differences in motives for Instagram use. *Computers in Human Behavior, 75*, 643-651. https://doi.org/10.1016/j.chb.2017.06.009

Statista (2024a). *Number of users of Twitter in South Korea 2019-2028 (in millions)* [Graph]. In Statista. Retrieved October 01, 2024, from: www.statista.com/statistics/558435/number-of-twitter-users-in-south-korea/

Statista (2024b). *Number of Twitter users in the United States from 2017 to 2022 (in millions)* [Graph]. In Statista. Retrieved October 01, 2024, from: www.statista.com/statistics/232818/active-us-twitter-user-growth/

Tagliacozzo, S., Albrecht, F., & Ganapati, N. E. (2021). International perspectives on COVID-19 communication ecologies: Public health agencies' online communication in Italy, Sweden, and the United States. *American Behavioral Scientist*, *65*(7), 934-955. https://doi.org/10.1177/0002764221992832

te Poel, F., Linn, A. J., Baumgartner, S. E., van Dijk, L., & Smit, E. S. (2021). Sick for information?: Information needs and media use of the Dutch public during the Covid-19 pandemic. *European Journal of Health Communication, 2*(3), 24-43. https://doi.org/10.47368/ejhc.2021.302

Usher, N. & Wong, A. & Raynal, I., Bigman-Galimore, C., & Maslowska, E. (2023). Localizing COVID-19 public health department outreach on digital platforms: The role of discoverability, reach, and moderation for Illinois' COVID-19 vaccination rates. *American Behavioral Scientist.* Advance online publication. https://doi.org/10.1177/00027642231166884

Van Dijck, J., & Alinejad, D. (2020). Social media and trust in scientific expertise: Debating the Covid-19 pandemic in the Netherlands. *Social Media + Society*, *6*(4). https://doi.org/10.1177/2056305120981057

Veil, S. R., Buehner, T., & Palenchar, M. J. (2011). A work-in-process literature review: Incorporating social media in risk and crisis communication. *Journal of contingencies and crisis management*, *19*(2), 110-122. https://doi.org/10.1111/j.1468-5973.2011.00639.x

Voegel, J., & Wachsman, Y. (2022). The effect of culture in containing a pandemic: The case of COVID-19. *Journal of Risk Research*, 25(9), 1075-1084. https://doi.org/10.1080/13669877.2021.1986566

Wildavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why. *Daedalus, 119*(4), 41–60.

World Health Organization. (2017). *Communicating risk in public health emergencies: A WHO guideline for emergency risk communication (ERC) policy and practice*. World Health Organization. https://www.who.int/publications/i/item/9789241550208

Ye, W., Dorantes-Gilardi, R., Xiang, Z., & Aron, L. (2021). COVID-19 Twitter communication of major societal stakeholders: Health institutions, the government, and the news media. *International Journal of Communication*, *15*, 4443–4479.

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