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Public agencies tweeting the COVID-19 pandemic: cross-country comparison of must have and forgotten communication topics

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Introduction: Despite the importance of national-level public health agencies in times of a pandemic, there is limited comparative understanding of their must-have and forgotten pandemic-related communication topics.

Methods: To fill this gap in the literature, this article presents an analysis of COVID-related communication topics by national-level health agencies in Italy, Sweden, and the United States using the IDEA (Internalization, Distribution, Explanation, Action) model on crisis message framing. The public health agencies included in the study are the Italian National Institute of Health (Istituto Superiore di Sanità; ISS), the Public Health Agency of Sweden (Folkhälsomyndigheten), and the Center for Disease Control and Prevention (CDC) in the US.

Results: Based on these agencies' Twitter posts (n = 856) in the first 3 months of the pandemic, the article reveals a greater attention paid to action oriented (e.g., disease prevention) and explanatory messages (e.g., disease trends) than to distribution (e.g., transmission) and internalizing messages (e.g., risk factors) in all three countries. The study also highlights differences in terms of referrals to other communication channels and communication topics, especially in terms of these agencies' emphasis on individual risk factors (related to the risk of a person suffering from serious COVID-19-related health consequences) and social risk factors (related to the chance of an individual to become infected with COVID-19 because of the social context).

Discussion: The study's findings call for better incorporation of information that is directly relevant to the receivers (internalizing messages) by public health agencies.

KEYWORDS

health communication, communication topics, pandemic, cross-country comparison, health agencies, IDEA model

1. Introduction

During health emergencies, public health organizations are called upon to provide timely information to the public on appropriate risk prevention and management behaviors, thus enhancing risk understanding and decision making (Ophir, 2018). The exercise of mapping topics which are given more prominence is relevant since it provides knowledge on the content of public organizations' messages during health emergencies. As demonstrated by Ophir et al. (2021), message framing can have significant consequences in terms of reinforcing some behaviors while discouraging others. Passing on the right information at

the right time may mark the difference between handling or losing control over the spread of the disease.

Recently, the literature that examines the content of risk communication has grown substantially (e.g., Sandell et al., 2013; Barchitta et al., 2015; Bailey et al., 2021). However, research remains centered on single-country studies (e.g., Saxon et al., 2019), missing out cross-country insights (Ophir et al., 2021). It is also mainly limited to messages published in English (e.g., Odlum and Yoon, 2015). Communication is massively influenced by contextual and cultural factors that shape its content, tone and styles and define what messages are more appropriate in certain situations (Masuda and Garvin, 2006). A cross-country analysis of health crisis-related topics would allow for a more comprehensive view of what aspects in health communication transgress social and cultural boundaries and are unequivocally considered as "must have" topics by public health organizations (Niknam et al., 2021). At the same time, cross-country comparison would shed light on the "forgotten" topics, those that remain neglected in this communication.

To address this gap in the public health crises communication literature, we use a cross-country comparative design to investigate the content of public health agencies' communications in Italy, Sweden and the U.S. on Twitter. We explore the content of said communication by investigating which topics are covered and which ones are overlooked in the agencies' tweets over the first 3 months of the pandemic outbreak in each country. The codebook for the analysis builds on the previous literature on messages' content during health crises as well as the theoretical framework offered by the IDEA (Internalization, Distribution, Explanation, Action) Model (Sellnow et al., 2015), which provides guidelines for the framing of effective instructional crisis messages.

In line with previous literature, our results show that preventive messages and disease trends are by far the most addressed topics by all the health agencies. These two message categories fall under the components of explanation and action of the IDEA model, highlighting the importance of explaining the characteristics and diffusion patterns of the virus as well as the actions to reduce the chances of infection. In terms of overlooked contents, we highlight a greater need for transmission and risk factor-related tweets in the early days of the pandemic. Furthermore, we emphasize the importance of addressing the public's both physical and mental health needs. In order to be effective, crisis communication needs better incorporation of information that are directly relevant to the receivers (internalizing messages). Our study also highlights similarities (e.g., lack of attention paid to traditional mass media) and differences (e.g., the Swedish Public Health Agency's frequent invitations to press conferences) across the three contexts in terms of how their Twitter communication refers to other channels of communication (distribution messages).

Methodologically, we introduce a distinction between two risk factor categories: those that address individual factors related to the risk of a person to suffer from serious COVID-19-related health consequences ("severity risk factors" such as having medical pre-conditions) and those that address the social factors that increase the chances of an individual to become infected with COVID-19 ("infection risk factors" such as being in crowded places like conferences or meat packing plants). Such a distinction is important as public health agencies need different strategies to deal with the individual and social factors across countries.

This paper is organized as follows. First, we review the extant literature on messages' contents and framing during public health emergencies to disentangle which categories have been previously utilized by other scholars to conduct the analysis. We then describe the theoretical grounding of our study, the IDEA model, explaining the main results of past research. Based on these, we introduce the codebook used for the analysis. The results of the analysis are interpreted against the IDEA model's instructions for effective risk and crisis communication. In the Section 5, we highlight which topics have received large attention cross-countries and which ones remain neglected. Finally, we provide recommendations to improve risk and crisis messages during health crises.

2. Literature review

Below we present a review of the relevant literature on public health crises structured around three sub-sections: (1) key topics of health-related messages addressed in public debates; (2) contents of public health agencies' online communication; and (3) theoretical grounding of our study.

2.1. Public discourse on public health crises

Prior to the COVID-19 pandemic, the world experienced multiple infectious disease outbreaks (e.g., Zika virus, H1N1, Ebola). One stream of the literature on these outbreaks has focused on how mass media represented these outbreaks (e.g., Huang and Leung, 2005). For example, based on an analysis of 5,006 articles from leading American newspapers covering H1N1, Ebola, and Zika virus epidemics, Ophir (2018) found three main media themes on these diseases: (a) a pandemic theme, centering on organizational response; (b) a scientific theme, focusing on medical and health risks; and (c) a social theme, discussing social/economic disruption. Another literature stream (e.g., Odlum and Yoon, 2015) examined the public discourse emerging online (e.g., on social media platforms) on diseases. While some of these studies (e.g., Odlum and Yoon, 2015) analyzed the Twitter disease contents on a global scale, others (Chew and Eysenbach, 2010) had a narrower geographical focus. In terms of communication topics, the public discourse mainly pertained to risk factors (e.g., cause, transmission, infection), prevention education (prevention methods, signs, symptoms), disease trends (i.e., spread and location), and compassion (e.g., prayers) (Odlum and Yoon, 2015). There were also accounts of personal experiences and tweets expressing humors, concerns, and questions about the outbreaks (Chew and Eysenbach, 2010).

The emerging literature on the COVID-19 outbreak has contributed significantly to the earlier literature on the public health crisis. Similar to Ophir (2018), Ophir et al. (2021) identified three main COVID-19 themes featured in Italian newspapers: a scientific frame (symptoms and health effects), a containment frame (e.g., seriousness of the disease and the required policies to mitigate risks) and a social frame (e.g., political and social impact).

Moving attention to COVID-19 public discourse in online social media (Weibo) in China, Zhu et al. (2020) revealed that there was a great deal of discussion around how the disease emerged and how its spread was kept under control. In the context of Instagram in Iran, Niknam et al. (2021) found two core COVID-19 themes, namely "diagnosis and treatment" and "general prevention guidelines", besides the disease epidemiology, disease trends, the socio-cultural impacts of the pandemic, the condition of the healthcare system, and the economic concerns. Studies conducted in other countries confirmed the importance of these topics across diverse social media platforms (e.g., Han et al., 2020; Kouzy et al., 2020; Stechemesser et al., 2020; Abd-Alrazaq et al., 2021).

In terms of the global coverage of COVID-19 topics, discourses around the origin and source of the virus were widespread on Twitter (Abd-Alrazaq et al., 2021) and were often presented with racist undertones (Stechemesser et al., 2020). The pandemic's impact on the people and countries (e.g., number of deaths, fear and stress, effects of travel bans, economic impacts, and panic buying) and the methods for slowing the spread of COVID-19 (quarantine measures, wearing face masks) received much attention in the literature (Rao et al., 2020; Abd-Alrazaq et al., 2021). However, cross-countries studies are rare. One exception is Garcia and Berton (2021), which focused on the content of crisis communication in Brazil and the U.S. This study noted that case reports/statistics, economic impacts, proliferation care, treatment, politics, entertainment, and sports were frequently discussed in both the countries. Rather than on the type of subjects discussed, the difference stood on the weight given on each topic in each country. While the economic impacts were most frequently mentioned in the U.S., a greater attention was given to proliferation care (e.g., how to prevent the spread) in Brazil.

2.2. Public health agencies' online communication

Despite the importance of public health agencies' communication in times of a pandemic (Sutton, 2018), the literature on what public health agencies communicate or not communicate across different contexts (and through which channels of communication) is rather limited. The exceptions include Raamkumar et al. (2020), Malik et al. (2021), and Kompani et al. (2022) which had an international focus, and Sutton et al. (2020) with a focus on different levels of governments in the U.S. Most of these studies examined social media-mediated official communications. Indeed, these new communication technologies have become paramount in emergency and disaster communication (Hughes and Palen, 2012; Reuter et al., 2018), despite the multitude of challenges faced by emergency managers when using these channels for scope beyond the mere dissemination of messages (e.g., raising and obtaining situational awareness, and two-way communication) (Reuter and Kaufhold, 2018). These challenges include, for instance, information overload, lack of dedicated staff and difficulty to filter out rumors and inaccurate information, and lack of specific organizational policies (Plotnick and Hiltz, 2016).

Malik et al. (2021) compared the contents of Instagram communication by four health organizations (International Federation of Red Cross and Red Crescent, the Center for Disease Control and Prevention—CDC in U.S., National Health Systems in U.K. and the World Health Organization) during the initial phase of the COVID-19 pandemic. This study found that most COVID-19 messages were about personal preventive measures and mitigation, followed by general advisory and vigilance (e.g., alerts, tips, or cautions to help public and entities responding to the pandemic), showing gratitude and resilience and social/common responsibility and empathy. Few messages covered aspects related to symptoms and transmission, and clarifications (e.g., addressing misconceptions, myths, and fake news, etc.). Raamkumar et al. (2020) examined posts and comments from the Facebook pages of the Ministry of Health in Singapore, the CDC in the United States, and Public Health England. The analysis revealed that posts in Singapore were more diverse and were related to preventive measures, travel advisories, disease information, falsehood correction, and appreciation for health care workers and other frontline staff. The attention to myth debunking was also evident in Singapore but lacking in the U.S. and England, where public health agencies emphasized preventive measures.

Sutton et al. (2020) made a longitudinal analysis of the tweets released in the initial days of the pandemic by the agencies involved in public health messaging at multiple levels (including emergency management organizations and public health entities) in the U.S. The subject of these agencies' communication varied across distinct periods and revolved around communicating information, promoting individual and collective actions, sustaining motivation, and setting social norms. As the time progressed, new COVID-19 topics emerged, such as attention to its economic and mental health impacts. More recently, Kompani et al. (2022) analyzed 1,633 COVID-19-related from health authorities in Germany, Norway, Sweden, Switzerland, and the U.K. through different pandemic stages (e.g., pre-pandemic, first lockdown, post-lockdowns, return of restrictions). The authors noticed that themes like long COVID-19 or exercising were communicated infrequently across all the nations during the pandemic. They also highlighted a difference in the type of messages posted between the social media platforms with the noticeable case of Twitter that was used for posting links and informing about press conferences. In the pre-pandemic phase (Jan 1–March 11, 2020), the five most frequently communicated themes were case reports, handwashing, press conferences, external sources of information, and symptoms. During the first lockdowns (March 12–May 10, 2020), attention shifted to messages about staying at home and social distancing. In the post-lockdown periods (May 11–September 14, 2020), stay-at-home messages were less relevant whilst stress was given to handwashing, wearing facemasks, social distancing and common responsibility. In the return of restrictions phase (September 15–December 31, 2020), there was reintroduction of certain restrictive measures after resurgence of cases. However, after the rolling of COVID-19 vaccination began, many posts were dedicated to this theme. Kompani et al.'s (2022) study demonstrated that messages' contents during a pandemic can vary depending on the stages of the pandemic.

Berg et al. (2022) conducted a study to generate a list of the key topics concerning COVID-19 to be communicated to the public in the opinion of experts in Norway. These authors divided the emergent topics into three macro-categories: (1) how the virus enters the human body and generates the disease; (2) how to protect oneself and others from being infected; and (3) pandemic health risk for the individual and the society. The first macro-theme is further divided up into two sub-categories: modes of virus transmission and virus and immunity (e.g., virus characteristics). The second macro-theme includes infection prevention at the individual level (e.g., few close contacts, hand hygiene, and testing.) and infection prevention at the group level (e.g., risky activities, COVID-19 shame). The third theme was related to three sub-themes: solidarity, control of the spread (e.g., situational reports, and replication number etc.), and risk trade-offs (e.g., primary vs. secondary consequences).

2.3. Theoretical grounding

Many theoretical frameworks exist that deal with how communication practices should be implemented during crises and disasters [see, for example, the Crisis and Risk Communication (CERC) model; Miller et al., 2021]. However, most of these frameworks focus on general crisis and risk communication principles, without providing clear instructions on message framing, that is, which aspects and topics need to be conveyed in communication. One noticeable exception is provided by the IDEA Model (Sellnow et al., 2015). The IDEA model divides message framing into four components: internalization, distribution, explanation, action. Internationalization, explanation and action components make clear reference to the themes that need to be included in the messages whilst the distribution component refers to the channels through which the messages have to be distributed. Internalization refers to the impacts of the crises and the relevance of these impacts at personal and individual level (e.g., how am I or my loved ones going to be impacted?). Explanation includes elements related to the characteristics of the crisis that need to be communicated to a non-scientific audience (e.g., what is happening and why?). Action relates to what needs to be done to reduce the risk and stay safe (e.g., What to do/not to do?). According to this model, in order to be effective, crisis communication needs to include the aspects of internalization, explanation, and action. It also should be distributed through appropriate communication channels to reach the intended audience (distribution component).

The IDEA model was proven to be effective in many different crises, such as Hurricane Katrina (e.g., Sellnow et al., 2017). It was also applied to risk and crisis communication during public health emergencies, including the Ebola crisis and the COVID-19 pandemic. As outlined by Sellnow-Richmond et al. (2018, p. 149),

> In the case of a health crisis event, effective instructional risk messages would include mention of the potential effects of the disease on people who become infected, how much time one has to notice symptoms and to seek medical help, and where the disease is appearing (internalization). Such messages would also explain what the disease is and how it is contracted in simple, nonscientific language (explanation). Finally, such messages would propose specific actions to take (or not to take) to avoid contracting the disease as well as what to do (or not to do) if one has been exposed to an infected individual or is experiencing any of the symptoms (action).

Utilizing the IDEA model, Sellnow-Richmond et al. (2018), for example, examined the health-related messages issued locally (by a local newspaper), nationally (by the CDC) and internationally (by WHO) during the Ebola crisis in Texas in 2014 (the infection and death of Liberian national Thomas Eric Duncan in Dallas, Texas). This study revealed that most of the Ebola messages privileged explanation over action and internalization. Conversely, Salazar (2021) noted that the messages on the CDC's "Holiday Celebrations and Small Gatherings" website during the COVID-19 pandemic focused more on internalization and action than on explanation and distribution.

In his IDEA model for Instructional Health Risk and Crisis Communication (IHRCC), Bang (2021) partially revisited the original IDEA model, using the component "distribution" to refer to messages on COVID-19 virus symptoms and infection and virus transmission in Cameroon. This study characterized the coverage of internalization messages (e.g., on timeliness, compassion, and impact) in the country as poor, distribution and explanation messages as fair, and action messages as mediocre.

3. Study context and method

To address the gaps in the literature, we study public health agencies' COVID-19 communication content in three different countries (Italy, Sweden, and the U.S.) and in three different languages (Italian, Swedish, and English). The public health agencies included in the study are: the Italian National Institute of Health (Istituto Superiore di Sanità; ISS), the Public Health Agency of Sweden (Folkhälsomyndigheten), and the Center for Disease Control and Prevention (CDC) in the U.S. (see Tagliacozzo et al., 2021 for details on these agencies). Examining these agencies' communication topics presents an interesting comparison as each country had a different strategy to cope with the COVID-19 pandemic, ranging from a country-wide lockdown (Italy) to almost no restrictions in societal sectors (Sweden) to a range of COVID policies adopted across different states (U.S.). Due to differences in political cultures and bureaucracies across the three countries, we expected to find country-specific patterns of online communication. At the same time, we anticipated similarities across the communication topics discussed or not discussed by public agencies, in part due to their similar missions.

To study COVID-19 related communication topics, we conducted content analysis of public health agencies' 856 tweets in the first 3 months of the pandemic, beginning in each country when community transmission of COVID-19 was confirmed. For Italy, we studied 123 tweets published between 21 February and 21 May 2020. In Sweden, we examined 124 tweets in the period 10 March to 10 June 2020. For the U.S., we looked at 609 tweets published

TABLE 1 Topics in communication during health emergencies by IDEA model categories.

Topic	Definition	Examples
Internalization		
Severity risk factors (individual)	Information regarding factors that increase the chance of suffering serious consequences (e.g., severe illness or death) from COVID-19 infection such as elderly age and people with pre-conditions (e.g., diabetes, asthma, obesity)	Prepare for the possible spread of #COVID19 in your community. Preparation is especially important for older adults and people with underlying medical conditions. Learn what actions you should take: https://t.co/SlDrVXXfCz. https://t.co/ORuZeFGb1D (CDC, 20 March 2020)
Infection risk factors (social)	Information regarding factors that increase the chance of getting infected with COVID-19 (e.g., certain workplaces/roles such as supermarkets, meat factories or, being in crowded places such as attending conferences or being on cruise ships)	CDC continues to advise travelers to avoid all non-essential international travel. Travel increases your chances of getting and spreading #COVID19. Learn more: https://t.co/hrPVGhnQ6V; https://t.co/s6bbaEfDlS (CDC, 22 May 2020)
Symptoms	Information regarding COVID-19 symptoms such as fever, cough etc. and how to recognize them, including long-term effects/symptoms	Maintaining normal #VitD levels could be important in treating two typical symptoms of #Covid19, such as loss of smell and taste. To learn more, read here: https://t.co/NWLc5GwFiB (ISS, 21 May 2020)
Mental wellbeing	Information regarding how to maintain mental wellbeing during the pandemic (e.g., coping with stress or social distancing, dealing with worries)	In the midst of the #COVID19 pandemic, it's understandable that many Americans may experience heightened stress or anxiety, affecting our thoughts and emotions. Here, are 5 things to know about staying mentally healthy. https://t.co/q1RMjQuMQ7 #MentalHealthAwarenessMonth https://t.co/RSRMx4uL5R
Physical wellbeing	Information regarding how to maintain physical wellbeing during the pandemic (e.g., exercise, non-COVID-related healthcare such as checkups and regular doctor visits)	It is vital that your child is up to date with their recommended childhood #vaccines. Ask your doctor about what they do to ensure safe well-child visits. https://t.co/AR7356yU5p; https://t.co/2MuoFvwJBg
Concurrences	Concurrent risks for or impacts by other crises or disasters (e.g., natural hazards), diseases (e.g., flu) or other medical emergencies during the COVID-19 pandemic	Food disturbances can get worse during the #COVID19 #pandemic. This year health centers go on the map thanks to the project #Manual from ISS and @MinistryofHealth (ISS, 6 May 2020)
Distribution		
Online platforms	Identification of online platforms (e.g., YouTube, Twitter, Facebook, WhatsApp, Email, E-Newsletter, and Blog) for distributing COVID-19 and its risk messages	President @s_brusaferro: The measures have been taken to contain the circulation of the virus, awareness and responsibility are key factors without which the measures are ineffective #coronavirus watch live at Facebook https://t.co/K2yNrlqzAT (ISS, 5 March 2020)
Phone platforms	Identification of phone-based platforms (e.g., call, hotline, text, app) for distributing COVID-19 and its risk messages	Everyone reacts differently to stressful situations like #COVID19. You may feel anxiousness, anger, sadness, or overwhelmed. If you or a loved one is feeling overwhelmed, get support 24/7 by calling 1-800-985-5990 or text TalkWithUs to 66746. https://t.co/6MgWoJ2pmy (CDC, 21 March 2020)
Traditional media	Identification of traditional media platforms (e.g., radio, TV, and news) for distributing COVID-19 and its risk messages	The American people have embraced the #socialdistancing guidance that CDC put out and it will be critical that we continue thoughtful mitigation steps to slow the spread of #COVID19 as we begin to bring our country back to work: https://t.co/HVRI7fa2Jc @FoxNews (CDC, 13 April 2020)
Press conference/briefing	Identification of press conferences/briefings for distributing COVID-19 and its risk messages	Invitation to press conference on COVID-19, 25th March at 14:00 - Public Health Agency https://t.co/djG4AZ6JoL (Swedish Health Agency, 25 March 2020)
Press/news release	Identification of press or news releases for distributing COVID-19 and its risk messages	The #Coronavirus mortality to date is 5.8% higher in men. The average age is 80. Read the ISS report on the characteristics of patients who died after testing positive for #covid19. Read the press release https://t.co/NvcKcoicwJ (ISS, 13 March 2020)
Explanation		
Transmission	information on how the COVID-19 virus gets/does not get transmitted to humans (excluding transmission to pets)	# COVID19 and # atmospheric pollution: #Pulvirus, the joint research project @ENEAOfficial @istsupsan and @SNPAmbiente to offer answers and indications on the interactions (ISS, 30 April, 2020)
Disease trends	information about patterns of virus spread, figures of deaths and of people infected locally, regionally, nationally, or internationally	New COVID-NET data reported more than 6,000 #COVID19 hospitalizations. Of these, almost 2,000 had race/ethnicity info. When compared to residents in COVID-NET counties, Non-Hispanic black people were disproportionately affected by COVID-19 hospitalizations https://t.co/dTvhftTxuV; https://t.co/cei7elmBM7
Addressing misinformation	Information to address or correct inaccurate or false information and for myth bursting. It also includes clarifications about common doubts (e.g., infections through pet).	We have found errors in the report and now the authors go through the material again. We publish the report again as soon as this is done (Swedish Health Agency, 22 April 2020).
Testing	Information on whether, how and where to get tested for COVID-19 infection, the types of tests available	#DYK In the context of @NATO_SPS and are leading a scientific project to develop enhanced diagnosis capabilities for #Covid19 (ISS, 6 May 2020).

(Continued)

TABLE 1 (Continued)

Topic	Definition	Examples
Vaccine	Information regarding COVID-19 vaccines and vaccine development	The Public Health Agency is commissioned by the government to develop a plan for vaccination against COVID-19. "We are far from having a vaccine that is ready-for-use, but once we do, it is important to have a plan of e.g., who should be vaccinated first", says director general Johan Carlson. https://t.co/6Avq5L0wxf (Swedish Health Agency, 20 March 2020)
Action		
Prevention	Information regarding appropriate behaviors to prevent infecting oneself or other humans with COVID-19, e.g., avoiding crowds, avoiding travels, wearing masks, staying at home	Proper #IndoorAir quality management is another effective defense tool against #CORONAVIRUS #IndoorAir #indoor pollution #iaq #health #health #prevention #indoorair #GroupStudioNationalIndoor pollution @istsupsan https://t.co/5NzTODITAM (ISS, 13 March 2020)
Treatment	Information on treatments available in case of infection with or new possible treatments of COVID-19	@US_FDA and @HHSgov encourage those who have fully recovered from #COVID19 to contact your local blood or plasma donation center and arrange an appointment to #DonateCOVIDplasma. Your donation can help others recover from the virus. #DonatePlasma More: https://t.co/RNnhUhrQVj (CDC, 22 April 2020)
Other		
Other	Information on other aspects related to the pandemic, e.g., webinars, training, press conferences, scientific information about the virus, acknowledgments. Also includes tweets that cannot be coded under any of the remaining categories because the phrasing is too vague (general information).	Translated into music part of the # SARSCov2 genome Listen to the song on the ISS youtube channel https://t.co/BJCii0WbG7 (ISS) The Public Health Agency asks for the swift reallocation of pesticide management responsibility due to the pandemic—Public Health Agency https://t.co/ZzECL5GvK5 (Sweden) New rules for restaurants and pubs—Public Health Agency https://t.co/qgqItca2ZP (SWEDEN) Thank you to all dialysis staff protecting vulnerable patients from #COVID19. CDC's new training webinars can help to prevent the spread in your facility. https://t.co/h4lFRh0Xpo; https://t.co/HHswY1WW6a (CDC)

in the time window from 26 February to 26 May 2020. This data selection increases comparability between the cases because the data from all countries corresponds to the same stage in crisis management.

We translated the tweets from the Italian and Swedish agencies into English. One person carried out the initial coding for IDEA model's internalization, explanation, action components while another person coded the model's distribution component. The coders then discussed unclear cases collaboratively with the co-authors of this article. In cases of disagreement, the team accepted the recommendations of the person who was most familiar with that particular context. Following a deductive approach, the construction of the codebook built mainly on the categories of topics highlighted in previous research on messages' contents in health emergencies (see Section 2). However, we also used an inductive approach, creating new categories as new relevant topics emerged during the analysis. The resulting codebook is shown in Table 1. Except for the "Other" category, our coding categories were not mutually exclusive. Where relevant, we coded multiple topics for each tweet as a single message can convey multiple types of information. For example, the following tweet describes both the individual risk factors and the COVID-19 symptoms: "#Caregivers: Older adults and people with severe chronic health conditions may be at higher risk for more serious #COVID19 illness. Watch for symptoms such as fever, cough, and shortness of breath, and for emergency warning signs. Find out more: https://t.co/SlDrVXXfCz. https://t.co/dwOfVZ1GKD" (CDC, 12 March 2020).

In terms of our methodological contributions to the literature, we did create new topic categories for risk factors and wellbeing. Our newly created risk factors topic was further divided into individual risk factors (e.g., factors that increase the chance of suffering serious consequences from the virus such as asthma, also called "severity risk factors") and social risk factors (e.g., factors that increase the chance of getting infected with COVID-19 such as working in a supermarket, labeled as "infection risk factors"). This diction partially reflects the distinction made by Berg et al. (2022) between infection prevention at individual level (e.g., few close contacts, hand hygiene, testing, etc.) and infection prevention at group level (e.g., risky activities). However, its focus is on the risk factors rather than on prevention *per se*. Such a distinction in risk factors is necessary to unveil the attention given to different types of vulnerability: the one that refers to a person's characteristics (individual vulnerability) and the one deriving from the social context where the individual works and lives (social vulnerability). As for the wellbeing category, our sub-categories included physical and mental wellbeing. This distinction permits us to examine whether both the dimensions of wellbeing are considered in the message framing. Finally, the "other" category included tweets that could not be coded under any of the four components of the IDEA model or included general information. Among these tweets, there were also acknowledgments written in appreciation of the efforts of public health workers and first responders.

Content categories were then grouped based on the four components of the IDEA model (internalization, distribution,

TABLE 2 Communication topics' frequency in tweets by public health agencies.

	Italy (%)	Sweden (%)	U.S. (%)
Internalization			
Individual risk factors (severity)	4.9	2.4	7.4
Social risk factors (infection)	3.3	5.7	4.6
Risk factors (combined)	8.2	8.1	12
Symptoms	3.3	2.4	2.3
Mental wellbeing	4.1	0	8.5
Physical wellbeing	6.5	3.2	4.9
Wellbeing (combined)	10.6	3.2	13.4
Concurrences	3.3	0	1.6
Distribution			
Online platforms	6.5	0.8	6.4
Phone platforms	3.3	2.4	4.4
Traditional media	0	0.8	0.8
Press conference/briefing	4.1	31.5	0.5
Press/news release	5.7	0	0.3
Explanation			
Transmission	6.5	0	3.5
Disease trends	21.1	11.3	11.8
Addressing misinformation	12.2	6.5	4.4
Testing	3.3	8.9	3.6
Vaccine	0	0.8	0
Action			
Prevention	38.2	31.5	56.3
Treatment	4.1	0	2.5
Other			
Other	11.4	11.3	10

TABLE 3 Public health agencies' communication topics ranked within each IDEA category.

	Italy	Sweden	U.S.
Internalization	- Wellbeing (esp. physical wellbeing) - Risk factors (esp. individual) - Symptoms - Concurrences	- Risk factors (esp. social) - Wellbeing (esp. physical wellbeing) - Symptoms - Concurrences	- Wellbeing (esp. mental wellbeing) - Risk factors (esp. individual) - Symptoms - Concurrences
Distribution	- Online platforms - Press/news releases - Press conference/ briefing - Phone platforms - Traditional media	- Press conference/ briefing - Phone platforms - Online platforms and traditional media - Press/news release	- Online platforms - Phone platforms - Traditional media - Press conference/ briefing - Press/news release
Explanation	- Disease trends - Addressing misinformation - Transmission - Testing - Vaccine	- Disease trends - Testing - Addressing misinformation - Vaccine - Transmission	- Disease Trends - Addressing misinformation - Testing - Transmission - Vaccine
Action	- Prevention - Treatment	- Prevention - Treatment	- Prevention - Treatment

explanation, and action). In particular, the component internalization that reflects the impacts of the virus on oneself or loved ones, included topics concerning the risk factors (individual and social), the personal wellbeing (mental and physical), the manifestation of the symptoms and the presence of concurrent hazards (e.g., co-morbidities, flu pandemic, etc.). Although this study examined public health agencies' communication distributed through Twitter, some of their tweets referred to other communication channels. Hence, the component distribution included online platforms (e.g., YouTube, Facebook), phone platforms (e.g., hotline, text, app), traditional media outlets (e.g., radio, TV, news), press conferences/briefings, and press/news releases. The component explanation involved the topics related to the modes of transmission, the disease trends, how to get tested, the development of COVID-19 vaccine, and the dispel of myths and incorrect information. The component action encompassed topics concerning how to prevent and treatment options in case of infection.

4. Results

Here we present the results of the analysis divided by country. First, we present an analysis of the content disaggregated by topic. Table 2 provides an overview of the frequency of all studied communication topics in each country. Then we highlight the most represented components in the message framing based on the IDEA model (Table 3).

4.1. Italy

In the *internalization* category, the Italian National Institute of Health (Istituto Superiore di Sanità; ISS) dedicated 10.6% tweets to wellbeing, most of which were on physical wellbeing (6.5%) than on mental wellbeing (4.1%). Risk factor tweets came next, accounting for 8.1% of the messages, with individual/severity risk factors being slightly more represented than social/infection risk factors (respectively, 4.9 and 3.3%). Symptoms and concurrencies received the least attention in this category (with 3.3% each). The agency's tweets referred also to other *distribution* channels. These channels included online platforms (6.5%), press/news releases (5.7%), press conference/briefings (4.1%), and phone platforms (3.3%). Unlike other distribution channels, traditional media was not mentioned

by the ISS during the study period. Under *explanation*, most of the tweets fell under the disease trends topic (21.1%), followed by addressing misinformation (12.2%). A smaller percentage of posts were on transmission (6.5%) and testing (3.3%). There were no vaccine related tweets. In terms of *action*, the ISS had more tweets on prevention (38.2%) than treatment (4.1%).

The tweets that fell under the "Other" category (11.4%) mostly included tweets related to general information and clarification of terminologies. An example of terminology related tweets is the following: "*What is a 'close contact'? And an 'asymptomatic person'? The keywords of the #coronavirus epidemic in the glossary of the ISS*" (February 25, 2020).

4.2. Sweden

The largest percentage of Sweden's Public Health Agency *internalization* communication fell under risk factors (8.1%). Risk factor tweets mainly dealt with social risk factors (5.7%) rather than individual risk factors (2.4%). 3.2% of Public Health Agency's tweets were on wellbeing (none of which were on mental health) while 2.4% touched upon COVID-19 symptoms. There was no tweet that dealt with the topic of concurrences. Under the *distribution* category, the agency's tweets primarily included invitations to Press Conferences/Briefings (31.5%) (see Table 1 for an example post). The rest of the distribution outlets received little [i.e., the phone platforms (2.4%), online platforms (0.8%) and traditional media (0.8%)] to no attention (press/news release) from the agency. In terms of *explanation*, the agency paid the most attention to disease trends (11.3%), followed by testing (8.9%) and addressing misinformation (6.5%). It is important to note that some of these misinformation tweets went beyond misinformation about the COVID-19 virus; they were acknowledgments of the agency's mistakes. One tweet, for example, noted, "*We have found errors in the report and now the authors go through the material again. We publish the report again as soon as this is done*" (April 22, 2020). The subject of vaccine constituted <1% of agency's tweets while the agency did not mention transmission in any of its tweets. In the *action* category, the agency's exclusive focus was prevention (31.5%), with no tweets being dedicated to the topic of treatment.

In the Swedish case, the "Other" category covered 11.3% of all tweets. Under this category, most tweets provided general information on COVID-19, as in the example of "*The Public Health Agency asks for the swift reallocation of pesticide management responsibility due to the pandemic" (April 24, 2020).*

4.3. U.S.

CDC devoted the majority of its *internationalization* communication to the wellbeing (13.4%) category. A greater share of wellbeing tweets was on mental wellbeing (8.5%) as opposed to physical wellbeing (4.9%). The next largest category was the risk factors (12%). The agency had more individual risk factor tweets (7.4%) than social risk factors ones (4.6%). Tweets related to symptoms and concurrencies constituted a small percentage of the agency's tweets (2.3 and 1.6%, respectively). As in the case of Italian and Swedish agencies, CDC's tweets alluded to other *distribution* channels. The agency mentioned online (6.4%) and phone (4.4%) platforms the most while mentioning the traditional media (0.8%), press conferences/ briefings (0.5%), and press/news releases (0.3%) the least. In terms of the *explanation* category, CDC paid a relatively greater attention to disease trends (11.8%) than to addressing misinformation (4.4%), testing (3.6%) and transmission (3.5%). There were no tweets related to vaccines during the 3-month period. CDC tweets that fell under the *action* category mostly dealt with prevention (56.3%), followed by treatment (2.5%).

CDC tweets that fell under the "Other" category (10%) varied in terms of their topics, including acknowledging the efforts of CDC staff or the public in dealing with pandemic, general information about the pandemic, and the re-opening of businesses. An example to an acknowledgment tweet in the "Other" category is the following: "*I would like to recognize the tireless commitment of CDC staff who have deployed all over the US to fight #COVID19. Technical expertise and public service are the backbone of CDC's contribution to the COVID-19 response.*" (May 12, 2020).

4.4. Cross-case comparison

Under the IDEA model, we identified several similarities and differences in the topics public health agencies regarded as must have topics and the topics they overlooked in the early stages of the pandemic (see Table 3) as well as in the channels through which they communicated these topics. Since our communication topic categories were not mutually exclusive, we discuss these similarities and differences across each communication topic (e.g., prevention) and in terms of the ranking of communication topics within each IDEA model category (e.g., 1. Prevention; 2. Treatment in the Action category) without providing the aggregate totals for each IDEA model category.

Within IDEA model's *internalization* category, wellbeing and risk factor topics (each as a combined group) received the most attention from all three public health agencies. However, wellbeing ranked first in Italy (10.6%) and the U.S. (13.4%) whereas it ranked second in Sweden. The overall emphasis given to wellbeing in Sweden was much less than its counterparts (3.2%). The top ranked topic in Sweden was risk factors (8.1%). There were also differences within wellbeing and risk factor topics. In terms of wellbeing, it is worth noting the major emphasis given to mental wellbeing in the U.S. (8.5%) and its total absence in Swedish messages (Figure 1). In the mental wellbeing category, Italy was in between (4.1%) while focusing more on physical wellbeing (as in the case of Sweden). In terms of risk factors (Figure 2), public health agencies' focus in Italy and the U.S. was on messages related to individual risk factors (4.9 and 7.4%, respectively) whereas the agency in Sweden preferred to communicate more on social risk factors compared to individual risk factors (2.4%). The three agencies gave similar emphasis to COVID-19 symptoms (2.3–3.3%). Concurrences received more attention in Italy (3.3%) as opposed to little (U.S.) to no attention (Sweden) in the other contexts.

As far as the *distribution* category is concerned, there was a major difference between how the Swedish agency referred to other communication platforms than its counterparts in Sweden

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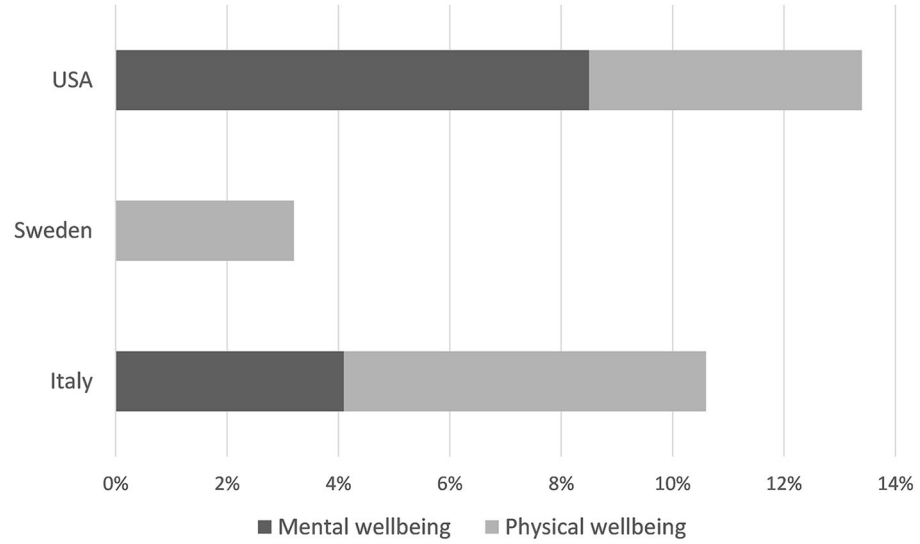

FIGURE 1
Mental and physical wellbeing related messages in Sweden, U.S., and Italy.

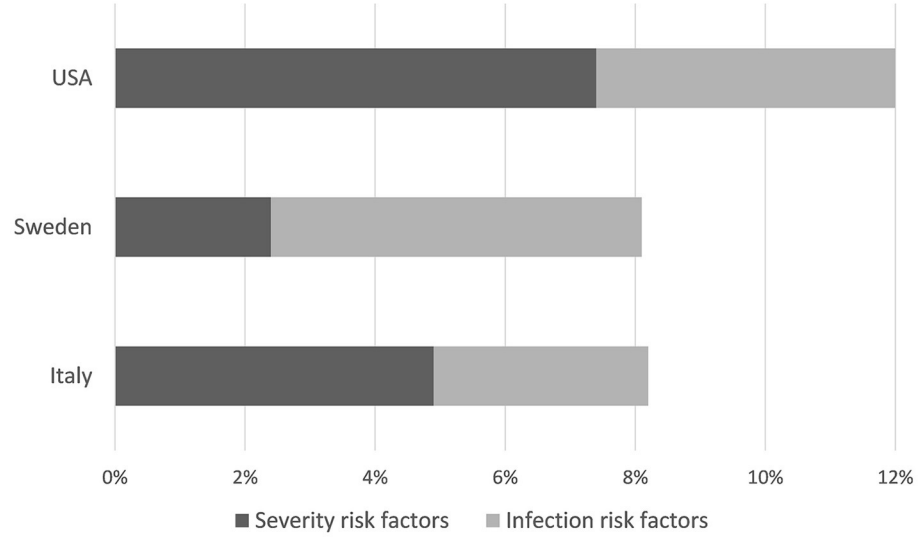

FIGURE 2
Severity and infection risk factors related messages in Sweden, U.S., and Italy.

and the U.S. Despite the use of Twitter by the Swedish Public Health Agency, almost one third of this agency's tweets directed the Twitter audience to press conferences or briefings. Tweets that mentioned such events was less than 5% in Italy and the U.S. (4.1 and 0.5%, respectively). Another major difference in this IDEA model category related to how the ISS utilized press/news releases (5.7%) compared to Sweden (0.3%) and the U.S. (0%). There were similarities in terms of how the ISS (6.5%) and the CDC (6.4%) mentioned other online platforms (e.g., Facebook, YouTube), compared to the Swedish Public Health Agency (0.8%). Traditional media received the little to no attention (0–0.8%) across the three contexts.

The emphasis given to communication topics within the *explanation* category was similar. Disease trends was the top ranked topic across the three contexts although the percentage of ISS's messages on this topic (21.1%) was twice the percentage of its counterparts' messages (11.3% in Sweden and 11.8% in the U.S.). Tweets addressing misinformation ranked either the second (Italy and the U.S.) or the third (Sweden) in the explanation category. The percentage of ISS's misinformation focused tweets (12.2%) was two to three times the percentage of tweets by the Swedish Public Health Agency (6.5%) and the CDC (4.4%), however. In Sweden, testing (8.9%) ranked ahead of misinformation while receiving much less attention in Italy and the U.S. (3.3 to 3.6%, respectively). Public

health agencies in the three countries pursued different strategies in terms of addressing COVID-19 transmission. This topic received the most attention in Italy (6.5%) and the least attention in Sweden (0%), with U.S. being in the middle (3.5%). Across the board, vaccine received no (Italy, U.S.) to little attention (0.8% in Sweden).

In terms of overall IDEA model categories, the priorities of public agencies across the three contexts were the same in the *action* category, where prevention was the leading topic, followed by treatment (although none of the Swedish tweets mentioned treatment). The CDC, however, had a much higher percentage of prevention focused tweets (56.3%) than Italy (38.2%) and Sweden (31.5%). Treatment constituted a small percentage of overall tweets in Italy (4.1%) and the U.S. (2.5%).

The messages that fell under the "Other" category constituted approximately 10–11% of public health agencies' tweets across the three contexts. Most of these tweets in Italy and Sweden touched upon general information and/or clarification of terminologies whereas the U.S. tweets acknowledged the efforts of public health personnel and the public in dealing with or trying to "stop" the virus, among others (e.g., business re-openings).

5. Discussion

Our study illustrated that public health agencies across the three contexts considered select COVID-19 topics as must have topics in their Twitter communication, especially those that fell under the IDEA model's *internationalization*, *explanation*, and *action* categories. These topics involved wellbeing and risk factors in the *internationalization* category (despite within subject group differences); disease trends and addressing misinformation in the *explanation* category, and prevention in the *action* category. The rather overlooked topics were symptoms and concurrences in the *internationalization* category; vaccine and transmission in the *explanation* category; and treatment in the *action* category. Of the four categories of the IDEA model, our study demonstrated a significant difference in how public health agencies' Twitter messages referred to other channels of communication (*distribution*). We elaborate on each of these topics below in the context of prior studies.

5.1. Internationalization

Despite the overall emphasis given to wellbeing and risk factors across the three contexts, different aspects of wellbeing were emphasized in the U.S. (mental health of the general public through supportive messages) vs. Italy and Sweden (physical health). The CDC's greater emphasis on promoting mental health might have been due to the agency's concerns regarding the public's mental health (e.g., increased mental health search queries) prior to the issuance of stay-at-home orders, as revealed by Jacobson et al. (2020). The absence of mental wellbeing messages in Sweden might have been due to the Public Health Agency's assumption that the mental health issues were less relevant for the Swedish population due to the country's less restrictive COVID-19 policies (Claeson and Hanson, 2021), as revealed in their public statements.

While the primary mission of health agencies rests on mitigating public health threats, health crises and the measures undertaken to manage these crises can produce side effects that can be equally detrimental for the individual and collective wellbeing. This is demonstrated by the fact that, as the time passes, the public and the mass media shift their attention rapidly to the social, economic and political impacts of the crisis (e.g., Rao et al., 2020; Zhu et al., 2020). As highlighted by Berg et al. (2022), it is essential to explain the risk trade-offs between primary and secondary consequences of public health decisions clearly. For public health agencies, neglecting these consequences could imply that the messages around prevention and mitigation could become less effective as the public concerns start revolving around other topics that are left unaddressed by public health agencies' communication.

The emphasis given to social risk factors in Sweden as opposed to Italy and the U.S. might be explained by the country's decision to avoid lockdown measures. Indeed, the Swedish health agency confronted the need to assist people and companies in navigating spaces that were open to decrease risks of infection and thus preferred "situational" communication. Conversely, in Italy and the U.S., where most of the public and private facilities were shut down, messages related to individual risk factors were predominant and more frequently addressed to groups at risk (e.g., people with pre-conditions; see Tagliacozzo et al., 2021).

Limited attention given to COVID-19 symptoms in Italy, Sweden and the U.S. might reflect the fact that there were significant delays in compiling a complete list of COVID-19 symptoms in the initial stages of the pandemic (Zolbanin et al., 2021). However, it is evident that the public needs information about what symptoms can signal the infection and what vectors can carry the disease from one host to another to contain the spread of the disease (Berg et al., 2022). As for the concurrences, while the latest research promotes an approach that considers concurrent and cascading risks in disaster management (e.g., Collier et al., 2020), lack of attention given by public health agencies in all the three countries to concurrent risks during the COVID pandemic suggest that risk management is approached one risk at the time.

5.2. Distribution

The Swedish Public Health Agency's use of Twitter to invite the general public to press conferences reflected a different communication approach than the approach followed by its counterparts in Italy and the U.S. via Twitter. Josefsson (2021) confirmed the importance of press conferences for the Public Health Agency by noting that the agency held more than 100 press conferences (1 h long) from March to October 2020. This study also noted the importance of press conferences for the public to track the progression of the pandemic and the government's policies to deal with the pandemic in addition to the public having their questions answered by experts in an open forum for debate.

Little to no references to traditional media outlets in public health agencies' Twitter communication was expected. Unlike prior pandemics (e.g., SARS in 2003 and the H1N1 in 2009) during which information was mainly distributed through TV, radio and print media, COVID-19 is "the first pandemic in the social media age"

with information flowing in real-time (Hammer et al., 2021, p. S11). Furthermore, Twitter and traditional media might have different audiences and different agendas, as shown by Han et al. (2021).

5.3. Explanation

The overall focus on disease trends (e.g., deaths and infections) across the three contexts is understandable. Statistics and epidemiology are essential to detect variations in the pandemic curve and to determine whether the adopted behavior yields the desired outcome. In addition, as revealed by Garcia and Berton (2021) and Niknam et al. (2021) this topic is of interest for communication by the general public.

The prominence of COVID-19 testing as a communication topic in Sweden as opposed to Italy and the U.S. can be attributed to the country's laisse faire approach to the pandemic and to utilize testing as a crisis management strategy. While the topic of "addressing misinformation" ranked high in the explanation category in all three countries, it did not receive as much attention in Sweden and the U.S. as it did in Italy. Misinformation has been a major concern during the pandemic (Kouzy et al., 2020). Since social media have often been pointed out as potential drivers of misinformation (Ferrara et al., 2020), it should be in the interest of public organizations to counteract misinformation on social media platforms such as Twitter (Sutton, 2018). Italy made a great deal about educating the public about the new terminologies brought about by the pandemic (e.g., close contact, and contact tracing) and addressing common doubts and misconceptions to minimize the formation of rumors. This may be attributed to Italy experiencing the impacts of the COVID-19 pandemic earlier than Sweden and the U.S. Risk education is essential for reducing the spread of misinformation and for promoting virtuous behaviors; however, social media platforms remain underutilized for disaster risk education (Dufty, 2015). Together, public health agencies' focus on "disease trends" and "addressing misinformation" topics highlight the need for explaining the patterns of the new disease and for providing accurate information about its characteristics, especially in the first stages of a pandemic.

Little to no emphasis given to the COVID vaccine across the three contexts might be attributed to the fact that the vaccine was still seen as a remote possibility at the beginning of the pandemic, even though research for the development of a vaccine had started almost immediately (Sharma et al., 2020). From a logical standpoint, however, lack of attention given to the topic of transmission may come as a surprise because the studied period marked the onset of the pandemic during which information on transmission was crucial (e.g., Tobías and Molina, 2020). However, Malik et al. (2021) also found that this type of information was lacking in the communication by national and international health agencies.

5.4. Action

Prevention's ranking as the top communication topic in the action category is not a surprising result since a common strategy in all three countries was preventing infections, especially among the vulnerable groups, as well as preventing the collapse of healthcare systems. Results from other studies on past health emergencies and COVID-19 related communication by public health agencies and other stakeholders yielded similar results (Raamkumar et al., 2020; Malik et al., 2021). Hence, issuing action-oriented messages concerning the appropriate behaviors to prevent infecting oneself or others with COVID-19 constitute an important crisis management strategy during a health emergency and a must-have of communication in a public health crisis, as highlighted by Berg et al. (2022). Information about available treatment options was also underrepresented in the agencies' communication probably due to the fact that treatment options were still unclear in the early months of the pandemic and that public health agencies placed an emphasis on disease containment through prevention measures.

5.5. Other

In line with previous findings (e.g., Kompani et al., 2022), this study indicates that Twitter communication is, in some cases, used for different purposes than other social media platforms. It suggests that health agencies used their tweets to disseminate general information on COVID-19 virus characteristics and on the re-opening of business activities after the lockdown. The U.S. forms a special case in which the CDC used Twitter frequently to acknowledge the public or professionals' efforts, especially the efforts of their own employees. This could be interpreted as a means to boost morale and show emotional support, which previous research has identified as essential parts of successful leadership during crises (Wooten and James, 2008; Gigliotti, 2016).

6. Conclusion, limitations, and future research

This article presented a comparative analysis of COVID-related communication topics tweeted by three national-level health agencies in Italy, Sweden, and the U.S. in the first 3 months of the pandemic. Based on the IDEA model, our findings indicate that all three agencies paid a greater attention to action- and explanation-oriented messages with particular emphasis given to prevention strategies and information about disease trends. Some important information such as how the virus gets transmitted and manifests itself through symptoms were infrequently mentioned across the messages analyzed. The distinction made in the risk factors and wellbeing categories yielded interesting insights, indicating that a finer look is needed when categorizing crisis messages.

Compared to the explanation and action component, internalizing messages (e.g., how am I or my loved ones going to be affected?) were present to a lesser extent. This is an important gap as crisis messages are more effective if receivers can perceive the relevance of the information provided for their own situation. Effective message framing during a crisis requires a balance between internalizing, action-oriented, and explanatory information so that people can understand the main features of the threat, figure out how this is relevant to them and what to do to reduce the risk.

This article also highlighted the differences in terms of how public health agencies' Twitter communication referred to other distribution outlets. The Swedish Public Health Agency massively employed Twitter for inviting the public to press conferences unlike its counterparts in Italy and the U.S. Across the three contexts, traditional media outlets were ignored in Twitter posts.

A limitation of the study is that it did not explore strategies and objectives behind the use of communication topics. Addressing perspectives on public health agencies' communication objectives can be meaningful contributions in future research. This study discussed the potential function of acknowledgments from a leadership perspective, thereby highlighting the importance of future studies on leadership aspects of public health agencies' communication. There is also a need for studies that examine which social groups public health agencies targeted with their different communication topics. We also ask that public crises communication scholars rethink their categorization of communication topics to better capture new content identified in our study, including motivational messages (e.g., CDC tweets targeting their own employees or acknowledging the work of professionals during the pandemic). Another avenue for research relates to studying communication topics in other social media platforms. As shown by Salazar (2021), many organizations during the COVID-19 pandemic prioritized different messages on Twitter than on Facebook and Instagram. Hence, similar studies conducted on other social media platforms might yield different insights on what was communicated with the public and through which communication channels.

Based on our findings, we have the following recommendations for public health agencies' online communication: (1) not ignoring the needs for transmission, risk-factor and symptom tweets, especially in the early days of the pandemic; (2) better acknowledging different place- or individual-based factors that put people at risk of infection; (3) recognizing the importance of addressing both physical and mental health (as in the case of the U.S.); (4) having organizational communication plans in place to deal with concurrent and consequent emergencies (e.g., other public health emergencies, hurricanes); (5) acknowledging the role of traditional mass media (e.g., TV, radio, press media) in reaching the public; and (6) engaging in a meaningful and an active online dialogue with the public, as recommended by Lin et al. (2016), rather than using Twitter primarily to direct audiences to other channels of communication (e.g., Press Conferences).

Data availability statement

Publicly available datasets, available via Twitter, were utilized in this study. Interested parties can also contact the authors for accessing the dataset.

Author contributions

ST contributed to the original idea, literature review, data collection, data analysis, and paper writing. FA and NG contributed to the original idea, data collection, data analysis, and paper writing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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