Received 16 September 2020
Revised 2 February 2021
Accepted 19 May 2021

Health information communication during a pandemic crisis: analysis of CDC Facebook Page during COVID-19

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Abstract

Purpose – This study investigates the Centers for Disease Control and Prevention (CDC) Facebook Page to examine what kinds of information is shared to public using Facebook and how Facebook users share and engage with information during a health crisis situation with a case of the COVID-19 pandemic.
Design/methodology/approach – Using Facebook Graph API, CDC's Facebook Page posts and users' engagement and reactions for six months from January to June 2020 were collected and analyzed. The posts were categorized into five categories. Users' engagement and reactions include share, comment, like, love, haha, wow, sad and angry.
Findings – The findings show that the type of posts have significant association with COVID-19 situation and the level of users' engagement and reactions differs significantly when COVID-19 related information is shared. The findings show that users become more active during health emergency situation. The results provided an insight into how different types of posts gain users' attention and motivation to interact.
Originality/value – This study investigates the use of social media during a national health crisis situation. While literature provides the use of social media during emergency and crisis cases, as health crisis situation is unique in that the boundary of time and location as well as people's daily life, the findings of this study provide an insight into how health authorities could communicate with the public during a health crisis situation.
Peer review – The peer review history for this article is available at: https://publons.com/publon/10.1108/OIR-09-2020-0416

Keywords Social media, Facebook, Health communication, COVID-19, Health crisis
Paper type Research paper

Introduction

Social media has become an important health communication tool (Chou *et al.*, 2009; Thackeray *et al.*, 2012). Not only the users of the social media but also medical professionals recognize that social media is a good media to disseminate health information and promote health care (Thackeray *et al.*, 2012; Jha *et al.*, 2016). In addition to general health communication, social media is considered to provide a new platform for online word-of-mouth communication during unique situations such as an emergency and crisis (Austin *et al.*, 2012). Web users consider social media as an alternate channel to request help in emergency situation and as one of the most popular sources of emergency information during a disaster (Syn, 2015). For emergency responders, social media is considered to be beneficial compared to previous efforts in developing crisis management systems as it has already established active user population, and can eliminate the costly development of crisis management systems (Crowe, 2011). Advantages of using social media during emergency and crisis situations include being free, direct communication among users, communication between organization and users, and effective information dissemination (Crowe, 2011).

The author appreciates Leah Valenti for her help with the coding process of the content analysis of this study.

Online Information Review
Vol. 45 No. 4, 2021
pp. 672-686

1468-4527
DOI 10.1108/OIR-09-2020-0416

As social media is designed mainly for user engagement, it also enables sharing of contextualized information and emotional supports among users who are impacted by the situations (Yates and Paquette, 2011). A major concern in using social media in crisis situations includes difficulties with verification of the sources (Crowe, 2011), which is also related to a concern about rumor propagation and dissemination of false or misleading information (Alexander, 2014). In social media environment, information overload becomes an issue, particularly for emergency and crisis situation when people do not have time to identify useful information (Acar and Murai, 2011; Austin *et al.*, 2012). Moreover, ethical concerns such as privacy and unregulated public mass communication need to be addressed when using social media for crisis management and communication (Alexander, 2014).

This study investigates the Centers for Disease Control and Prevention (CDC) Facebook Page to examine what kinds of information is shared to public using Facebook and how Facebook users share and engage with information during a health crisis situation with a case of the COVID-19 pandemic event, particularly in the US. Research questions of this study are:

RQ1. How is social media used for health communication during a health crisis situation?

RQ2. How does users' engagement differ depending on the types of information shared on social media?

RQ3. How the patterns of user engagement change during a health crisis situation?

It is expected that the results of the study will represent the health information communication during a pandemic crisis, and suggest ways to efficiently communicate with the public during a health crisis situation.

Background

Use of social media in crisis situations

Research literature on social media use in crisis situation is still limited (Alexander, 2014). Many studies focus on actual events and individual uses, thus only providing short-term and limited impact of social media during crisis event. For example, Acar and Murai (2011) examined how Twitter was used during Japan's tsunami disaster and how users shared and used information through Twitter. This study compiled about 100 original tweets shared during over 9-h duration of the day of the event. The results demonstrated that people who were affected by the event use social media to let their family and friends know their status, and discussed the importance of timely dissemination of trustworthy information. Li *et al.* (2011) analyzed tweets related to UT Austin shooting to observe what people share and comment on information about the event. This study particularly looked at the tweets of the community of the date of the event and showed that Twitter users actively react to the event during and immediately after it happened. Palen *et al.* (2009) examined computer-meditated communication and information sharing activities through various channels including social media during Virginia Tech shooting event, and suggested how computer-based communication should be organized when facing geographical and temporal diffusion of collective information of a crisis event.

Another stream of research is performed to investigate the use of social media by the authorities and officials during crisis and emergency, particularly examining social media contents based on the stages of crisis (e.g. Yang and Stewart, 2019; Xu, 2020). Yang and Stewart (2019) investigated the Houston Police Department's public engagement using Twitter during Hurricane Harvey crisis and revealed that governmental agencies' accounts take an influential role during emergencies. Their investigation was done across three phases of the disaster, including preparedness, response, and recovery. Xu (2020) used Twitter data

from 66 accounts of emergency management officials related to the Hurricane Irma, and investigated it using Fink's four-stage model of crisis and disaster that are prodromal, acute, chronic, and termination stages. The findings reported that the most engaging tweets were by the official accounts in the prodromal stage, and that the official accounts did not cover important topics that the users expect during disasters. Stephenson *et al.* (2018) discussed different use of social media platforms particularly during crisis and emergency, for example, using Twitter for broadcasting information while using Facebook for encouraging specific behavior. While these studies are limited to certain incidents and organizations, they provide insights into how social media could be used for efficient information dissemination during crisis and emergency circumstance.

Researchers have discussed the roles of social media, particularly in the perspectives of social media as a communication channel during crisis. Alexander (2014) introduced the seven ways in which social media can be used in crisis response: a listening function, monitoring a situation, integration of social media into emergency planning and crisis management, crowd-sourcing and collaborative development, creating social cohesion and promoting therapeutic initiatives, the future of causes, and research. Using the social-mediated crisis communication model, Austin *et al.* (2012) investigated users' behavior of social media use for crisis communication and reported that in comparison to the traditional media, users desire to obtain insider information from social media and the source of crisis information affect users' information behaviors. Bird *et al.* (2012) found that Facebook users consider Facebook as a communication channel that is real-time and timely for such emergency situation although the information may be inaccurate. They further discussed that in this regard, the government groups providing accurate information in a timely manner through social media becomes critical during crisis. Jayasekara (2019) found that the people use Facebook for different purposes at different stages of a disaster. For example, in the during-disaster phase, people used Facebook to share disaster warning, request for help or rescue, share information related to rescue activities, ask for volunteering, etc. On the other hand, in the post-disaster phase, people used Facebook to request volunteer help or donations of post-disaster support and provide feedback about the progress.

Still, little has been examined for the use of social media in case of national or organizational health emergency situation such as an epidemic or pandemic crisis. Health crisis situation is unique in that the boundary of time and people who are impacted is not easy to identify and people who are not currently impacted may be influenced in some time later. Health crisis situation is complicated as it is involved with everyday life of human and community in terms of food, environment, business, health system, mental health, etc. This leads to different types of information needs and behaviors from other crisis situations.

Health information communication on Facebook

A huge set of literature explores health information communication and activities on Facebook. For example, it has been observed that members of Facebook groups on diabetes interact to share information (65.7%), social and emotional support (28.8%), and request of information (13.3%) (Greene *et al.*, 2011). Another study that examined Facebook groups for communities of specific diseases reported that members of Facebook groups share specific disease-related experiences and request information about self-management topics (Apperson *et al.*, 2019). In addition, it has been discussed that the ways users engage on Facebook depend on the purpose of Facebook groups and health conditions (Bender *et al.*, 2011; Hale *et al.*, 2014), and social media users seek professional and personalized information for health-related topics (Liu and Jansen, 2012; Oh *et al.*, 2013). Studies indicated different outcomes of what draws users' engagement on social media, particularly during health crisis. For example, Ngai *et al.* (2020) reported that there is a significant interaction between post

content and style on the number of likes while Syn (2015) report that user engagement depends on the content of post rather ant types of posts.

Some studies conducted content analysis on health-related Facebook groups, their post types, and users' engagement to identify characteristics of health information and communications. For the content analysis, researchers suggested different ways of categorizing the types of Facebook groups or their posts. Bender *et al.* (2011) categorized Facebook groups by their purposes as fundraising, awareness, patient/caregiver support, product of service promotion and contents as fundraising, awareness, promote-a-site and support. Farmer *et al.* (2009) categorized Facebook groups as patient groups, support groups, fundraising/charity groups and other. Greene *et al.* (2011) analyzed 15 Facebook groups and categorized the post types as information-providing posts, request for information, demonstration of support, advertisements/promotional posts and irrelevant. Hale *et al.* (2014) defined categories for post contents as patient support, general support, information/awareness, marketing/promotion, Wikipedia information, blank, and other. Rosa and Sen (2019) categorized the types of posts as information and awareness, event advertising and petitions, fundraising, patient support, drug discussion, clinical trials and research studies, product and drug advertising, and other. Although post types in prior studies do not specifically represent the communication patterns of the pandemic crisis, they were used as basis of coding strategy for this study.

Research design

The data was collected using the Facebook Graph API from CDC Facebook Page (https://www.facebook.com/CDC). The CDC is a national public health institute of the United States and aims to protect public health and prevent disease. It is the government organization to respond to health crisis such as a pandemic situation and is one of the major authoritative sources for the information related to the virus such as symptoms and preventions and for the updates of status in the United States. The CDC maintains a Facebook Page as one of their public information dissemination channels along with other social media including Twitter, Instagram and Snapchat.

Among other social media channels, Facebook Page is one that serves well as a public dissemination tool as it allows users to view the information without creating an account or logging into Facebook. It is reported that as of January 2014, out of 50 US states and DC health departments, majority use Facebook (66.7%) and Twitter (80.4%) for health communication, for topics including healthy living, communicable diseases, vaccines and immunization, emergency preparedness and response, infant and child health, smoking and tobacco, etc. (Jha *et al.*, 2016). It has been found that the communication professionals find Facebook to provide more benefits and opportunities for preventive relationship building, fast delivery of crisis messages and identification of specific target groups (Eriksson and Olsson, 2016). Facebook Pages are designed to be a broadcasting platform which in many cases used by business, organizations, or celebrity to push information and provide updates to their fans. Fans "like" Pages to be connected for updates from the hosts. By design, Facebook Page allows an organization to disseminate information publicly and being a public environment enables observation of user engagement.

Another reason that Facebook is selected for this study is that it provides various ways of user engagement such as reactions, shares and comments, and it is the most popularly used social media by American adults (Duggan *et al.*, 2015). Prior studies also analyzed Facebook as a platform of communication during a pandemic crisis (DiStato *et al.*, 2015; Sharma *et al.*, 2017). Since Facebook page posts are mainly created by the hosts, users' participation can be observed from their reactions to the posts. Therefore, this study observed users' participation through their reactions to the posts that CDC makes. This study collected the contents and

types of posts, the numbers of posts, reactions, shares and comments per posts, and the post dates to analyze the patterns of communication and user engagement for sharing and discussing information related to the pandemic situation.

The data from the CDC Facebook Page is collected for the six-month period, from January to June 2020. The timeframe is determined to cover the COVID-19 spread in the US. In the US, the first case was confirmed in early January and on January 31st, the Department of Health and Human Services declared a public health emergency (Wikipedia, 2020). On March 11, WHO declares COVID-19 a global pandemic and on March 13th, the US declares COVID-19 a national emergency (AJMC, 2020). As of the end of June, data shows that there were 126,140 total deaths, 2.59 million confirmed cases in the US (Wikipedia, 2020). Major events related to COVID-19 from the initial case confirmation to national emergency declaration to major increase of confirmed cases happened during the six months, and thus, it is expected that the data will have a good coverage of the changes in status of the pandemic. The data was collected using Facebook API and the date, post content, links in posts, counts of users' reactions were collected. There is a total of 445 posts shared on CDC Facebook Page for the six-month period with an average of 2.68 posts per day. All 445 posts were reviewed and identified whether the post is about COVID-19 or other subject. The types of Facebook posts were examined along with users' engagement and reactions to investigate how their engagement and reactions differ depending on the types of post contents. Users' engagement on Facebook includes sharing the post, commenting on post, and using the reactions features provided by Facebook.

The coding of post categories was defined consulting the literature. In observing 15 Facebook groups on diabetes management, Greene *et al.* (2011) categorized the post contents in five categories as information-providing posts, request for information, demonstration of support, promotional messages for products and services, and irrelevant posts. Bender *et al.* (2011) examined 620 breast cancer groups on Facebook by categorizing their contents by the purposes of fundraising, awareness-raising, supporting survivors and caregivers, and promoting a website. Hale *et al.* (2014) categorized Facebook page posts into seven categories including patient support, general support, marketing/promotion, information/awareness, Wikipedia information, blank, and other. Rosa and Sen (2019) categorized the types of Facebook posts as information and awareness, event advertising and petitions, fundraising, patient support, drug discussion, clinical trials and research studies, product and drug advertising, and other. While studies conducting content analysis of Facebook posts on health information defined the categories in different ways, there are some overlaps such as information, awareness, support, promotion and fact delivering. This study identified five categories based on prior studies and considering the contents focusing on COVID-19 which provide unique patterns, for example, factual posts reporting COVID-19 cases and instructional posts promoting preventive guidelines become important during the pandemic. Table 1 explains the categories for the coding of the content analysis. All posts were analyzed independently by two coders using the post categories in Table 1. The intercoder reliability was in the moderate range as suggested by Landis and Koch (1977) (Cohen's kappa = 0.565). The results of the two coders' coding were compared and discrepant codes were reviewed for agreement.

Findings

Characteristics of CDC posts during COVID-19

Out of the collected 445 posts, most of the posts ($N = 435$, 97.75%) includes links mainly to CDC webpages ($N = 422$, 96.79% of the links). Majority of the posts includes images ($N = 428$, 96.18%) and some includes videos ($N = 16$, 3.60%). From the 445 posts, the content texts of the posts, excluding the URLs, include a total of 23,169 words with 2,795 unique terms.

Post category	Literature	Description	Examples of subject
Educational/ informative	Information-providing posts (Greene *et al.*, 2011), Awareness-raising (Bender *et al.*, 2011), Information/ awareness (Hale *et al.*, 2014), Information and awareness (Rosa and Sen, 2019)	When the intention of the post is to educate users and spread information for users' attention and raising awareness. This kind of information is also to announce and inform users about CDC's guidelines and strategies	Symptoms, N96 respirators and surgical masks, baby vaccination during COVID-19, higher risk groups
Factual	Wikipedia information (Hale *et al.*, 2014), Clinical trials and research studies (Rosa and Sen, 2019)	When the information provides facts on health such as positive or death case reports and research findings	Cases report, case examples, research findings
Instructional/ promotional	Promote-a-site (Bender *et al.*, 2011), Information/ awareness (Hale *et al.*, 2014), Drug discussion (Rosa and Sen, 2019)	When the information encourages healthy actions, or promotes/ advertises CDC guidelines and resources	Safety guidelines, household prevention, quitting smoking, COVID-19 social media toolkit
Conversational/ engaging	Demonstration of support (Greene *et al.*, 2011), Supporting (Bender *et al.*, 2011), Patient support (Hale *et al.*, 2014), General support (Hale *et al.*, 2014), Patient support (Rosa and Sen, 2019)	When the information is to share a way to interactively communicate with CDC or others, and to initiate an issue for open discussion	COVID-19 Q&A, appreciation to frontline staffs, testimonials
Event	Promotional messages for services (Greene *et al.*, 2011), Marketing/promotion (Hale *et al.*, 2014), Event advertising and petitions (Rosa and Sen, 2019)	When the information is introducing and promoting CDC events and activities	Webinars, live lecture events, launch of symptom checker

Table 1.
Post categories

The top 10 most frequently appearing terms are "covid (388 times)," "learn (187)," "cdc (148),' "spread (134)," "health (125)," "help (121)," "people (102)," "face (100)," and "protect (96)" demonstrating that the posts during the 6-months of data collection period mainly discuss about COVID-19 related information. Figure 1 presents a wordcloud visualization based on the term frequency.

When the posts were compared by months using one-way ANOVA test, there was a statistically significant difference in the number of posts among months ($F(5, 160) = 9.290$, $p < 0.001$). A Tukey post hoc test showed that the number of posts in January ($N = 56$, 12.58%), February ($N = 43$, 9.66%), March ($N = 70$, 15.73%), and May ($N = 75$, 16.85%) were significantly lower than April ($N = 97$, 21.80%) and June ($N = 104$, 23.37%). Among the 445 posts, 315 posts were COVID-19 related posts (70.79%). When COVID-19 related posts were compared by months, one-way ANOVA test resulted a statistically significantly difference in the numbers of COVID-19 posts ($F(5, 160) = 29.123$, $p < 0.001$). A Tukey post hoc test revealed that the numbers of COVID-19 related posts in January ($N = 10$, 17.86%) and February ($N = 13$, 30.23%) were statistically significantly lower than March ($N = 63$, 90.00%), April ($N = 86$, 88.66%), May ($N = 65$, 86.67%) and June ($N = 78$, 75.00%). It is clear that not only the number of postings by the CDC dramatically increased from March, but also the posts were dominantly relevant to COVID-19 topics. This demonstrates that the CDC's public

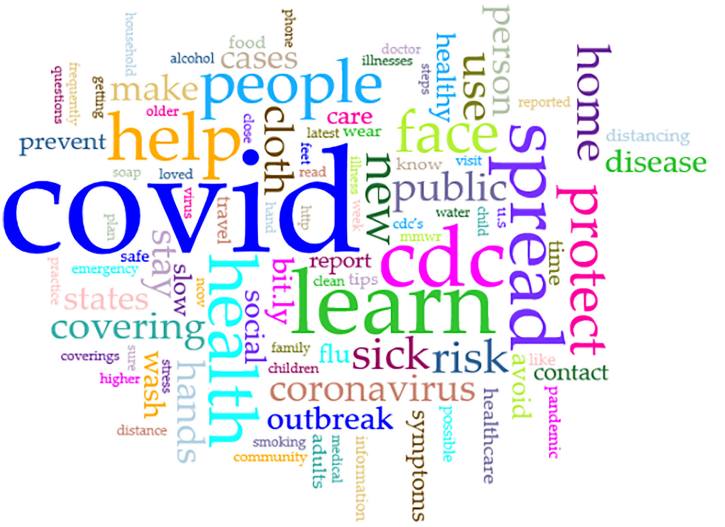


Figure 1.
Wordcloud from CDC Facebook posts

communication was devoted to sharing and educating people about the pandemic. Figure 2 presents the percentages of COVID-19 related posts and number of posts per month and demonstrates how COVID-19 related posts significantly increase by time as the virus spreads the country from March.

The Facebook posts were categorized into five categories, namely, educational/informative posts, factual posts, instructional/promotional posts, conversational/engaging posts, and event posts (Table 1). Figure 3 presents the percentages of each category by month. With double-counted measures, it showed that overall, the CDC publishes educational/informative posts most ($N = 296$, 66.52%), followed by instructional/promotional ($N = 251$, 56.04%), factual ($N = 98$, 22.02%), conversational/engaging ($N = 39$, 8.79%) and event posts ($N = 20$, 4.49%). When looked by month, it showed that educational/informative posts dominated in January and February (over 70% of the posts), whereas instructional/promotional posts increased during the pandemic ranging between 52 and 73%. This is understandable as instructional information such as safety and prevention guidelines are

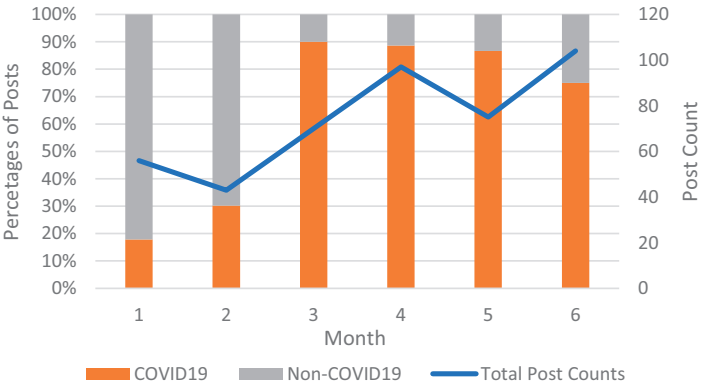
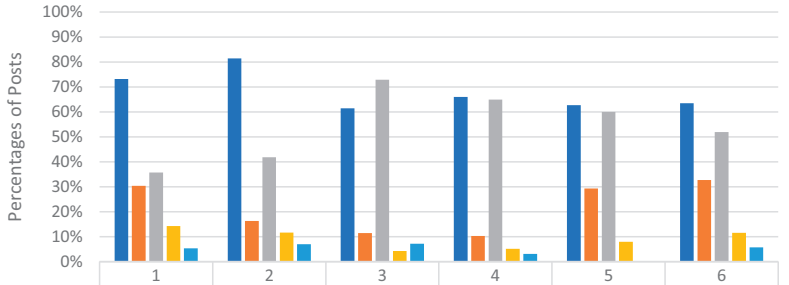


Figure 2.
Number of post and percentages of COVID-19 related posts by month



	1	2	3	4	5	6
Educational/Informative	73.21%	81.40%	61.43%	65.98%	62.67%	63.46%
Factual	30.36%	16.28%	11.43%	10.31%	29.33%	32.69%
Instructional/Promotional	35.71%	41.86%	72.86%	64.95%	60.00%	51.92%
Conversational/Engaging	14.29%	11.63%	4.29%	5.15%	8.00%	11.54%
Event	5.36%	6.98%	7.14%	3.09%	0.00%	5.77%

Figure 3.
Percentages of post categories by month

shared more during the pandemic to widely disseminate such information to various user groups to stop virus spread. When the posts are looked closer, it can be observed that the same kind of safety guidelines are posted multiple times to different targeting audiences. It is also noteworthy how factual posts including cases and death rates decreased in the early pandemic and started to increase as the number of cases increased.

The numbers of the posts by categories were compared between COVID-19 related and non-COVID-19 related posts. The chi-square tests revealed that there were significant relationships between the content of the posts and the post categories of instructional/promotional posts ($\chi^2(1) = 11.779$, $p = 0.001$), conversational/engaging posts ($\chi^2(1) = 21.599$, $p < 0.001$), and event posts ($\chi^2(1) = 12.969$, $p < 0.001$). Instructional/promotional posts had a higher mean for COVID-19 related posts ($M = 0.62$) than non-COVID-19 related posts ($M = 0.44$). On the other hand, conversational/engaging and event posts had lower means for COVID-19 related posts ($M = 0.05$ and $M = 0.02$ respectively) than non-COVID-19 related posts ($M = 0.18$ and $M = 0.10$ respectively). There were no significant relationships between educational/informative or factual posts and COVID-19 or non-COVID-19 related posts. The findings represent that the CDC tended to sharing education/informative and factual posts regardless of emergent or normal situations, however, during a health crisis, it seems the CDC focus on delivering instructional/promotional posts to encourage healthy actions. It is also interesting to notice that during a health crisis, interactions with users tend to be less emphasized, and this may be because the CDC is trying to deliver informative and factual information in timely manner as situation changes rapidly.

User engagement and reactions on CDC Facebook Posts

Users' engagement and reactions on Facebook include sharing the post, commenting on post, and using the Facebook reactions such as like, love, haha, wow, sad and angry. Overall, users tended to express their reactions with the reaction emoticon buttons (53.34%) followed by shares (40.18%) and comments (6.48%) (Figure 4). From the options given for reaction buttons, users used like (86.79%) most followed by sad (4.59%), love (3.68%), wow (2.50%), haha (1.83%), and angry (0.62%).

When users' engagement and reactions were compared by months using one-way ANOVA tests, it was found that there were statistically significant differences in numbers of share, comment, and reactions by months ($F(5, 439) = 7.681$, $p < 0.001$ for share,

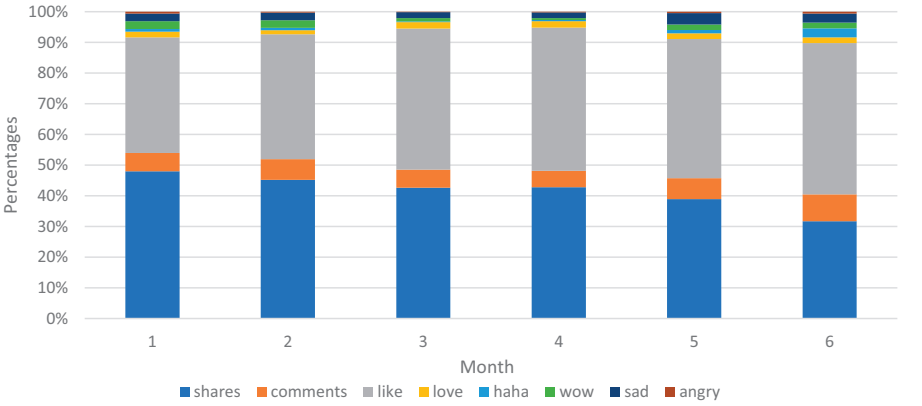


Figure 4.
Percentages of users' engagement and reactions by month

$F(5, 439) = 3.916$, $p = 0.002$ for comment, and $F(5, 439) = 7.200$, $p < 0.001$ for reactions). As for share, January ($M = 542.32$) and February ($M = 584.74$) were lower in average number of shares than March, April, May, and June ($M = 3046.11$, 2363.61, 1660.71 and 1083.63 respectively). Similarly, there were less comments for January ($M = 67.71$) and February ($M = 86.44$) than other months ($M = 419.41$ for March, $M = 296.55$ for April, $M = 291.32$ for May, and $M = 298.53$ for June). There were highest reactions shared in March ($M = 3673.41$) followed by April ($M = 2867.34$), May ($M = 2317.37$), June ($M = 231.14$), February ($M = 621.63$), and January ($M = 519.71$). The reaction emoticons were examined further with one-way ANOVA tests and there were statistically significant differences in numbers of like, love and haha by months ($F(5, 439) = 8.335$, $p < 0.001$ for like, $F(5, 439) = 3.299$, $p = 0.006$ for love, and $F(5, 439) = 2.666$, $p = 0.022$ for haha). Like and love show a similar pattern with share and comments, that is, for like, March has the highest number of likes ($M = 3282.87$) followed by April ($M = 2582.72$), May ($M = 1938.57$), June ($M = 1682.42$), February ($M = 526.40$) and January ($M = 425.59$); for love, having the highest number in March ($M = 148.06$) followed by April ($M = 115.35$), May ($M = 77.84$), June ($M = 63.36$), January ($M = 20.77$), and February ($M = 17.51$). On the other hand, haha shows a different pattern, having highest number of haha in June ($M = 100.65$) followed by May ($M = 46.49$), April ($M = 19.78$), March ($M = 15.03$), February ($M = 9.70$), and January ($M = 9.58$). Regardless, it is obviously observed that richer engagement and reactions were made during the pandemic from March to June, demonstrating users' high interest in the topic and eagerness of obtaining and sharing information related to COVID-19.

Users' engagement and reactions for COVID-19 related post and non-COVID-19 related posts were compared. One-way multivariate ANOVA tests revealed that there was a statistically significant difference in users' engagement and reactions between COVID-19 related and non-COVID-19 posts ($F(3, 441) = 11.789$, $p < 0.001$; Wilk's $\Lambda = 0.926$, partial $\eta^2 = 0.074$). Whether a post is COVID-19 related or not has statistically significant effect on share ($F(1, 443) = 24.373$, $p < 0.001$, partial $\eta^2 = 0.052$), comment ($F(1, 443) = 16.851$, $p < 0.001$, partial $\eta^2 = 0.037$), and reactions ($F(1, 443) = 35.023$, $p < 0.001$, partial $\eta^2 = 0.073$). For all cases, the means of share, comment and reactions were higher for COVID-19 related posts (Table 2). When each of the reaction emoticons was examined, there was a statistically significant difference in types of reactions between COVID-19 related and non-COVID-19 posts ($F(6, 438) = 13.107$, $p < 0.001$; Wilk's $\Lambda = 0.848$, partial $\eta^2 = 0.152$). Whether the post is COVID-19 related or not has statistically significant effect on all reactions except wow ($F(1, 443) = 38.248$, $p < 0.001$, partial $\eta^2 = 0.079$ for like; $F(1, 443) = 6.264$, $p = 0.013$, partial

$\eta^2 = 0.014$ for love; $F(1, 443) = 4.123$, $p = 0.043$, partial $\eta^2 = 0.009$ for haha; $F(1, 443) = 8.923$, $p = 0.003$, partial $\eta^2 = 0.020$ for sad; and $F(1, 443) = 5.370$, $p = 0.021$, partial $\eta^2 = 0.012$ for angry). The findings show that for all types of users" engagement and reactions, the means of reactions were higher for COVID-19 related posts (Table 2), indicating users' higher engagement and interactions on the CDC Facebook Page during the pandemic.

Users' engagement and reactions depending on the post categories were examined with one-way multivariate ANOVA tests. There was a statistically significant effect by instructional/promotional posts to users' engagement and reactions ($F(3, 441) = 2.766$, $p = 0.041$; Wilk's $\Lambda = 0.982$, partial $\eta^2 = 0.018$), particularly for share ($F(1, 443) = 5.229$, $p = 0.023$, partial $\eta^2 = 0.012$) and reactions ($F(1, 443) = 4.634$, $p = 0.032$, partial $\eta^2 = 0.010$). Whether it is a conversional/engaging post influenced users' sharing behavior significantly ($F(1, 443) = 5.495$, $p = 0.020$, partial $\eta^2 = 0.012$). For factual posts, there were statistically significant differences between factual posts and non-factual posts in like ($F(1, 443) = 4.464$, $p = 0.035$, partial $\eta^2 = 0.149$), love ($F(1, 443) = 7.852$, $p = 0.005$, partial $\eta^2 = 0.017$), wow ($F(1, 443) = 25.769$, $p < 0.001$, partial $\eta^2 = 0.055$), and sad ($F(1, 443) = 33.263$, $p < 0.001$, partial $\eta^2 = 0.070$). Like ($M = 1308.49$ for factual posts and $M = 2071.83$ for non-factual posts) and love ($M = 24.01$ for factual posts and $M = 45.48$ for non-factual posts) have higher means for non-factual posts while wow ($M = 128.73$ for factual posts and $M = 33.95$ for non-factual posts) and sad ($M = 262.97$ for factual posts and $M = 54.86$ for non-factual posts) have higher means for factual posts. For instructional/promotional posts, there were statistically significant differences between instructional/promotional posts and non-instructional/promotional posts in share ($F(1, 443) = 5.229$, $p = 0.023$, partial $\eta^2 = 0.012$) and like ($F(1, 443) = 6.406$, $p = 0.012$, partial $\eta^2 = 0.014$). For both share and like, instructional/promotional posts have higher means of share ($M = 1943.50$) and like ($M = 2236.14$) than non-instructional/promotional posts ($M = 1275.48$ for share and $M = 1473.65$ for like). For conversational/engaging posts, there was a statistically significant difference between conversational/engaging and non-conversational/engaging posts in share ($F(1, 443) = 5.495$, $p = 0.020$, partial $\eta^2 = 0.012$) with a higher mean for non-conversational/engaging posts ($M = 1757.49$) than conversational/engaging posts ($M = 556.95$). There were no statistically significant differences for educational/informative and event posts in all of the engagement and reactions. It is noteworthy that the findings present instructional/promotional and conversational/engaging posts had high user shares and reactions, especially like, whereas factual posts were reacted with wow and sad. During a health crisis, users tend to share and like to informative and useful posts, while they share emotional reactions to factual posts which mainly were updates and reports on cases and deaths.

Discussion

This study investigated CDC's Facebook Page posts during the COVID-19 pandemic to explore how health authority utilized a social media for public health communication and how users engaged and reacted to the information shared. Overall, the six-month posts examined presented that as the COVID-19 spread gets severe in the US, there were more instructional/promotional posts shared on Facebook Page to educate the public with safety

Table 2. Means of User Reactions for COVID-19 and non-COVID-19 posts

				Reactions					
	Share	Comment	All	like	love	haha	wow	sad	angry
COVID-19	2102.20	332.43	2838.82	2477.30	97.97	52.93	63.61	130.15	16.86
Non-COVID-19	562.07	106.26	630.15	513.92	38.73	9.28	33.55	29.31	5.38

guidelines. Along with the higher traffic of posts, users' engagement and reactions increased significantly during the pandemic. Overall, the findings show that the type of posts have a significant association with COVID-19 situation and the level of users' engagement and reactions differs significantly when COVID-19 related information is shared. Moreover, factual, instructional/promotional and conversational/engaging posts tend to have impact on users' engagement and reactions.

RQ1. How is social media used for health communication during a health crisis situation?

It is not surprising to see an increase in the number of posts with a wider spread of COVID-19 in the US. From March, the number of posts along with users' engagement and reactions increased significantly. The post categories show that with higher severity of COVID-19, more instructional/promotional posts were posted to share safety guidelines for actions. This was shown from the findings that the content of the post with COVID-19 related information impacted instructional/promotional posts. On the users' side, instructional/promotional posts were shared and liked more showing high interests in learning how to prevent the spread of the virus. The high sharing also demonstrates that users have a high intention to widely spread the instructional/promotional information for their friends and family. This aligns well with previous findings of social media users' information sharing behaviors and motivations of reciprocity and learning (Syn and Oh, 2015).

Factual post category was another category with a significant increase. As the virus spreads widely, users were keeping eyes on the case reports. As Bird *et al.* (2012) pointed, users expect to have timely and accurate information during emergency, especially coming from government authorities. Similar pattern was observed with COVID-19 case reports as users were reviewing them directly from CDC which was the central case data collection authorities, especially in the earlier stage of COVID-19. This is also observed from users' engagement and reactions that users selecting significantly higher reactions of wow and sad to factual posts, as most of factual posts during COVID-19 reported the number of confirmed cases, hospitalized cases, and death.

Overall, educational/informative posts continued to be high in portion among CDC shared Facebook posts even after the COVID-19 outbreak. Considering that the CDC is using Facebook Page for public health information dissemination, it is not surprising to find that educational/informative posts take a high portion and this rate did not change for both COVID-19 related and non-COVID-19 posts. During COVID-19, educational/information posts explain the symptoms of COVID-19, virus precautions, etc. and they continue to be shared via Facebook Page. Particularly as previous study observed, it was found that the CDC utilize Facebook to deliver crisis related information to different target groups (Eriksson and Olsson, 2016) as the same guidelines were posted multiple times with different ways of statement for the different target groups.

Interestingly, while other types of posts were stimulated by the pandemic situation, conversational/engaging and event posts were impacted negatively. It is true that these two types could have been least shared in ordinary situation; however, the pandemic resulted in the CDC having less event-based activities from March affecting the number of posts for conversational/engaging and event posts. Some examples of these posts during the pandemic include COVID-19 Q&A webinar and live streaming information sessions. Although they would gain public attention, the findings show that COVID-19 related conversational/engaging posts were significantly less shared by users. This could be compared with how other COVID-19 related posts gained attention from the public with significantly higher shares, comments, and reactions, as in a crisis situation, information needed and shared is more time-sensitive and fact-based. It is also worthwhile considering what Austin *et al.* (2012) stressed in terms of how personalized recommendations encourage social and traditional

media use during crises. While many CDC's COVID-19 related posts were designed with target audiences indicated such as parents, school administrators, health professionals, which may have attracted users of these audience groups, the live events may have been less attractive due to lack of personalized information and limitation of time in participation.

RQ2 and RQ3. How does users' engagement differ depending on the types of information shared on social media? How the patterns of user engagement change during a health crisis situation?

Looking into various types of user engagement and reactions supported by Facebook platform, overall likes and shares were made most popularly. Users tend to express their feelings with simple methods of clicking buttons such as the reaction buttons and shares. Commenting requires more thinking and writing, resulting less use by users unless they consider sharing something is important. This finding is consistent with prior study (Syn, 2015). The findings show that the use of users' engagement and reaction features increased after the COVID-19 outbreak. March, the month when the global pandemic and national emergency were declared, records to have the highest user engagement of all kinds. All engagement and reactions, except wow, were significantly highly used for COVID-19 related posts, demonstrating high interests on the content from the public. Like and share were the most popularly used methods for users' engagement; however, like showed an increasing tendency whereas share showed a decreasing tendency in portion. A possible assumption is because recent CDC posts were dominated with COVID-19 related information that they may not be serendipitous information all the time to users, this could have resulted users react with like, but tend not to share. It can also be explained with the changed landscape of users' engagement and reactions. While like and share continued to dominate as major methods of indicating users' engagement, with the pandemic situation, users' expressions became richer with other reactions such as sad and love, resulting less use of share in portion. One thing that is noteworthy is that, although not dramatic, users engage with the CDC and other users with comments more as the pandemic continues. These observations align with the discussion from Palen *et al.* (2009) that in crisis situation, users create a new ordering and social norm that is different from the normal routine of participation as social media establishes new, temporary, social structures in response. Users are able to build new ways of communication in response to the situation and topic with increased active engagement.

Implications of the study

This study provides an observation of how the types of posts were engaged differently by the public during health crisis situation. Timely share of instructional/promotional and factual information seems to be critical during health crisis as the public seeks for immediate and accurate information. As a government agency, users expect to have such information from the CDC Facebook Page and have intention to share it to their networks. If this tendency is applied to emergency communication strategy, it can boost dissemination of information. Findings also show that users seek for personalized information which they can adopt and apply immediately for their situation. Creative design of information dissemination or events that can target audiences and their needs would encourage users' participation and engagement. The findings of this study provide a research implication in terms of providing empirical analysis of how a government agency communicate with people during a pandemic situation and how users react and engage to such information. The difference in CDC's post and users' engagement patterns provide an important observation of emergency communication that allows researchers to understand patterns of emergency communication.

Conclusion

This study investigated the CDC's Facebook Page posts during the COVID-19 pandemic to understand the use of Facebook for health crisis communication by a government authority. The posts and users' engagement and reactions were examined from Facebook posts of six-month period during which the COVID-19 spread in the US. The findings show that the type of posts have significant association with COVID-19 situation and the level of users' engagement and reactions differs significantly when COVID-19 related information is shared. The findings show that users become more active during health emergency situation. The results provided an insight into how different types of posts gain users' attention and motivation to interact. From the analysis, it was found that users seek for accurate report of the pandemic situation as well as personalized applicable information for healthy actions. The findings provide some insights into how health authorities could communicate with the public during a health crisis situation.

This study includes limitations as it investigated only one information source related to one health crisis situation on Facebook. Other social media services, other information sources and other cases of health emergency can be explored as future research. In terms of methodology, previous studies used other methods such as content analysis of contents and users' engagement (Acar and Murai, 2011; Li *et al.*, 2011) and direct input from social media users with questionnaires or interviews (Acar and Murai, 2011; Austin *et al.*, 2012). In addition to the findings of this study, such methods can be applied to extend for a future study to better understand user behavior of health crisis communication on social media. Moreover, the findings of this study shed a light on how users' engagement through commenting has increased during the pandemic. Future research can be design to investigate users' interactions and engagement through their comments to these posts.

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