



The Saudi Ministries Twitter communication strategies during the COVID-19 pandemic: A qualitative content analysis study

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ABSTRACT

Objectives: To understand government communication strategies during the COVID-19 pandemic by examining topics related to COVID-19 posted by Saudi governmental ministries on Twitter and situating our findings within existing health behavior theoretical frameworks.

Study design: Retrospective content analysis of COVID-19 related tweets.

Methods: On November 7th, 2020, we extracted relevant tweets posted by five Saudi governmental ministries. After we extracted the data, we developed and applied a coding schema.

Results: A total of 3,950 tweets were included in our dataset. Topics fell into two groups: disease-related (49.2%) and non-disease related (50.8%). The disease-related group included seven categories: awareness (18.5%), symptom (0.6%), prevention (7.7%), disease transmission (1.9%), treatment (0.3%), testing (3.4%), and reports (16.7%). The non-disease related group included eight categories: lockdown (5.9%), online learning (12.8%), digital platforms (4.3%), empowerment (12.0%), accountability (1.1%), non-disease reports (2.1%), local and international news (10.8%), and general statements (1.9%). Based on the correlation analysis, we found that the top positively correlated categories were: “testing” and “digital platforms” ($r = 0.4157$), “awareness” and “prevention” ($r = 0.3088$), “prevention” and “disease transmission” ($r = 0.3025$), “awareness” and “disease transmission” ($r = 0.1685$), “symptom” and “testing” ($r = 0.1081$), “awareness” and “symptom” ($r = 0.0812$), “symptom” and “digital platforms” ($r = 0.0645$), and “disease transmission” and “digital platforms” ($r = 0.0450$), p -values < 0.01. Several health behavior theoretical constructs were linked to our findings.

Conclusions: Integrating behavioral theories in the development of health risk communication should be taken seriously by government communication specialists who manage social media accounts, as these theories help underlining determinants of people’s behaviors.

1. Introduction

Worldwide, government communication with the public plays a vital role in responding to pandemics; it directly affects health and social outcomes of populations. Social media has been utilized as a key channel of communication in several countries across the globe. Social media platforms have become very popular among government entities due to their ease of use as a communication channel, ease of accessibility, and

real-time updates [1–3]. While governments’ use of their social media accounts, specifically Twitter, to communicate with the public has thrived massively during the COVID-19 pandemic [4], [–] [6] its use during pandemics and public health emergency of international concern has not been new [7–9].

The Kingdom of Saudi Arabia (KSA) is an example where the government is heavily investing in social media platforms, namely Twitter, as one of the main channels of communication, due to its popularity

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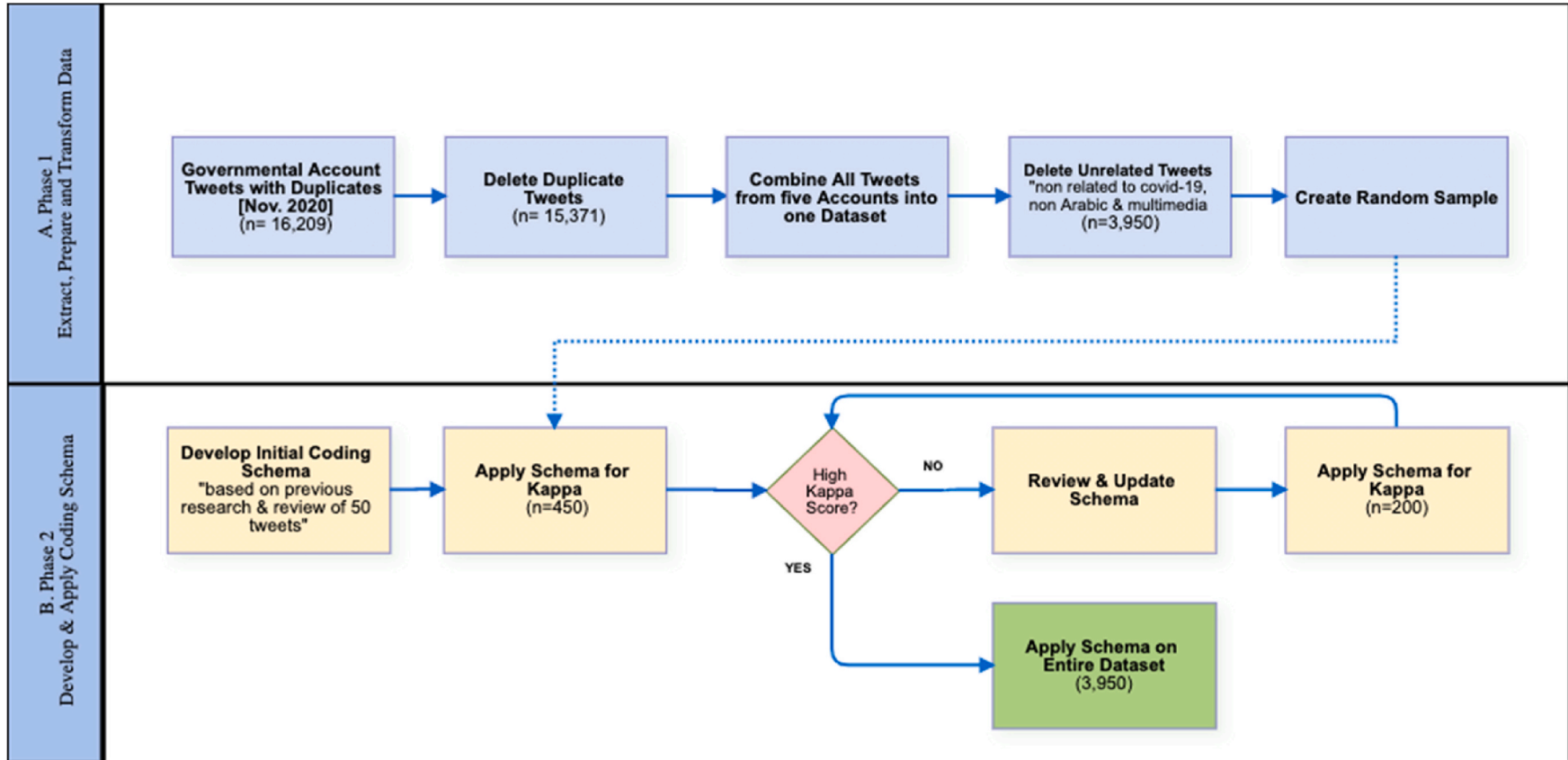


Fig. 1. (A) data extraction, preparation, and transformation and (B) coding schema development and application.

among the public [10]. The healthcare digital transformation in KSA [11] supported by the technological infrastructure in the country has created a massive opportunity for the Saudi government to utilize different digital platforms in responding and managing the COVID-19 pandemic [12]. In 2013, the Saudi Ministry of Communications and Information Technology reported that “41% of the online population in Saudi Arabia uses Twitter, a higher percentage than anywhere else in the world” [13]. The popularity of using Twitter among the Saudi population, was one of the drives for the Saudi government to utilize Twitter in sending different communication messages during the COVID-19 pandemic. As a result, many research studies were published to examine the use of Twitter in Saudi Arabia during the COVID-19 pandemic. These studies can be divided to those that focus on the analysis of the public use of Twitter [14], and those that reflect the use of Twitter by governments [15]. Different analysis methods were also published, which focused on analyzing tweets in the Arabic language during the COVID-19 pandemic, including content analysis approaches using manual or machine learning methods [16–18].

While previous research has described the role of governments in utilizing Twitter to communicate with the public regarding COVID-19, these studies mainly focused on the specific role of the Saudi Ministry of Health (MOH) in responding to the pandemic. To our knowledge this is the first study that examines the use of Twitter by several Saudi governmental bodies that represent the government cabinet during the COVID-19 pandemic. There are 24 ministries, representing the governmental bodies in KSA [19]. Among the 24 ministries, there were four that scored the top accounts on Twitter, based on the number of followers during the time of our study [20].

Our objective is to examine topics related to COVID-19 posted by Saudi governmental ministries on Twitter, by conducting a qualitative content analysis through the development and application of a topic classification schema. We also aim to understand mechanisms by which the use of Twitter for governmental communication was expected to guide appropriate coordinated actions by utilizing existing health behavior theoretical frameworks.

2. Methods

2.1. Study Design

Our study involved a retrospective content analysis of tweets posted by official Saudi ministries on Twitter during the COVID-19 pandemic. We identified the ministries' names and governmental twitter profiles from the Saudi Governmental website [19] and Twitter [21]. We only included the top four ministries based on the number of followers during the time of our study: Ministry of Health, Ministry of Interior, Ministry of Education, and the Ministry of Foreign Affairs. We also included the Ministry of Media in our study due to its unique role in regulating the media and the communications between Saudi Arabia and other countries.

We conducted this study in three phases: (1) data extraction, preparation, and transformation, (2) coding schema development and application, and (3) content analysis (Fig. 1).

2.2. Phase 1: data extraction, preparation and transformation

Using the Twitter search API embedded in NodeXL (Social Media Research Foundation) [22], we extracted tweets on November 7, 2020, posted by the five government ministries. With Twitter limitations, which limits the number of tweets per user to a maximum of about 3,200 and a dataset to a maximum of 18,000 tweets per hour, our extracted dataset included a total of 16,209 tweets. To prepare the data for analysis, we removed duplicate tweets ($n = 838$), based on the “unified twitter ID” (a unique ID generated from Twitter associated with every

Table 1

Coding schema.

| # | Category | Description |
|--|---------------------------------------|--|
| Group 1: Disease-Related Topics | | |
| 1 | Awareness | Messages focused on sending general awareness information about COVID-19 and correcting false information about the virus. Announcements for upcoming daily media awareness coverage. |
| 2 | Symptom | Reports of symptoms such as fever, cough, diarrhea, and shortness of breath or answers related to these symptoms. |
| 3 | Prevention | Messages related to describing specific preventive measures or the mention of new prevention strategies, including a vaccine. |
| 4 | Disease Transmission | Messages describing how the disease is transmitted, and how to prevent disease transmission after infection, including quarantine measures. |
| 5 | Treatment | Messages regarding treatment of the disease, which include describing clinical trials for treatment. |
| 6 | Testing | Messages describing testing procedures, follow-up after testing, locations on where to get tested. |
| 7 | Reports | Reports of daily/weekly/monthly cases, including no reported cases, total cases, recovered and death. |
| Group 2: Non-Disease Related Topics | | |
| 8 | Lock down | Messages and announcements of lockdown directives, lockdown locations, or duration of lockdown or suspension of lockdown, including school, travel, prayer, Hajj and Omrah, formal gatherings, shopping malls, and sports lockdowns. |
| 9 | Online Learning | Messages and announcements related to the shift to online learning including procedures, digital platforms, and training students and teachers. |
| 10 | Digital Platforms | Messages and announcements of mobile applications/digital platforms (other than educational platforms) used during the pandemic for testing, locating clinics, permission to leave home during lockdown, and court platform. |
| 11 | Empowerment | Messages of public encouragement and gratitude focused on motivating people (ill or healthy) to continue to fight the pandemic and take preventative measures, in the form of a direct message or sharing of a personal story with the aim to encourage the public to gain mastery over their lives and the community. |
| 12 | Accountability | Reports on penalties imposed on regulations violators set by the government, such as social distancing, wearing masks, and curfews. |
| 13 | Non-Disease Reports | Media reports of general statistics including online learning, support during the pandemic, travel, and general media coverage |
| 14 | Local & International News | Update coverage during the pandemic, including coverage of Hajj, initiatives taken by different organizations to support government actions, coverage of the G20 Virtual Summit. |
| 15 | General Statements | Messages that present a general information statement. |

single tweet) resulting in a total of 15,371 tweets. The number of tweets extracted, and the total number of duplicates found and removed representing each ministry included are described in appendix A, Table A1.

We combined the extracted tweets from the five ministries into one dataset, then two researchers (SA and AA) manually reviewed the entire dataset to remove “unrelated” tweets ($n = 11,421$). The exclusion of “unrelated” tweets was determined based on our research objective and scope. Non-Arabic tweets, tweets that only included multimedia (video, image) with no text, or tweets that were not related to COVID-19 were considered “unrelated” and thus removed from our dataset (Appendix A, Table A2). Following the removal of “unrelated” tweets, our final research dataset was comprised of 3,950 tweets. Two researchers (RA and SB) independently observed the tweets to examine the type of topics. We then created a random sample, using the RAND function in Excel® of 500 tweets to use in our second phase.

2.3. Phase 2: schema development and application

2.3.1. Schema development

Our schema was iteratively developed using the entire dataset to determine the main topics representing the messages posted by government accounts to the public during the COVID-19 pandemic. Developing the schema was based on an approach used in other studies to analyze clinical notes within the electronic health record [31–33], and microblogs. [9,10,34,35] All researchers and annotators are native Arabic speakers with insider knowledge of cultural language nuances and accent.

Our coding schema consisted of two phases. The first phase focused on developing the annotation guidelines and an initial coding schema. This phase was based on the analysis of 50 randomly selected tweets and enhancing the schema through weekly meetings and discussions involving three subject matter experts, from the research team (RA, SB and NA). The initial schema consisted of two groups, which were disease related and non-disease related. Seven categories were identified under the disease-related group and five categories under the non-disease-related group. The second phase involved calculating inter-rater agreement using the Cohen's kappa statistic to ensure consistency in categorizing tweets between two reviewers (RA and SA), and applying the

initial version of the schema for 450 randomly selected tweets. When the kappa statistic scored under 0.80, we discussed differences, enhanced the schema, and updated the annotation guidelines. The final version of the schema included two groups; (1) disease-related and (2) non-disease related with a total of 15 categories (Table 1).

2.3.2. Schema application

The same two annotators (RA and SA) jointly annotated the remaining 3,300 tweets. The annotators assigned one or more categories from the 15 categories according to the contextual information for each tweet. Table 2 demonstrates examples of Arabic tweets and our translation of the tweets into the English language, assigned to their respective groups and categories.

2.4. Phase 3: content analysis

After we completed annotating the entire dataset, counts and percentages were calculated representing each category's frequency within the dataset. Percentages describe each category's percentage from the total number of category occurrences among each group and 15 categories. We conducted a correlation analysis "Pearson" using R statistical language to examine the relationship between categories, excluding the

Table 2
Coding examples.

| # | Category | Example |
|--|------------------------------|---|
| Group 1: Disease Related Topics | | |
| 1 | Awareness | #وزارة الصحة تُهيب بالجميع التواصل مع مركز "تواصل الصحة 937" في حال الرغبة في أي استفسار يخص الفيروس. #TheMinistryofHealth recommends everyone to contact the "Health Service 937" center, in case of any inquiry regarding the virus |
| 2 | Symptom | #عزل نفسك عن عائلتك إبهني أول خطوة عند شعورك بأعراض #كورونا: "كحة، ارتفاع في الحرارة، ضيق بالتنفس، وكلم الصحة 937". #QuarantineYourself from your family! This is the first step when you feel symptoms of #Corona: Cough, fever, shortness of breath, and call health 937 |
| 3 | Prevention | #وزارة التعليم تستقبل موظفيها بإجراءات احترازية من فيروس #كورونا، وتؤكد على أهمية لبس الكمامة، وغسل أو تعقيم اليدين، وعدم المصافحة، وترك مسافة مع الآخرين، والحد من التجمعات. The Ministry of Education welcomes its employees with precautionary measures against the Corona virus, and stresses the importance of wearing a mask, washing or sanitizing hands, not shaking hands, leaving a distance between others, and limiting gatherings |
| 4 | Disease Transmission | #خطورة التجمعات تتعدى المصاب نفسه، لتنتقل العدوى إلى أهله وكل من حوله. التزم بالتعليمات الصحية واحرص على إبقاء مسافة آمنة بينك وبين الآخرين. The dangers of gatherings exceeds the infected themselves, it transmits the infection to their families and everyone around them. Adhere to health instructions and be sure to keep a safe distance between yourself and others |
| 5 | Treatment | #مصاحبًا استفادوا من العلاج عن طريق بلازما الدم للمتعافين من فيروس كورونا، ضمن دراسة بحثية شارك فيها نخبة من الباحثين والمراكز البحثية بالمملكة (132). (132) infected people who benefited from blood plasma treatment are recovering from the Coronavirus, as part of a research study in which a group of researchers and research centers participated in the Kingdom |
| 6 | Testing | #المملكة اتخذت منهجًا في الفحص الموسع، وهو الفحص المبكر الذي يهدف إلى الوصول للمجتمع وعلاجهم قبل أن يصلوا للمستشفيات في حالات التوسع والمرض. The Kingdom has taken an approach of expanded coronavirus screening, which is early examination that aims to reach the community and treat them before they reach hospitals in cases of illness and disease |
| 7 | Reports | #الصحة تعلن عن تسجيل (1019) حالة إصابة جديدة بفيروس #كورونا الجديد (كوفيد19)، وتسجيل (30) حالات وفيات رحمهم الله، وتسجيل (1310) حالة تعافى إجمالي عدد الحالات المتعافية. (286,255) حالة والله الحمد #MOH announces the registration of (1019) new cases of the new Coronavirus (Covid 19), the registration of (30) deaths, may God have mercy on them, and the registration of (1310) cases of recovery, bringing the total number of recovered cases to (286,255) cases |
| Group 2: Non-Disease Related Topics | | |
| 8 | Lock down | #مصدر مسؤول بـ #وزارة الداخلية: منع التجول على مدار (24) ساعة يوميًا في كل من (الرياض، تبوك، النمام، الظهران، البهوف)، وكذلك في أرجاء محافظات (جدة، الطائف، القطيف، الخبر) كافة. #كلنا مسؤول Official source at the Ministry of Interior: 24-h curfew in (Riyadh, Tabuk, Dammam, Dhahran, and Al-Hofuf), as well as in all governorates of (Jeddah, Taif, Qatif, and Khobar) #WeAreAllResponsible |
| 9 | Online Learning | #منصة مدرستي.. تعليم تفاعلي عن بُعد بأدوات إلكترونية متنوعة، وفصول افتراضية بين الطلاب ومعلمهم. #MadrasatiPlatform "my school platform" ... interactive remote learning with various enriching tools, and virtual classes between students and their teachers |
| 10 | Digital Platforms | #المراكز الصحية في خدمتك! بيئة آمنة ومعبقة للإجراءات الوقائية لك ولعائلتك، لا تهمل صحتك واحجز موعدك عبر تطبيق موعد. Health centers at your service! A safe environment with the application of precautionary measures for you and your family, Do not neglect your health and book your appointment through the Mawid application |
| 11 | Empowerment | #الملك سلمان: نحن على ثقة بأننا سنتمكن معاً من تجاوز هذه الأزمة والمضي قدماً نحو مستقبل نطمح فيه الجميع بالرخاء والصحة والازدهار. #King Salman: We are confident that together we are able to overcome this crisis and move forward towards a future in which everyone enjoys health, and prosperity |
| 12 | Accountability | #حتى #نعود يحذر يجب الالتزام بلبس الكمامة عند الخروج من المنزل، وترك مسافة آمنة، وعباقب من تعمد مخالفة الإجراءات الاحترازية والتدابير الوقائية بغرامة مالية. #ToReturnSafely, one must adhere to wearing a mask when leaving the house, leaving a safe distance between them and others, and whoever deliberately violates the precautionary and preventive measures will be fined |
| 13 | Non-Disease Reports | #عودة آمنة من لندن إلى جدة .. وصول 252 مواطناً إلى أرض الوطن. #Safe_Return From London to Jeddah. 252 citizens arrive home |
| 14 | Local and International News | #من السعة السريرية الأساسية للعلاجات المركزة تم زيادتها خلال ثلاث أشهر فقط" أهم ما جاء في المؤتمر الصحفي لوزارة الصحة 30% "30% of the basic clinical capacity for intensive care was increased in just three months." Highlights of the Ministry of Health press conference |
| 15 | General Statements | #منظمة الصحة العالمية: قرار المملكة حول الحج، مثال على الإجراءات الصعبة التي يجب أن تتخذها الدول لجعل الصحة أولًا. #WHO: The Kingdom's decision regarding Hajj is an example of the difficult measures that countries must take to make health a priority |

Table 3
Category frequencies.

| # | Category | frequency | % of occurrence among group | % of occurrence among total categories |
|--|------------------------------|--------------|-----------------------------|--|
| Group 1: Disease Related Topics | | | | |
| 1 | Awareness | 842 | 37.7% | 18.5% |
| 2 | Symptom | 28 | 1.3% | 0.6% |
| 3 | Prevention | 351 | 15.7% | 7.7% |
| 4 | Disease transmission | 88 | 3.9% | 1.9% |
| 5 | Treatment | 12 | 0.5% | 0.3% |
| 6 | Testing | 153 | 6.8% | 3.4% |
| 7 | Reports | 761 | 34.0% | 16.7% |
| Total | | 2,235 | 100% | 49.2% |
| Group 2: Non-Disease Related Topics | | | | |
| 8 | Lock down | 267 | 11.6% | 5.9% |
| 9 | Online Learning | 580 | 25.1% | 12.8% |
| 10 | Digital Platforms | 194 | 8.4% | 4.3% |
| 11 | Empowerment | 544 | 23.6% | 12.0% |
| 12 | Accountability | 48 | 2.1% | 1.1% |
| 13 | Non-Disease Reports | 97 | 4.2% | 2.1% |
| 14 | Local and International News | 492 | 21.3% | 10.8% |
| 15 | General Statements | 87 | 3.8% | 1.9% |
| Total | | 2,320 | 100% | 50.8% |
| Total Occurrences | | 4,555 | - | 100% |

category “general statements” due to the diversity and nature of these tweets.

We performed further analysis utilizing a theoretical approach by examining tweets found under the “empowerment” category, as it pertains to public health. We specifically selected the “empowerment” category, as empowerment communication statements during

pandemics are an essential element in risk communication, based on the social constructionist risk model approach, “whereby risk is seen to be interrelated with sociocultural context” [23]. Due to the type of tweets within the “empowerment” category, rather than utilize one specific health behavior theory we used the following health behavior theories: the Health Belief Model, the Theory of Planned Behavior, and the Social Cognitive Theory [24–27].

3. Results

3.1. Topics

Non-disease related topics were slightly more than disease-related topics. “Awareness” was the highest disease-related category found in our dataset (n = 842, 37.7%), followed by “reports” (n = 761, 34%). Among the non-disease related topics, tweets that focused on “online learning” was the highest category (n = 580, 25.1%), followed by the “empowerment” category (n = 544, 23.6%) (Table 3). The total number of likes and retweets within each category are illustrated in Fig. 2. The highest total likes were Tweets under the “disease related reports” category, while the highest total retweets were under the “empowerment” category.

Multiple categories may be assigned to a single tweet. Most of the tweets (n = 3,428) were assigned a single category from our coding schema. A total of (n = 521) tweets were assigned two or more categories (Table A3). Based on the correlation analysis between categories, we found that the top positively correlated categories with p-values < 0.01 were: “testing” and “digital platforms” (r = 0.4157), “awareness” and “prevention” (r = 0.3088), “prevention” and “disease transmission” (r = 0.3025), “awareness” and “disease transmission” (r = 0.1685), “symptom” and “testing” (r = 0.1081), “awareness” and “symptom” (r = 0.0812), “symptom” and “digital platforms” (r = 0.0645), and “disease transmission” and “digital platforms” (r = 0.0450) (Fig. 3).

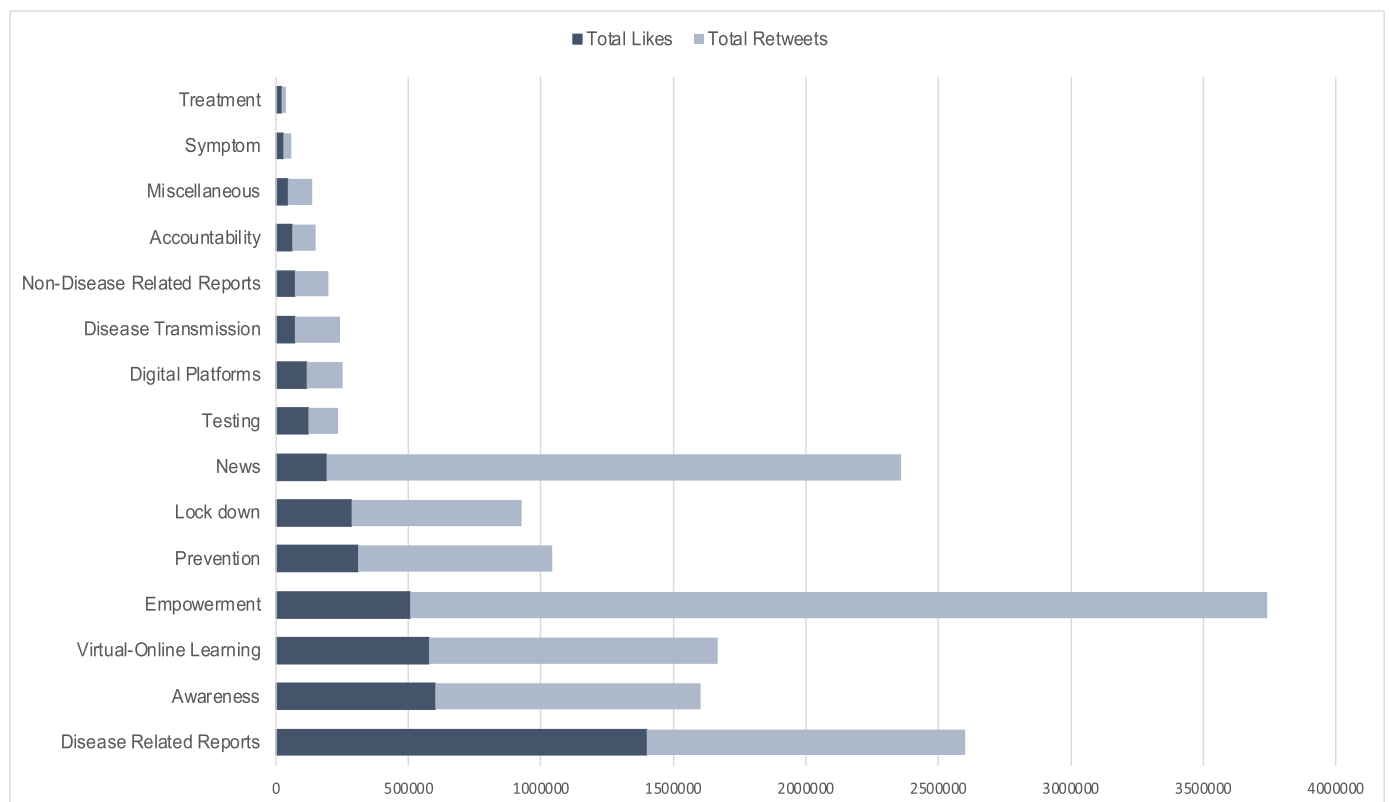


Fig. 2. Total number of likes and retweets among each category.

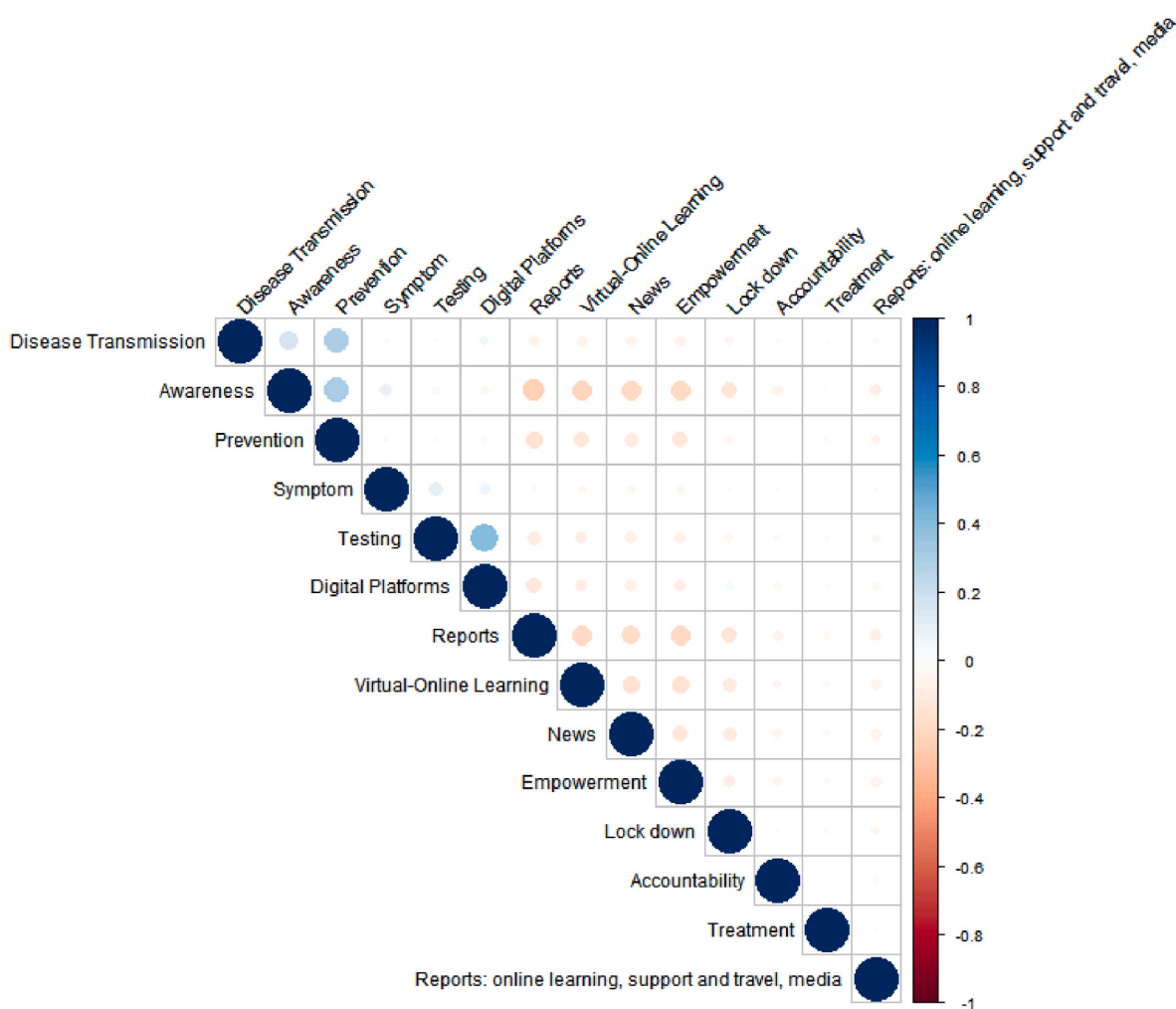


Fig. 3. Correlation between categories. The correlation matrix shows the correlation between assigned categories. As indicating in the color legend, the positive correlations are shown in blue color, while the negative correlations are shown in red color. The larger size and more intense color of the circle the higher values of correlation coefficients. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

3.2. Public health conceptual frameworks

Theoretical based analysis showed tweets under the “empowerment” category were found to mainly be linked to the following theoretical constructs: perceived benefits, perceived severity, perceived behavioral control, observational learning, incentive motivation, self-efficacy, collective efficacy, and facilitation [24–27]. It is to be noted that in some tweets, more than one construct was linked to the same Tweet (Table 4).

4. Discussion

Our work examined the use of Twitter by Saudi Arabian ministries, as one of the public communication methods utilized during the COVID-19 pandemic. Through our analysis of these collectively instructed messages that covered a wide range of disease and non-disease-related topics, we found “awareness” and “reports” were the most common topics found in the disease-related group, followed by “online-learning” and “empowerment” found in the non-disease-related group, with much less information around “symptom” and “treatment” in our dataset. The prevalence of communication messages related to disease awareness, disease reports, and empowerment appeared to be an effort by these government ministries to indicate the relative amount of potential support for the public in the fight against this pandemic. The low prevalence of messages around disease treatment could be due to our study’s timing, which during that time no COVID-19 treatment was

announced on a global level.

While our work focused on analyzing the contents of governmental messages on Twitter as they relate to disease or non-disease related topics, previous notable work focused on either disease or non-disease-related topics [8,28]. Other researchers specifically explored the type of symptoms experienced by patients with COVID-19 by analyzing public conversations posted on Twitter [29,30]. Our findings have shown the interconnections between these two topic groups, which is similar to the findings of a recent study that examined public concerns during the COVID-19 pandemic in Saudi [15]. With digital platforms being extensively used during the COVID-19 pandemic, it was no surprise to see some tweets include information about digital platforms and disease testing information. During the early stages of the spread of the disease, specific efforts by the MOH were focused on ensuring the continuity of care and protecting the public, by developing several digital applications, and widely using Twitter as one method to inform the public about their use [12].

As major community closures took place and formal education shifted to online platforms, tweets on online learning and news increased, reflecting the rapidly changing scene at the time. The government tweeted “empowerment” content to address the psychological distress inflicted by these unexpected and life changing measures during the early months of the pandemic. On the other hand, a survey of the public revealed they were most interested in knowing about curfew, any progress in treatment and vaccines, and preventing the spread of the

Table 4
Empowerment^a and health behavior theoretical constructs.

| Theoretical Construct | Example |
|--|---|
| Perceived Benefits Health Belief Model (beliefs about the effectiveness of taking action to reduce risk or seriousness) | <p>المملكة من بين دول العالم المتميزة في تطبيق الفحوص وأيضاً في التحكم حتى الآن من حيث إحصائيات عدد المصابين لكل مليون نسمة، وهذا يدل بفضل الله على أثر تطبيق الإجراءات الاحترازية الاستباقية. نرجوكم أن تتمسك جميعاً بالتعليمات وأن لا تتسبب تجاوزات من المخالفين في وقوع تفشيات للإصابات.</p> <p>The Kingdom is among the countries that are recognized for massively applying tests and controlling percentages of infected cases per million people, and this, thanks to God, indicates the effect of applying protective precautionary measures.</p> <p>We ask that we all adhere to the instructions and reduce violations that could cause outbreaks of cases</p> <p>ما حدث من ازحام وتجاوز للاحترازاات الوقائية في اليوم الوطني مقلق ومؤسف جداً، الوباء لا يزال موجود وبقوة، التساهل والتهاون يمكن أن يعيد زيادته وتسارعه لا سمح الله. حافظوا على صحتكم وسلامتكم وحياتكم وحياء من تحبون، نأمل منكم التعاون.</p> <p>What happened in terms of crowding and ignoring preventive precautions on the National Day is extremely worrying and unfortunate. The epidemic is still seriously present. Tolerance and complacency can increase and accelerate it, God forbid.</p> <p>Protect your health, safety, life, and the lives of those you love. We hope you all cooperate</p> <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Perceived Severity Health Belief Model (beliefs about the seriousness of a condition and its consequences) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Perceived Behavioral Control Theory of Planned Behavior (Belief that one has, and can exercise, control over performing the behavior) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Observational Learning Social Cognitive Theory (Learning to perform new behaviors by exposure to interpersonal or media displays of them, particularly through peer modeling) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Incentive Motivation Social Cognitive Theory (The use and misuse of rewards and punishments to modify behavior) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Self-Efficacy Social Cognitive Theory (Beliefs about personal ability to perform behaviors that bring desired outcomes) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Collective Efficacy Social Cognitive Theory (Beliefs about the ability of a group to perform concerted actions that bring desired outcomes) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |
| Facilitation Social Cognitive Theory (Providing tools, resources, or environmental changes that make new behaviors easier to perform) | <p>لست وحدك، الحياة تتأثر بقرارك نعوذ بحذر #</p> <p>You are not alone, life is heavily affected by your decisions. #we_are_back_with_caution</p> <p>هذي سعاد أحد #أبطال المجتمع ارعائيتها لزوجها في الحجر المنزلي، تعرف على قصتها. #كنا مسمول</p> <p>This is Suaad, one of the #sociey_heros who took care of her husband while he was in quarantine. Get to know her story: #We are all responsible</p> |

^a Some examples are associated with multiple categories.

virus. The public's interests align with the top tweet categories during this time period [31]. In summer 2020, people were speculating the fate of annual calendar events such as summer vacation, religious holidays (Eid Al-Fitr and Eid Al-Adha), Hajj pilgrimage, and the start of the academic year in September. This could explain the re-rise in tweets conveying news and about online learning.

Our theory-based analysis was further employed to evaluate the communication of multiple government entities in Twitter, through the lenses of health behavior theoretic frameworks. Communication is essential in connecting the public with policy decision makers for collaboration and cooperative actions, which therefore enhances the effectiveness of pandemic preparation, management, and recovery [32]. Our findings indicate that a substantial amount of Tweets, especially in the "empowerment" category, were linked to constructs related to key health behavior theories such as the Health Belief Model, the Social Cognitive Theory, and the Theory of Planned Behavior. Such findings could indicate efforts and techniques that were used to create a persuasive language, even if following such specific frameworks was not intentional.

Our findings demonstrate that Twitter can be a powerful communication platform to send messages to the public during a health crisis. Such messages are of utmost importance to guide the public during different stages of a pandemic [16,33]. While social media platforms, especially Twitter, play an essential role in sending public health messages during pandemics, such as COVID-19, they also play a vital role in secondary use of data for research and public communication improvement. Understanding the Twitter communication strategies by Saudi ministries is vital in understanding the breadth and depth of these messages, which may potentially guide efforts in developing public health communication frameworks, designed to fit a particular community.

Our study has several limitations. First, our selection criteria only included Saudi Ministries representing governmental entities. Other entities, which played a role in the fight against the pandemic such as the Saudi Data and Artificial Intelligence Authority and the National Health Information Center were not represented in our study. Second, we conducted a manual content analysis on a relatively small dataset. Using text mining techniques, such as automatic topic modeling and content analysis, would expand the dataset to include other disease outbreaks and government entities. This would increase the generalizability of our findings. Third, we did not analyze reach and impact, which could have measured the type of messages that drew a public reaction. Fourth, we limited our analysis to tweets that contained text only, which resulted in excluding multimedia tweets from our analysis, even though Saudi ministries heavily used them. Analyzing multimedia tweets could have potentially changed the prevalence of categories in our dataset. Lastly, our study exclusively analyzed Arabic tweets, which may not provide an overall view of governmental communication efforts towards non-English expatriates, given that the cooperation of expatriates living in Saudi Arabia played an important role in COVID-19 mitigation and control measures. Considering these limitations, our study may not have reflected the entire communication efforts of the five ministries included in our study, during COVID-19. Our research dataset can serve as a corpus for future work related to training and evaluating machine learning algorithms for automatic classification of public health messages posted on Twitter. Evaluation of multimedia and English language tweets related to these 15 topic areas will be conducted to further enhance the communication representation model, which can be used to extract information from other social media platforms and contribute to the development of social media communication frameworks used during pandemics.

5. Conclusion

Analyzing the contents of text found in Twitter communication messages demonstrated that collective communication efforts by

government ministries during the COVID-19 pandemic were constructed to ensure that the public was informed, supported, and empowered to respond to the disease outbreak. Our analysis demonstrated the importance of governmental communication messages covering disease and non-disease related topics. Our findings can help governments and health organizations build their social media communication strategies to effectively utilize relevant messages to enhance the public response to pandemics. Our study also contributes to theory development in the intersection between social media platforms, public health theories, and public communication messages. Integrating behavioral theories in the development of health risk communication should be taken seriously by government communication specialists who manage social media accounts, as these theories help underlining determinants of people's behaviors. This integration is even more relevant during public health crisis where comprehending the risk language, adherence to instructions and effective response by the public is crucial.

Ethical approval

This study was approved by King Saud University Medical City Institutional Review Board Research Project No. E-20-5323 on October 29, 2020.

Declaration of competing interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhip.2022.100257>.

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