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COVID-19 on Instagram: A content analysis of selected accounts

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ABSTRACT

Objective: This study aimed to characterize the representation of public health information related to COVID-19 posted on Instagram in 2020.

Methods: This qualitative content analysis study was conducted in Iran as one of the countries with the highest number of confirmed cases of COVID-19. Data were collected from the contents published from February 19 to April 3, 2020, on Instagram. The search feature of the Instagram app was used to find the posts related to Coronavirus or COVID-19. Overall, 1612 posts from 92 accounts were retrieved and analyzed using thematic analysis.

Results: A total of 23 themes emerged from the analysis of the retrieved posts. These themes include epidemiology and statistics, training and caring, general prevention guidelines, hygiene, healthy diet and lifestyle, patients, diagnosis and treatment, personal protective equipment, traditional medicine, psychology, children, cultural aspects, socio-cultural impacts, religious, misinformation, and wrong behaviors, animals, satire, condition of the healthcare system, politics, quarantine, operations of the Iranian National Disaster Management Organization (NDMO), economic impacts, and world news.

Conclusion: The contents analysis of Instagram posts during a public health crisis can provide new and realistic insights into the crisis and identify the topics of interest or concern of the public. Furthermore, the information collected in this way can help policymakers identify the most critical issues from the public perspective and utilize the gained knowledge to manage the ongoing and future pandemics.

Introduction

An increasing number of people use social media as one of their main sources of information and a channel for expressing their opinions [1]. Social media is described as a group of Internet-based services that allow people to create, share, and exchange information in a virtual community [2]. The top most widely used social media are Facebook, YouTube, WhatsApp, Instagram, WeChat, Sina Weibo, and Twitter [3–6]. The widespread use of social media has changed the way people around the world receive news and information [7]. Indeed, social media applications have also played a key role in how public health crises are viewed and managed [8,9]. In this regard, a study by Seltzer et al. has shown that im-

age sharing platforms such as Instagram and Flickr have been extensively used to exchange information about public health crises [7]. Also, the results of a systematic review study suggest that the data obtained from the analysis of online social networks can be used to track and estimate public concern about pandemics in real-time [10]. Today, many parts of the world have been affected by a global health crisis caused by the pandemic outbreak of a new coronavirus called COVID-19. According to the World Health Organization (WHO), so far, this virus has affected nearly 35 million people in 235 countries, causing more than one million officially confirmed fatalities [11]. As COVID-19 spread around the world, so did information and discussions about the virus on social media [6], which attracted millions of people eagerly trying to get more information about the emerging pandemic [4].

It has been shown that the data posted publicly on social media can be analyzed to get a snapshot of people's thoughts, attitudes, feelings, and concerns about this new virus [3]. In a re-

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cent study, the public opinion related to COVID-19 in China was explored by analyzing Sina-Weibo (a popular social media platform in China). This study identified seven main topics and 13 sub-topics related to the virus [4]. A study by Abd-Alrazaq et al. [3], which analyzed Twitter data, identified 12 main topics related to COVID-19. The information collected by the content analysis of social networks can help policymakers and healthcare organizations to identify the needs of stakeholders and address their concerns appropriately [3]. During public health crises, this information can also help researchers and health professionals to assess public fear, fight misinformation, raise awareness, and provide targeted instructions and training [7]. The analysis of social media posts about COVID-19 may also help governments better understand public opinion and sentiment about the situation and provide swift emergency response and support for post-crisis management [4].

The present study focused on the posts published about the COVID-19 pandemic on Instagram. It is estimated that about 120 million new accounts are created on Instagram monthly, which makes it one of the world's most popular social networking services [12]. Instagram is also one of the most popular social networking platforms in Iran, where it has more than 24 million users, according to 2018 statistics, [13]. With the spread of COVID-19 in Iran and other countries, Instagram has become a widely used tool for publishing information about the pandemic in the form of images, videos, music, and text posts with thousands of daily views. Therefore, some studies investigated the diffusion of COVID-19 information on Instagram and provided a multilingual COVID-19 Instagram dataset [,[14]]. Since there has been no study on the Instagram posts in Persian language about COVID-19, the present study attempted to explore and analyze the contents of these posts.

Methods

This research was a qualitative study carried out using the content analysis method. Data were collected from the contents published from February 19 to April 3, 2020. The search feature of Instagram was used to find the posts containing انروک (Persian script of 'Corona'), انورک (another Persian script for 'Corona'), and #COVID-19. Only the Persian posts related to COVID-19 were included. Appendix A shows the results of the search on Instagram.

Data collection method

A data extraction form was prepared to facilitate the data collection from the Instagram posts (pages). This data extraction form had 9 items: 1- Upload date, 2- Media type, 3- Content description, 5- Number of likes, 6- Number of views, 7- Number of followers, 8- Biography information, and 9- Post presentation. The inclusion criteria for the Instagram posts were: being in Persian or having Persian captions or containing media (images and videos) with Persian captions, and being posted within the considered period of time (February 19 to April 3, 2020). The posts that were not in Persian or were published outside the study period were excluded. The contents of eligible posts were extracted using the data extraction form. Content analysis was continued until data saturation was reached (i.e. no new key contents emerged from the analysis). The data collected from the data extraction form was tabulated in Excel. Overall, 1612 posts from 92 accounts were reviewed (Fig. 1).

Data analysis method

The contents of the posts were analyzed using the thematic analysis method. In general, this method consists of these six
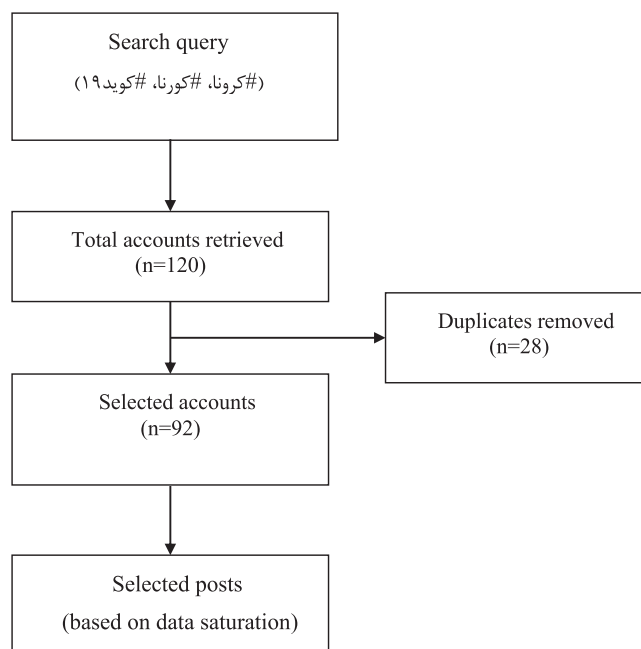

Fig. 1. Flow diagram of Instagram posts selection.

steps: 1- familiarization with data, 2- preliminary coding, 3- finding themes, 4- reviewing themes, 5- defining and naming themes, and 6- producing report [15]. In the first step, the contents of eligible Instagram posts were read multiple times to become familiar with the collected data and gain a general idea of what contained in the posts. In the second step, the key contents of the photos, videos, and captions of the posts of each page were extracted separately and arranged into a table of preliminary codes. In this step, a total of 1885 key contents with 160 preliminary codes were extracted. Similar semantic codes were given the same codes. The third step was to categorize the obtained codes into potential sub-themes and themes. The fourth step consisted of two stages: reviewing the themes, including the coded summaries to determine whether they are valid for the original data set, and refining the themes to make them more accurate and a better representative of the data. In the fifth step, the themes were defined based on their nature, what they discuss, and the aspect of the data which they represent. In the final step, the themes were named according to their definition with care to make sure they provide a comprehensive representation of the contents of Instagram posts about COVID-19 in Iran.

Lincoln and Guba's trustworthiness criteria were used to ensure the accuracy and robustness of the collected data [16]. To make sure of the credibility of the data, the authors spent a prolonged period of time on data collection and reviewed the data repeatedly to become immersed in the data. Also, the research protocol, data collection tools, and extracted codes and themes were examined and validated by a colleague with expertise in the field of qualitative research who was not involved in data collection and analysis, and had no conflict of interest.

In this study, Instagram was considered to be a system consisting of input, process, and output. In other words, the data were modeled using a simple systems analysis model called the input-process-output (IPO) [17]. The inputs of this model were extracted from the content analysis of the reviewed Instagram posts. According to the spectrum available in the literature [18,19], these inputs were considered to be in three general categories of the information needs of the Iranian society, social and cultural conditions of society, and the problems of this society during the

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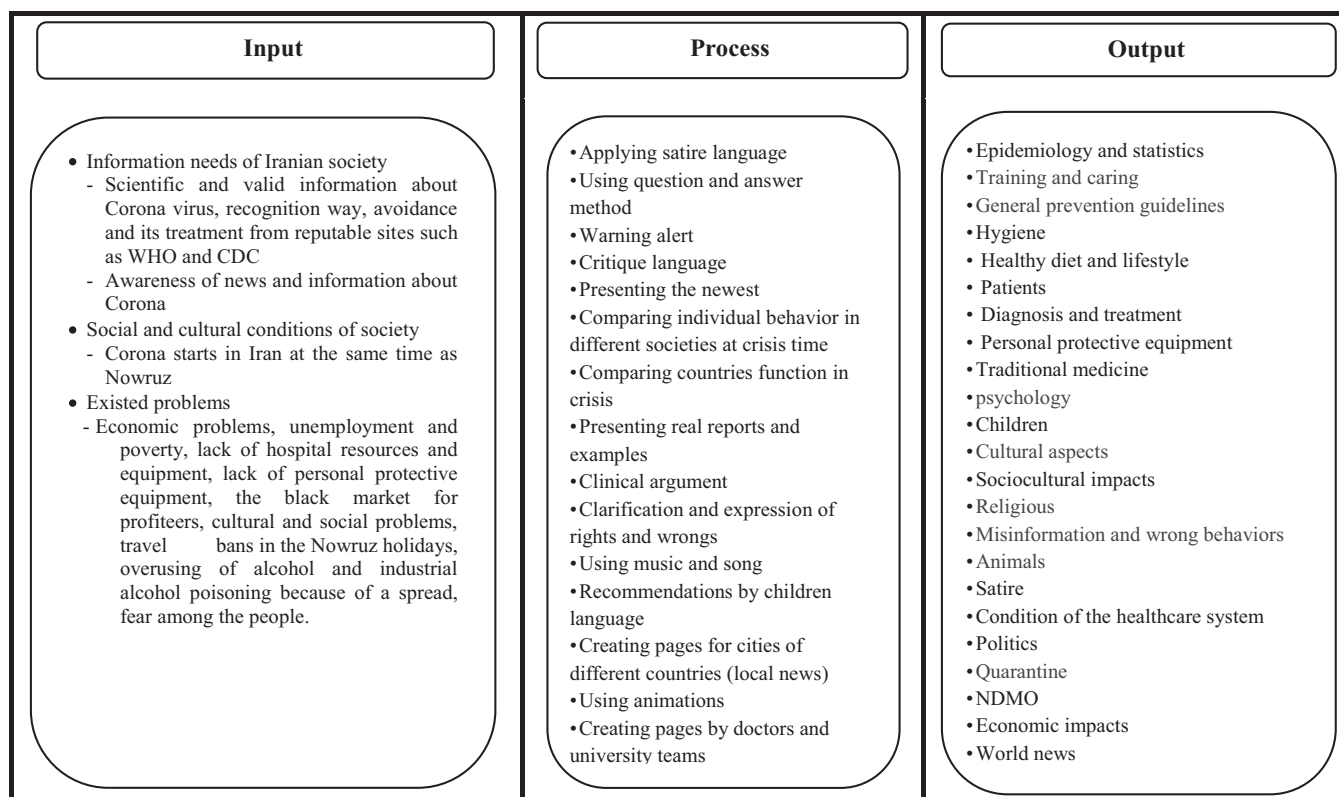| Input	Process	Output
• Information needs of Iranian society - Scientific and valid information about Corona virus, recognition way, avoidance and its treatment from reputable sites such as WHO and CDC - Awareness of news and information about Corona • Social and cultural conditions of society - Corona starts in Iran at the same time as Nowruz • Existed problems - Economic problems, unemployment and poverty, lack of hospital resources and equipment, lack of personal protective equipment, the black market for profiteers, cultural and social problems, travel bans in the Nowruz holidays, overusing of alcohol and industrial alcohol poisoning because of a spread, fear among the people.	•Applying satire language •Using question and answer method •Warning alert •Critique language •Presenting the newest •Comparing individual behavior in different societies at crisis time •Comparing countries function in crisis •Presenting real reports and examples •Clinical argument •Clarification and expression of rights and wrongs •Using music and song •Recommendations by children language •Creating pages for cities of different countries (local news) •Using animations •Creating pages by doctors and university teams	•Epidemiology and statistics •Training and caring •General prevention guidelines •Hygiene • Healthy diet and lifestyle • Patients • Diagnosis and treatment • Personal protective equipment •Traditional medicine •psychology •Children •Cultural aspects •Sociocultural impacts •Religious •Misinformation and wrong behaviors •Animals •Satire •Condition of the healthcare system •Politics •Quarantine •NDMO •Economic impacts •World news

Fig. 2. Modeling of Instagram system using IPO model.

COVID-19 pandemic. For the process component of the process, which here was considered to be the strategy, the data from the "Post presentation" item of the data extraction form were used. The data extracted from the first step of thematic analysis were read and re-read several times to determine the strategies used in each post and achieve complete mastery of the content. Then all identified items were reviewed, and ultimately 15 strategies were extracted from the existing semantic units. The themes extracted in the thematic analysis were considered as the output of this model.

Results

Out of 1612 posts reviewed, 811 had video-type contents, and 801 had photo-type contents. From the analysis of the contents of 92 Instagram pages, 1885 key post contents with 160 preliminary codes were extracted. The coded data summaries were classified into 26 themes. After refining the themes, the number of themes was reduced from 26 to 23. The corresponding themes, subthemes, and samples of example posts are presented in Table 1. The results of the system modeling of Instagram using the IPO model is depicted in Fig. 2.

In this study, tThe contents of Instagram posts were categorized into 23 themes, including 1-epidemiology and statistics, 2- training and caring, 3- general prevention guidelines, 4- hygiene, 5- healthy diet and lifestyle, 6-patients, 7- diagnosis and treatment, 8- personal protective equipment, 9- traditional medicine, 10- psychology, 11- children, 12- cultural aspects, 13- sociocultural impacts, 14- religious, 15- misinformation and wrong behaviors, 16- animals, 17- satire, 18. condition of the healthcare system, 19- politics, 20- quarantine, 21- Operations of the Iranian National Disaster Management Organization (NDMO), 22- economic impacts, 23- world news.

Discussion

In this study, we analyzed the contents of Instagram posts related to COVID-19 in Persian language. The results of the study are consistent with the findings of Abd-Alrazaq et al. [3], who reported that Twitter users pay more attention to the impact of COVID-19 on people and countries, especially the number of deaths. The results are also in agreement with the findings of Han et al. [4], who found that the general public is interested in finding out about the events. In the present study, the "epidemiology and statistics" theme contained references to the spread of the virus and its recognition as a pandemic with codes such as "COVID-19 spread declared a pandemic by WHO". A study by Stechemesse et al. [20] also observed that this topic had received many likes by Twitter users.

In the world news theme, a recurring topic was the "bad food habits of the Chinese". This may because the reviewed posts were related to the first month of the spread of COVID-19 in Iran, when it was rumored on social media that COVID-19 was being traced back to a Chinese bat soup. In the study of Stechemesse et al. [20], they reported that the attacks on Chinese food habits and health standards started in the second half of March with 2500 tweets per day. In this regard, Han et al. [4] reported that the topic of "condemning bad habit" was also trending among Sina-Weibo users. In the present study, the "world news" theme also contained codes about the banning of air travel from infected countries including Iran and China. Abd-Alrazaq et al. [3] also observed this in Twitter posts.

Two major themes in the reviewed posts were "diagnosis and treatment" and "general prevention guidelines". This may be because after becoming aware of the pandemic, many people start searching social media for ways to prevent infection and protect themselves and their families from the virus. The analysis of posts with the "general prevention guidelines" theme showed that they

Table 1
Themes, sub-themes and supporting quotes extracted from the content analysis of user accounts related to COVID-19.

Theme	Subtheme	Example posts
Epidemiology and statistics	• Virus prevalence • Ways of transmission • Number of corona cases and mortality • Patients age • Duration of coronavirus in a population	○ "Prediction of the peak of corona prevalence in Iran." ○ "WHO announced that coronavirus spreads through respiratory saliva, …" ○ "Confirmed Coronavirus cases in different countries …" ○ "WHO announced that older people are more vulnerable to covid-19." ○ "Coronavirus persistence in a society depends on factors, including the deadly and contagious nature of COVID-19 pandemic, …"
Training and caring	• Education and precautionary measures • Caring for high-risk individuals • Caring for oneself and others at home • Coronavirus tips for the deaf	○ "Coronavirus precautions for patients, including wearing masks, …" ○ "Guide for people at most risk of serious infection from COVID-19 include: elderly, immunodeficiency syndrome, …" ○ "How to care for confirmed or suspected COVID-19 patients at home? " ○ "Symptoms of coronavirus in deaf language …"
General prevention guidelines	• Recommendation for protecting yourself and others • Recommendation for travel • Recommendation for the workplace • Recommendation for using public transportation • Recommendation for bakers and bread buyers • Recommendation for protecting homes	○ "WHO recommendations for protecting yourself and others from spread COVID-19: …" "Passengers are required to wear face masks at the airport and in the cabin, …" ○ "Advice on preventing the spread of COVID-19 in Workplace, including …" ○ "Best public transportation in corona time …" ○ "Promoting social distancing when lining up for buying bread …" ○ "How to avoid the spread of COVID-19 in the kitchen…"
Hygiene	• Environment hygiene • Environmental impacts • Recognize contaminated devices and places • Infection control • Disinfection	○ "The request of the Yazdi sweeper from the citizens not to throw gloves, … " ○ "Environmentalists are worried about swallowing up masks by dolphins, …" ○ "The most polluted devices that we are in contact with, including mobile, …"; "Nutrition stores are the most dangerous place to get infected" ○ "Some recommendations of infection control committee to medical staff, …" ○ "What alcohol is suitable for disinfection? and what is not suitable …"
Healthy diet and lifestyle	• Nutritional recommendation • Food safety • Tobacco and alcoholic beverages • Exercise	"Protect yourself from the Coronavirus by taking Vitamins B, C, D, …""Meat should be cooked completely and consumption of raw … " ○ "Not smoking, can help prevent or lessen symptoms of COVID-19 … "; "Do not drink alcohol beverages while …" ○ " You can still exercise in some public places…"; "Practice yoga at home."
Patients	• Patients' condition • Patients experience • News of recovered patients	○ "Showing the suffering that Corona patients endure, …" ○ "….. says his bad experience of Covid-19 from diagnosis to recovery, …" ○ "A 113-years-old woman defeated Coronavirus."
Diagnosis and treatment	• Medication treatment • Drug distribution • Medicinal do's and don'ts • Vaccine news • Signs and symptoms and body's function • About virus • Paraclinical diagnostic methods	○ "Successful plasma injection experiment in Qom city, …" ○ "Queue to buy prescribed drugs for patients with Coronavirus." ○ "Whether treatment with hydroxychloroquine, Vitamin C, … can prevent symptoms of COVID-19." ○ "The first Coronavirus Vaccine was tested on human in Seattle …" ○ " The virus can cause a range of symptoms, ranging from mild illness to …." ○ "Corona virus explanation for kids to help them …" ○ "CT scans can be used to diagnose COVID-19, …"
Personal protective equipment	• Glove • Mask	○ "when we need to wear gloves, when to remove gloves …" ○ " Do not touch the mask while wearing and remove it …"
Traditional medicine	• Recommendation for using herbal medicines • Criticism of traditional medicine	○ "Using herbal medicine, such as ginger and cinnamon, is effective in, …" ○ "There is no scientific reason about smoking plants for treatment of corona …"
Psychology	• Stress and fear • Strategies to deal with stress, anxiety and depression • Hope	○ "Showing a strong fear of suspected cases and their family when …" ○ "Managing your mental health while working from home in COVID-19…" ○ "The birth of a baby in the Corona crisis is a manifestation of hope in society"

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Table 1 (*continued*)

Theme	Subtheme	Example posts
Children	• Behavior with children • Advice in children's language • Child labor • Covid-19 in children	○ "What should we say to our children about coronavirus or not say? …" ○ "I understand this can be scary. We're taking steps to keep healthy, and …" ○ "Interview with child labor who are on the street at the time of Corona …". ○ " A 4-year-old child is infected with corona."
Cultural aspects	• Human behavior in different countries • Culture of Behavior with Corona patients • Support of healthcare workers • Role of celebrities • Patients burial • Coronavirus lessons to humans	○ "Chinese people flee from contaminated area from the lake …" Many Tehranies travelled to the North in in the Covid-19 outbreak period." ○ "Corona disease is not a social disgrace, it's just a disease. …" ○ "Performing music, thanking and inspiring artists to patients and staff, …" ○ "The help of wrestlers to the people of Gilan, in the time of Corona …" ○ "If the family wishes only to view the body and not touch it, they may …" ○ "Current crisis offers some opportunities for most people, including rethink their habits …"
Sociocultural impacts	• Public donations • Jihadi efforts • Negligence • Saving water consumption • Family disputes	○ "Helping people in need on Eid night …" ○ "Distributing of health packs among rural people …" ○ "Heavy presence of people in the markets and gatherings in February …" ○ "Use proper handwashing technique. Turn off the tap to save water during …" ○ "What can we do to keep quarrels to a minimum when homebound with …"
Religious	• Praying and worship • Prejudices • Shrine disinfection	○ "Praying and crucifixion over the city by a priest for ending this disease …" ○ "Crowds forced their way into the shrines, protesting at the closures …" ○ "Special measures in holy shrine of Masoome, putting a separating rod in front of the shrine and disinfect the shrine, …"
Misinformation and wrong behaviors	• Superstitions and rumors • Ignoring rumors • Clarification about the rumors • Contradictory information	○ "Hundreds die in Iran from methanol poisoning aimed false claims it cures …" ○ "Rumors are fueling confusion and more damaging than fake cure …" "A vaccine to cure COVID-19 is available. **False;** "wearing a face mask affects the spread of covid-19. True …" ○ "Vitamin C alone is an effective cure of Covid-19″**; "A Newsweek article said, the effectiveness of vitamin C as a treatment for Covid-19 is not established …"
Animals	• Animal origins of CoronavirusPreventive tips for contact with animals • Animals care • Corona infected animals	○ "Scientists suggested that the ant-eating pangolin was the prime suspect …" ○ "Wash your hands with soap after touching animals and animal products…" ○ "If you are sick, avoid close contact with your animals as a precaution …" ○ "After being dog, cat, tiger, and lion hunted by the coronavirus, now Mink …"
Satire	• Satire about staying at home • Political satire • Satire about obsession • Health satire	"Satire about prohibition of visiting relatives in Iranian New Year (Norouz) …" ○ "Satire about the responsible person or position for Corona **…"** ○ "Satire about the obsession to disinfect people at the entrance of home **…"** ○ "Proper hand washing by using satire and music"
Condition of the healthcare system	• Hospital facilities and resources • Healthcare staff • International health assistance to Iran	○ "Lack of care facilities and equipment including, mattress, ventilator, …" ○ "Healthcare staff are working under extreme pressure and daily high risk …" ○ "WHO sends a planeload of supplies to fight coronavirus in Iran …"
Politics	• Political and marginal news • Hypothesis of human-made virus production • Politicians with coronavirus	○ "Iran are struggling with the double pressure of political sanctions to provide medical equipment and medicines to combat Covid-19 …" ○ "Is coronavirus a bioweapon? …" "Iran's deputy health minister have tested positive for coronavirus …"
Quarantine	• Quarantine entertainment • Reasons for home quarantine • Requirements for home quarantine	○ "Complete a puzzle, watch all the movies you've avoided until now …" ○ "Stay at home for breaking the transfer chain…" ○ "The home should be ventilated and have enough space for each person …"

Table 1 (*continued*)

Theme	Subtheme	Example posts
NDMO	• Legislation in crisisExecutive operations in crisis	○ "Car seizure and 5,000,000 IRR fine for travel bans offenders …" ○ "Report of fever screening for Coronavirus by the red Crescent forces at the exit of the provinces of Iran, …"
Economic	• Economic problems • Hoarders • Government economic support	○ "Those working in the informal economy and daily wage earners are likely to be the worst affected. With no fixed salaries, little to no savings, …" ○ "The hoarding of disinfectants and masks and selling them at high prices …" ○ The government stimulus package included funding for the unemployment insurance fund, aid to businesses, unemployed workers and poor families …"
World news	• Asian countries • European countries • Russia, United States of America, Australia	"China completed the second of two new hospitals in just over a week …" ○ "Italy was the first European country to impose lockdown on its citizens…" ○ Russian president Putin visited Moscow's main coronavirus hospital …"

contained recommendations for protecting yourself and others, for protecting your home, for travel, for the workplace, for the use of public transport, and about bread and bakeries. Many posts also contained questions and information about the challenges of diagnosing and treating infected people such as how to tell if someone is infected, what the symptoms are, and so on. The content analysis showed that the Instagram posts with this theme contained materials about drug treatment, drug distribution, vaccine news, virus description, how to diagnose the infection and identify its symptoms, and the body's response to the virus. The results of this part of the study are consistent with the results of the study of Han et al. [4], on the posts in Sina-Weibo in China, which showed that people pay considerable attention to prevention and treatment and that seeking medical help has been discussed extensively in this social network. The results of the present study about the symptoms of COVID-19 are in agreement with the findings of Yue et al. [6], who showed that WeChat users were talking extensively about the signs and symptoms of the virus. The results of the present study are also consistent with the results of Abd-Alrazaq et al. [3], which showed that Twitter users were interested in ways to reduce the spread of the virus. The results of a study by Kouzy et al. [21] also showed that medical/public health is one of the areas of interest in Twitter, which is consistent with our results. The results of the present study about the virus description are in agreement with the results of Abd-Alrazaq et al. [3], which reported that Twitter users were interested in talking about the source of the virus.

Another two common themes identified in the reviewed posts were the socio-cultural impacts of the pandemic and the condition of the healthcare system. Perhaps the reason for the presence of the first theme is that shortly after the official announcement of the spread of COVID-19 pandemic to Iran, many Iranians and community benefactors attempted to strengthen the spirit of empathy in the society and direct this energy to the charities that were launched to help the affected Iranians. Also, since the growth of the pandemic coincided with the Iranian New Year (Nowruz), which is Iran's busiest shopping and vacationing season, many Instagram posts showed concerns about the possibility of people neglecting social distancing rules. The reason for the attention of Instagram posts to the condition of the healthcare system may be the intention to raise public awareness about the situation of the healthcare workers and the hardships they are enduring in when caring for the affected people. Possibly the intention was to make negligent individuals comply with the hygiene and distancing guidelines. In the present study, there were also many posts showing that some people were neglecting govern-

ment guidelines, especially about travel. In contrast, the study of Han et al. [4] showed that following the announcement of movement restrictions in China, most Chinese people stayed at home and complied with the protection instructions, and this was reflected in the posts in Sina-Weibo. Another theme observed in the reviewed Instagram posts was the condition of hospital facilities and resources and the international aid sent to Iran. The study of Yue et al. [6] also reported that WeChat posts saw the relief efforts from other countries and the domestically manufactured medical supplies as heartening support for healthcare workers. The results of the present study regarding the theme "condition of the healthcare system" and the sub-theme "condition of healthcare workers" are also consistent with the findings of Seltzer et al. [7], which showed that 25% of the contents of Instagram and Flickr posts about Ebola were related to healthcare workers and specialists.

Other themes observed in the reviewed Instagram posts were the operations of NDMO, quarantine, economic impacts, false information, wrong behaviors, cultural aspects, training and care, personal protective equipment, satire, and psychology. The posts mentioning the operations of NDMO and other governmental institutions to handle the pandemic could be intended to reassure the people that they will have the support of the government in this crisis. Mostly, these posts contained information about pandemic-related legislation, crisis management operations, city-wide measures, preparation of medical center, and screening. In their study, Yue et al. [6] reported that with the deterioration of the pandemic situation in China, the policy of isolating the cities and keeping people at home became one of the issues discussed on WeChat.

The subject of quarantine was also frequently discussed in the Instagram posts of Iranian users, as the experience of Chinese had shown that it could be used to effectively limit the scope of the pandemic. This is because, at the onset of the COVID-19 pandemic in Iran, many Iranians were not taking this issue seriously. In fact, the 'stay at home' order before the Iranian new year was only for 14 days. However, with the growth of the pandemic, the subject of quarantine attracted more attention, and Instagram posts started to emphasize the importance of not traveling and staying at home and the reasons for this instruction and also to provide information about potential quarantine entertainment and the requirements for staying at home during the pandemic. These results are consistent with the findings of Abd-Alrazaq et al. [3], who reported that in Twitter, quarantining suspected cases and infected people was frequently mentioned as a way to reduce the spread of the virus, especially as a first step to keep the situation under control. These results of the present study are also in agreement with the results

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of Han et al. [4], which showed that staying at home and taking precautions were frequently discussed topics in Sina-Weibo.

Personal protective equipment, like face masks and gloves, was another theme commonly found in the reviewed posts. Perhaps, this can be attributed to the controversy about the use of face masks and the shortage of them and other personal protective equipment in the early days of the pandemic in Iran. This led to a wave of posts dedicated to news about masks, shortage and hoarding of masks, the correct way to wear a mask, the difference between various types of masks, and how to create rudimentary masks and gloves at home. These results are consistent with the results of the study of Yue et al. [6], where the word mask was found to be popular among WeChat users. Abd-Alrazaq et al. [3] also stated that the use of face masks as a way to reduce the spread of the virus is a topic frequency discussed by Twitter users. This study also noted that Twitter users have discussed the issue of mask shortages in several countries.

In the area of training and care, the semantic codes identified in the reviewed posts were related to education and precautionary measures, caring for high-risk individuals, caring for oneself, and others at home. The reason for the presence of this theme in posts could be the emphasis put by the CDC on preventing oneself, one's family, and high-risk individuals from contracting the virus [22]. Also, cautionary and education measures were essential for reducing the number of visits to medical centers due to the sudden outbreak of COVID-19 and the shortage of hospital resources in Iran. This need was reflected in the reviewed Instagram posts. These results of the present study are consistent with those of Han et al. [4], where it was observed that Sina-Weibo users had extensively discussed staying at home, taking cautionary measures, and helping patients. This study also reported that another popular topic that emerged after the beginning of this epidemic was the popularization of anti-epidemic knowledge in family.

The economic aspect of the pandemic was reflected in the reviewed posts with sub-themes such as economic problems, hoarders, and the government financial support. The reason for attention to such issue was the severe impact of this crisis on the economy, not only in Iran but in all around the world. In his study, Abd-Alrazaq et al. [3] also stated that the effect of COVID-19 on the economy was a hot topic of discussion for Twitter users. Stechemesser et al. [20] also reported that Chinese Twitter users talk about the economic impacts of COVID-19 in low and middle-income countries. Kouzy et al. [21] also reported that the economic impact of the pandemic is one of the topics of interest to Twitter users. Similarly, Bonaccorsi et al. [23] highlighted that the COVID-19 crisis has sharply reduced fiscal revenues for governments and hit economies at a critical moment. So, to mitigate the poverty and inequality caused by the crisis, financially fragile individuals should be sustained over the crisis period.

In the theme of cultural aspects, Instagram posts had sub-themes such as human behavior during the pandemic in different countries and the support and encouragement of healthcare workers. This is consistent with the findings of Yue et al. [6], according to which Chinese people on WeChat talk about healthcare workers as heroes. Abd-Alrazaq et al. [3] also detected the panic buying during the COVID-19 pandemic in the posts of Twitter users in China, which is consistent with the results of our studies in relation to human behavior during the pandemic in different countries.

In the area of misinformation and wrong behaviors, some Instagram posts had mentioned rumors and superstitions, some had recommended ignoring rumors, and some had provided clarification about the rumors. This is perhaps because of the large number of pages that are maintained by people working in healthcare or affiliated with medical universities. There was, however, some contradictory information in the posts, for example, about the effectiveness of vitamin C supplementation and how long COVID-19

survives in open spaces. Perhaps this is because each page had its own references, which all seemed scientific and legitimate, therefore confusing people as to which reference is offering the most accurate information. In a study by Merchant et al. [24], they also noted that social media provide a channel for the intentional dissemination of misinformation and rumors. They added that the majority of offending Facebook, WhatsApp, Twitter, and YouTube accounts are actively trying to cause panic and confusion, creating a situation in which it is very difficult for people to access reliable and trustworthy information. Zarocostas highlighted the rapid spread of both accurate and inaccurate information (infodemic) in the time of COVID-19 and stated that the global epidemic of misinformation presents a serious problem for public health [25]. In this regard, Kouzy et al. [21] reported that the lowest portion of false information on Twitter was related to public health and healthcare accounts. They also pointed out the existence of false and misleading information on Twitter about the COVID-19 pandemic. Likely, Cinelli et al. found diverse volumes of misinformation in each platform (Twitter, Instagram, YouTube, Reddit and, Gab) in the COVID-19 topic [24]. Therefore, WHO launched a platform called Information Network for Epidemics (EPI-WIN) to combat misinformation about COVID-19. As social media sometimes get ahead of the evidence, the public health community should help this social media in providing evidence-based information to the general public [23]. Also, Habersaat et al. emphasized anticipating and managing the misinformation as consideration for managing the COVID-19 transition [26].

In relation to the psychology of the pandemic, the subthemes found in the posts were fear and stress. This fear in the reviewed Instagram posts can be related to the stress of observing large numbers of infections and fatalities in other more resourceful and advanced countries such as China, Korea, and Italy, the fact that there is no definitive treatment for the virus, and the multitude of unanswered questions about the new virus. The fear of getting infected, the sense of extreme fear and stress among infected people, and the sense of panic among people were evident in the posts. These results are consistent with the results of Abd-Alrazaq et al. [3], which also identified a theme of fear and stress caused by COVID-19 among Twitter users; an effect that was attributed to the fast spread of the virus and the lack of definitive treatment.

Many of the reviewed Instagram posts had satirical content with a focus on political, social, and health dimensions of the issue. Perhaps, this is because satirical posts are more effective in conveying a message in times of crisis and distress. In this regard, the results of Kouzy et al. [21] show the widespread circulation of satirical tweets among Twitter users. Also, Seltzer et al. [7], who identified 9 themes in the contents of Instagram and Flickr posts about Ebola, reported that satire was a major theme in these posts and accounted for 23% of their content.

In regard to animals, the subthemes found in the posts were the animal cause of COVID-19, preventive measures for contact with animals, animal care, and the possibility of animals contracting COVID-19. The reason for this attention to animals in Instagram posts about COVID-19 is the hypothesis that the virus has animal origins and is likely to have jumped from a bat. The results of this part of the study are consistent with the results of Abd-Alrazaq et al. [3], which reported many tweets theories about the role of meat consumption in the spread of COVID-19 and placed this under the subtheme named the source of the virus. In their study, Yue et al. [6] reported that in WeChat posts, bat, pangolin, masked palm civet, and bushmeat were hypothesized to be the source of the virus.

Some of the reviewed posts contained a religious theme, with a focus on prayer. This is because many publicpeople, as well as religious figures in Iran and other parts of the world use posts to pray for the affected people and for their communities to overcome this

challenge. Similarly, Han et al. [4] reported that blessing and praying was a major topic in Sina-Weibo posts.

In the political theme, the subthemes found in the posts were related to political news and controversies about racism. As discussed earlier for another theme, this is probably because of negative public opinion in Iran as well as other countries about the food culture in some parts of China and the hypothesis that the virus has started from a seafood market in this country. Stechemesser et al. [20] also reported hateful attacks on Chinese culture in tweets. As well as, Schild et al. found that Sinophobia has increased due to COVID-19 on Web communities like /pol/, and Twitter [27,28]. Abd-Alrazaq et al. [3] also observed racism and prejudice against East Asian people among Twitter users. At the same time, the present study also found many posts with the message of sympathy of the Iranian people with China.

Several posts have also questioned whether COVID-19 could be man-made or a bioterrorism attack. In the study of Abd-Alrazaq et al. [3], this topic, which was widely discussed by Twitter users, was categorized under the subtheme of the source of the virus. The results of the present study regarding the political scope of the COVID-19 pandemic are also consistent with the results of Seltzer et al. [7], who showed that 45% of the contents of Instagram and Flickr posts about Ebola are related to politics.

Conclusion

This study analyzed the contents of the posts of Persian Instagram posts related to COVID-19 from February 19 to April 3, 2020. It was observed that Instagram account owners use multiple strategies in creating content about a public health crisis. Therefore, it appears that analyzing the contents of Instagram posts during a public health crisis can help us gain insight into the thoughts and feelings of people about the crisis and identify their topics of interest under this condition. The information collected in this way can help policymakers identify the most critical issues and challenges, and then employ the gained knowledge for the management of the ongoing and future pandemics. Politicians can also use this content-analysis-based approach to promote public participation in preventing and fighting pandemics. Also, government officials can use this medium during such public health crises to act more effectively in clarifying the ambiguities and informing the public about different aspects of the situation and keeping the communities calm and helping them relieve stress and tension, which are highly needed.

Limitations

The findings of this study should be interpreted in light of its limitations. The first limitation is the limited sample size used in the qualitative study, that may have induced some sort of bias. In this study, given the nature of qualitative study, we carried out a content analysis of the COVID-19 posts on Instagram in a specified period of time until data saturation was reached. However, considering a huge amount of data generated on Instagram every day, the time period of study may have affected the results. The second limitation is the focus on Persian names of Coronavirus hashtags instead of searching top posts and accounts; an approach that was chosen because of the large number of top posts and the high frequency of irrelevant posts. The third limitation is that contents of the caption of the posts were not examined separately, because in many cases the caption was not a perfect representative of what contained in the post, and therefore the extracted content was just a composition of the caption text and the description of the image or video in the post.

Appendix A. Account search on Instagram

Persian name	English translation	Account name
#کرونا #کروناﺯ	Corona	corona_ khabar, corona_tabriz،anticoronakb, coronavirus.8, corona_virusiran, corona__ir, corona virus info, virus_cruna, corona_virus_100, cancer. Nutrition, corona_va_amoom, chaboksar_sarvelat, golestan_corona, corona__ir, smm_ir, crona_virus_news, virus.corona.news, coronavirusir, corunvirus iranwithoutcorona, iranwithoutcorona, coronairan1, vaksan_tv,
#کووید19	COVID-19	corona2020bot, poyesh_corona_jums, Jfpwrpfarsa, corona.plus, khabar_korona, coronankhabar, coronakhandeh, coronavirus.ir, crona__joke, coronagonbad, korona_morona, ahde_mahdavii, coronadariran, coronavirussira, corona.irani, coronatums, man_dar_khane_mimanam, irancoro, winners 2020, khamir.anticrona.army, corona.iran.2019, coronanaa_, corona_virus_video, fasa_aminijavidi, corona.farrokhshahr, corona.iran.health, coronavirus2020world, akhbare_korona, esfhanihas, corona._.kovid19, corona_skh, koronawiros, coronairan_news. korona982020, coronavirus_ir, corona.oo, elnaz6hosseini, yasin_korona, yasin_korona, ahoora7890, iranmnto, ahmad_azmodh_beyranvand, mask_korona1, zed__corona, korona.0111, korona3957, hsnzary420, korona2029, khwrn47, wywskhwrn, ggguuy98, khlg21, dedo0oo0, mydmhmdy8677, tllbby65, khwrn82, mhamhard2020, rftqtbkhwrn, faryus_kwrna, df_f12, corona_ir1399. viroscoronacovid19, corona_verus.2020, coronaviruse_covid19, corona_ramsheh, iranwithotcorona

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