Research article

A content analysis of newspaper coverage of COVID-19 pandemic for developing a pandemic management framework

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ABSTRACT

Background: The emergence of COVID-19 pandemic has not only shaken the global health sector, but also almost every other sector, including economic and education sectors. Newspapers are performing a significant role by featuring the news of COVID-19 from its very onset. The temporal fluctuation of COVID-19 related key themes presented in newspaper articles and the findings obtained from them could offer an effective lesson in dealing with future epidemics and pandemics.

Aim and method: This paper intends to develop a pandemic management framework through an automated content analysis of local newspaper coverage of COVID-19 pandemic in Bangladesh. To fulfill the aim, 7,209 newspaper articles are assembled and analyzed from three popular local newspapers named "bdnews24.com", "New Age", and "Prothom Alo English" over the period from January 1, 2020 to October 31, 2020.

Results: Twelve key topics are identified: origin and outbreak of COVID-19, response of healthcare system, impact on economy, impact on lifestyle, government assistance to the crisis, regular updates, expert opinions, pharmaceutical measures, non-pharmaceutical measures, updates on vaccines, testing facilities, and local unusual activities within the system. Based on the identified topics, their timeline of discussion, and information flow in each topic, a four-stage pandemic management framework is developed for epidemic and pandemic management in future. The stages are preparedness, response, recovery, and mitigation.

Conclusion: This research would provide insights into stage-wise response to any biological hazard and contribute ideas to endure future outbreaks.

1. Introduction

Since its first appearance in December 2019 in China, Novel Coronavirus (SARS-COV-2) within a few months has spread all over the world via human-to-human interactions and exposed surfaces [1, 2]. In March 2020, the World Health Organization (WHO) declared COVID-19 epidemic as a global pandemic. This pandemic has already been recognized as a biological disaster causing widespread human, social, and economic damages [3].

In the last century, the world experienced many more such events like Seasonal Dengue, Malaria, Diphtheria, Plague, Foot-and-Mouth Disease, Bird Flu, Swine Flu, H1N1 Influenza, Cholera, Ebola, SARS, Zika, and Yellow Fever [4]. Along with these incidences, the global healthcare system has passed through gradual challenges and broader socio-economic consequences have occurred, both in the short and long run [5, 6, 7]. Climate change, alteration in biodiversity, lifestyle shifts,

and other associated environmental circumstances could influence any pandemic outbreak negatively and expedite to induce new epidemics frequently [8, 9, 10]. Therefore, it is important to develop adequate disaster management strategies under a systematic framework to combat any epidemic and pandemic.

WHO [11] has briefly pointed out the four segments of such disaster management framework focusing on the healthcare system: Mitigation, Preparedness, Response, and Recovery. For competent management of any biological disaster, adequate measures should be undertaken to reduce the risk before the appearance of disaster (mitigation); a nation-wide well-equipped healthcare system has to be prepared before the disaster (preparedness); an emergency response system requires to be developed for immediate action when the disaster prevails (response); and strategies have to be formed so that the system can bounce back from the crucial stage and diminish the long term effects of the disaster (recovery). But the jolt of any pandemic is not only limited to the healthcare

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system but also on diverse sectors, evidenced from the most recent COVID-19 [12,13]. Therefore, learning from COVID-19 pandemic can help to prescribe strategies under these four broader segments as well as to build up a pandemic management framework to fight any similar future emerging pandemic.

Since the initial period of COVID-19 pandemic outbreak, local, national, and international newspapers and news portals are playing an indispensable role by presenting regular updates on the pandemic, local and global interventions to prevent the pandemic, quality and critiques of the healthcare system, experts' opinions on the pandemic, and so on [14, 15]. Dissemination of such information through newspaper can contribute to guide the pandemic's status by sharing the views of all stakeholders on a single platform and engaging criticisms [9, 16]. Moreover, common people cannot easily perceive the knowledge of epidemics and pandemics. The local newspaper coverage acts as the most substantial information source for the people, through covering the whole phenomenon and aids to build up local capacity [17]. Therefore, reviewing and investigation of the appeared themes and contents in the newspaper about the pandemic and their timeline of discussions can provide insights for the policymakers and stakeholders to interpret the diversity of information flow and take necessary actions whenever demanded. The structural content analysis of newspaper articles can support in this regard. This method has formerly been employed in many fields such as research on climate change and global warming, environmental issues, ecological analysis [9, 18, 19, 20]; political analysis [21]; education sciences [22]; and tourism crisis [23]. This method enables to formulate topics independently by evaluating the newspaper contents and exploring the variation of contents over time [22, 24]. Furthermore, investigating the diversity of contents in newspaper articles via structural topic modeling (content analysis) can help to grab a stronger understanding of the dynamic aspects of pandemics, including its social, political, and economic implications [25]. By assembling these information, it is possible to develop a pandemic management framework incorporating various strategies for aiding the situation.

Until now, COVID-19 has blazed in 213 countries around the world while the state of outbreak differs from nation to nation [26]. Despite the number of confirmed cases is continually growing worldwide, a sharp rise has been shown in developing countries with time. Bangladesh, a developing country, has become one of the leading twenty countries in terms of total number of confirmed cases, containing approximately 14% cases of South-East Asia [26, 27]. After the first detection of COVID-19 case on March 08, 2020, a total of 0.55 million confirmed cases and 8, 502 deaths have been recorded in Bangladesh till March 12, 2021.

In the last twenty years, Bangladesh has confronted more than thirty epidemic outbreaks at various scales. COVID-19 (2020–21), Dengue (2000–2020), Chikungunya (2017–2018), Diphtheria (2017), Avian Influenza (2008–2012), Nipah Virus (2004), and Acute Neurological Syndrome (2001–2002) are some major epidemics documented in this country [15, 28]. Dengue and Chikungunya were responsible for around 0.15 million reported cases over their infection period in Bangladesh [29]. COVID-19, the most recent pandemic, has already broken all past records [28]. The news of these outbreaks is publishing in the local newspapers covering the national and international contexts. Therefore, investigations of newspaper coverage of COVID-19 can support to ascertain the effective way-out strategies to manage similar pandemic situation.

In light of the preceding context, this research aims to develop a pandemic management framework through an automated content analysis of local newspaper coverage of COVID-19 in Bangladesh. First, we have identified COVID-19 related key topics, their associated messages, and their timeline of discussion through automated content analysis of local newspaper articles of Bangladesh. Thereafter, a pandemic management framework has been developed with potential strategies based on the findings of content analysis. Such objective research based on computer-assisted algorithms using data from newspaper articles on pandemic crisis is limited in Bangladesh as well as in the world. As a result of such investigation, issues like response of the entire system to tackle the pandemic, the impact of pandemic, the interventions carried out to alleviate risks, and the capacities to tackle future epidemics could come to the light. Hopefully, this paper would invite more discussions on the pandemic crisis and support the policymakers to select the time demanding and subject-specific measures to deal with the pandemic situation.

2. Methodology

In this research, newspaper articles have been collected from three leading, pioneer, and familiar national newspapers of Bangladesh, named "*bdnews24.com*", "*New Age*", and "*Prothom Alo English*". Among them "*bdnews24.com*" and *"Prothom Alo"* are available both in Bangla and English; whereas, "*New Age*" is published only in English. As the web-portals of these newspapers are well-organized, it is comparatively easier to sort out the relevant newspaper articles and accumulate the data of pertinent articles from the portals through web scraping technique. These advantages have also influenced to select these three newspapers for this research. The keywords 'coronavirus', 'COVID-19', 'pandemic', or 'corona' have been employed to sort out an overall of 13,482 newspaper articles from the databases of the three selected newspapers over the period of January 1, 2020 to October 31, 2020. The data have been collected from January 1, 2020, because the newspapers of Bangladesh led to cover the news of the outbreak of COVID-19 from the beginning of January 2020. The unstructured data from the newspaper articles have been assembled and structured by the web scraping technique. This technique is adopted for extracting data from the website of the newspapers. For web scraping, the BeautifulSoup package of Python has been employed. Articles that are not written primarily for COVID-19 have been excluded from the structured database. To identify such articles, a criterion has been used: "keeping articles which have 'coronavirus' or 'COVID-19' keywords two or more than two times". This criterion has been selected by manually and randomly observing fifty (50) articles having the term 'coronavirus'/'COVID-19' in their title. After excluding the irrelevant articles, this research has yielded 7,209 articles for final investigation. The frequency distribution of the yielded articles is presented in Figure 1.

An automated content analysis approach has been employed in this study to identify the key topics related to the pandemic, which are extensively covered in the newspapers. Firstly, the considered articles have been tokenized employing the NLTK toolkit, which is a word segmentation module for tokenizing texts in Python. After the exclusion of stop words and punctuations which usually contribute slightly to the identification of topic, 46,189 keywords have been generated in this research. Secondly, the researchers have developed several topic models through the Latent Dirichlet Allocation (LDA) model using the Gensim package, a tool in Python for automated content analysis. To select the best-fitted model having optimum number of topics, topic models with 6, 12, 18, 24, and 30 topics have been developed. Model having twelve topics has been the best-fitted one among the developed models, which could capture topic diversity without obstructing topic interpretability. Following the identification of the best-fitted model, the dominant topics have been determined and their percentage of contribution in each article has been estimated. Word clouds for each topic have also been produced. Besides, title and representative text of each of the twelve identified topics have been written by inspecting the top keywords as well as reviewing the five most representative newspaper articles on the respective topic (representative texts have directly been copied from newspaper articles). Graphs have been developed to illustrate the timeline of discussion of the twelve identified topics. A brief flowchart of data collection and data analysis is presented in Figure 2. The results are discussed after completion of the analysis and a pandemic management framework incorporating the strategies is proposed for the better management of any biological hazard in the future. Detailed discussion on the process of content analysis and topic modeling is evaded here to
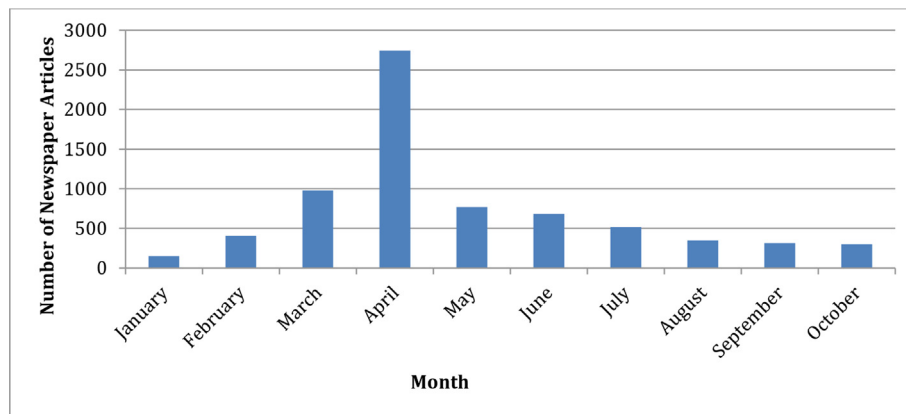
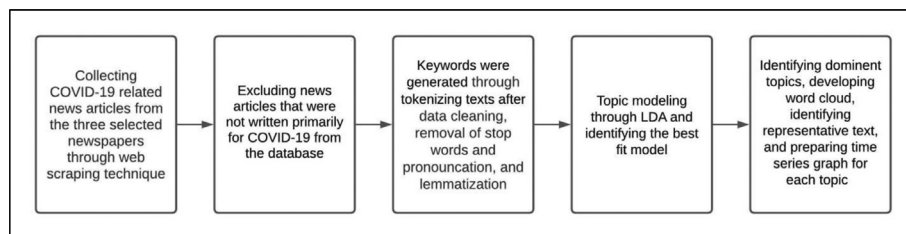**Figure 1.** The frequency of newspaper articles of COVID-19 from January 1, 2020 to October 31, 2020.

Figure 2. Methodological framework of this study.

concentrate more on the objectives of the study rather than methodological exercises. However, detailed methodological procedures are available in the studies of Khatun, Siddik, Rahman and Khaled [30] and Prabhakaran [31].

3. Results and discussion

3.1. Content analysis

As illustrated in Figure 3, twelve major topics related to COVID-19 with their keywords have emerged. Table 1 shows the titles and representative texts of the major topics. The temporal fluctuations of major topics are demonstrated in Figure 4. To accomplish more insights into the keyword clusters of Figure 3, twelve topics are discussed below individually.

3.1.1. Topic 1- Origin of COVID-19 and outbreak

This topic comprises the origin of COVID-19, its outbreak, the spread in other countries, controversies and politics over the origin, and so on. On December 31, 2019, an undesirable new type of pneumonia was detected in Wuhan, the capital of Hubei Province of China, and an explosive outbreak occurred within the province later [2, 32, 33]. A
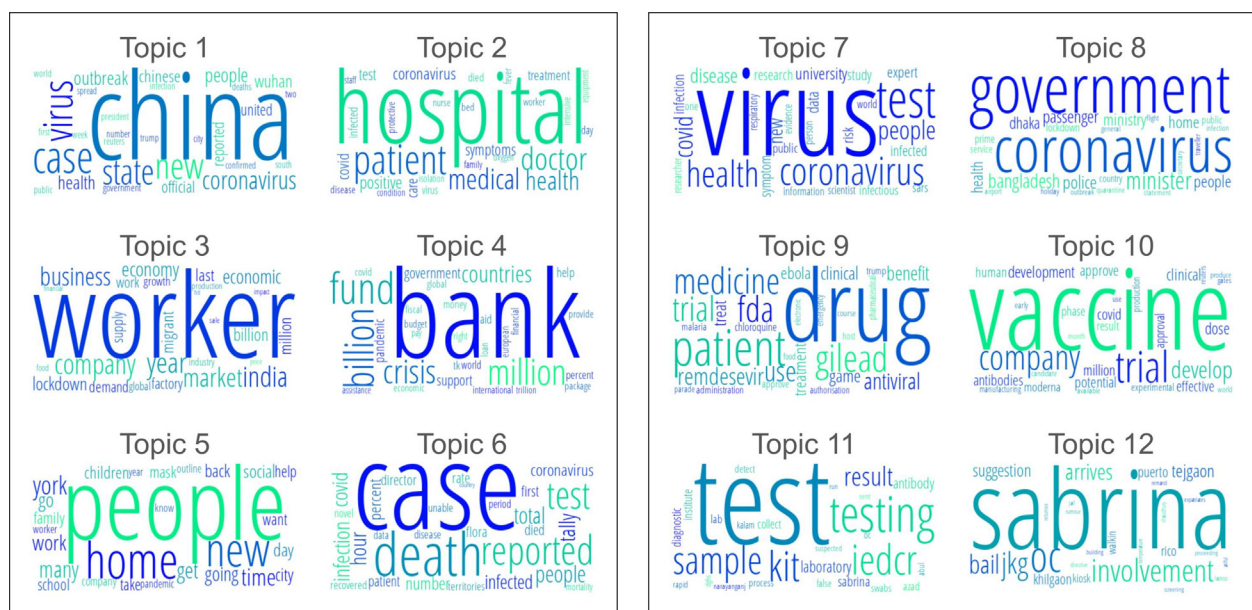

Figure 3. Keywords of the twelve identified topics.

Table 1. Title and representative text from newspapers for each of the twelve identified topics.

Topic no	Topic Title	Representative text
Topic 1	Origin of COVID-19 and outbreak	The toll in China rose to 425 as of the end of Monday, up by a record 64 from the previous day, the National Health Commission said on Tuesday. All of the new deaths were in central Hubei province, the epicenter of the virus outbreak.
Topic 2	Response (preparedness) of healthcare system	The cabin block beds have medical oxygen supply and include 24 from the emergency department and 15 from the intensive care unit. The hospital has set up a separate central facility to supply oxygen to the COVID-19 patients. Three teams will treat the patients at the "Corona Centre" in turns on a weekly basis. Up to 300 health workers, including 60 doctors, will be treating patients at the unit every week.
Topic 3	Impact of pandemic on economy	In its latest Global Economic Prospects report, the World Bank said that advanced economies are expected to shrink 7.0% in 2020, while emerging market economies will contract 2.5%, their first since aggregate data became available in 1960. On a per-capita GDP basis, the global contraction will be the deepest since 1945–46 as World War Two spending dried up.
Topic 4	Government assistance to response crisis	The government has drawn up a Tk 300 billion loan package at 9 percent interest to aid industries and the services sector with working capital through the banks, said the prime minister. There will be a similar package of Tk 200 billion for small, medium and cottage industries.
Topic 5	Impact of pandemic on the lifestyle of people	Educators experienced with remote learning warn that closures are a serious threat to children's academic progress, safety and social lives. They say that running a classroom digitally is much harder than bringing an adult workplace online and that it can disproportionately affect low-income students and those with special needs.
Topic 6	Regular updates of COVID-19	The caseload surged to 63,026 on the back of 2,635 new COVID-19 cases confirmed in the 24 h to 8 am Saturday, according to the health directorate. The recovery count also rose to 13,325 after another 521 patients were released from hospitals in the same period, DGHS Additional Director General Nasima Sultana said in a media briefing on Saturday. A total of 12,486 samples were tested at 50 authorised labs across the country in the last 24 h, of which 21.1 percent returned positive results, she added.
Topic 7	Expert opinions on COVID-19	"This is a powerful experimental study and the best evidence yet that the D614G mutation increases the infectivity of SARS-CoV-2," said Eddie Holmes, a professor at the University of Sydney and a specialist in viral evolution.
Topic 8	Non-pharmaceutical measures to prevent the spread of COVID-19	The government has allowed public transports to continue their services until Jun 30, while the offices will remain open on a limited scale. "The public transports including water vessels, trains and airplanes carrying limited passengers are allowed to operate in the approved areas; however, they must strongly follow the health protocols," the Cabinet Division said on Tuesday. The government imposed a lockdown on Mar 26 for 33 days and banned all public transports in the same period.
Topic 9	Pharmaceutical measures to fight against COVID-19	President Donald Trump said on Monday other countries had provided great reports on the effectiveness of malaria drug hydroxychloroquine for treatment of the deadly coronavirus, complaining that only US agencies have failed to grasp its benefit.
Topic 10	Update on vaccine	There are currently about 10 coronavirus vaccines being tested in humans and experts have predicted that a safe and effective vaccine could take 12–18 months from the start of development. Earlier this month, Moderna had released data that showed the vaccine, mRNA-1273, was safe and produced

Table 1 (*continued*)

Topic no	Topic Title	Representative text
		protective antibodies in a small group of healthy volunteers. The drug developer also reiterated its plans to begin late-stage trials in July.
Topic 11	COVID-19 testing and rapid testing kit	The health ministry has said rapid testing kits can produce up to 30 percent false positive or false negative results, which can be disastrous in the time of an outbreak. The DGDA, however, has recently approved trials of the Gonoshasthaya kits following the organisation's request.
Topic 12	COVID-19 certificate scam	Sabrina, a government doctor, was suspended and arrested over her alleged involvement in the testing scam on Sunday. Police brought charges against JKG Health Care for providing false reports without testing the swabs collected from the people for COVID-19 tests.

major controversy exists about the origin of SARS-COV-2; however, by evaluating the genetic sequences of this virus, researchers have already established that the bat population is the possible origin of this virus and no evidence supports its laboratory formation [34]. The World Health Organization (WHO) declared a "Public Health Emergency of International Concern" at the end of January 2020 and further named the Novel Coronavirus (SARS-COV-2) as Coronavirus Disease 2019 (COVID-19) [35]. After the onset of community transmission in other provinces of China and many more countries worldwide, on 11 March 2020, the World Health Organization (WHO) officially declared the COVID-19 epidemic as a global pandemic [32, 36, 37]. After that, this issue has become a matter of concern to public. Besides, source and hotspots of the virus, transmission pattern, and prevalence of the outbreak have been extensively highlighted through news coverage. Figure 4 reveals that this topic is widely discussed from January to April and the information flow on this topic has dropped after April. Discussions on this topic helped to aware people about the pandemic and also provided a wake-up call to governments around the globe for preparing to combat the pandemic.

3.1.2. Topic 2- Response (preparedness) of healthcare system

The healthcare system of a nation is the first and most important fort while fighting against a pandemic. The government has taken numerous steps to strengthen and prepare the healthcare system to combat COVID-19 pandemic. However, several major challenges have been faced while confronting the situation like very limited employees on health sector, poor diagnostic facilities and resources (e.g., hospital beds, isolation centers, intensive care unit (ICU), personal protective equipment (PPE)), and lack of ventilators in the hospitals in case of Bangladesh. This has happened due to mismanagement and paucity of adequate preparation [38]. Also, a segment of the doctors, nurses, and other health workers have shown unwillingness to serve due to the fear of high risks of infection via patients [39]. Sometimes, COVID-19 patients at critical state have also failed to receive any treatment despite being desperately moved from one hospital to another, and consequently many have expired without ever receiving professional medical care [39]. A study by Bodrud-Doza, Shammi, Bahlman, Islam and Rahman [40] demonstrated that 62% of people of Bangladesh strongly agreed with the statement that the healthcare system of the country is fragile and incompetent of dealing with the outbreak of COVID-19. Therefore, more investigations require to be conducted to detect the problems in the healthcare system and a long-term plan needs to be prepared and implemented to promote an efficient, effective, and accountable healthcare system to confront any extreme pandemic situation. From Figure 4, it is evident that very little discussion has been done on this topic

before March. This might be one of the vital reasons behind the absence of proper preparedness of the healthcare system to manage the outbreak.

3.1.3. Topic 3- Impact of pandemic on economy

The devastating impacts of COVID-19 both on the global and national economy are imparted under this topic. It is estimated that the global economy will shrink by 5.2% due to the pandemic within 2020. According to the World Bank, advanced economies are predicted to shrink by 7.0% in 2020; this value for emerging market economies is 2.5% [41]. The economy of Bangladesh will also face a stark decline because of countrywide lockdown and suspension of economic activities related to national and international trade, consumption and supply chain of foods, informal job sectors, remittance, transport, tourism, and so on [42]. According to the IMF, the GDP growth rate of the country has been projected to decelerate from 8.0% to 2.0% in FY 2019–20 [43, 44]. The ready-made garments (RMG), the key export-earning sector of Bangladesh, contribute almost 85% and 20% of the total exports and GDP of the country, respectively. However, canceled or put on hold orders by fashion companies worldwide are worth at least $3.15 billion. This largely threatens to devastate the country's economy and increase unemployment [45]. Furthermore, remittance inflow is one of the leading pillars of the country's economic growth. However, many migrant workers have already lost their jobs due to the economic recession hitting the Gulf and Western countries which would primarily hamper the rural economy [46]. A considerable number of workers from the dairy, poultry, transportation, tourism, hotel, and aviation sectors are in a substantial threat of losing their jobs due to the economic shutdown caused by the pandemic [46]. Consequently, this population would be pushed back into poverty due to economic stagnation.

The countrywide shutdown has caused to decline the per capita daily income of rural and urban slum poor by 80% [39]. Given the catastrophic impact on the economy, it is imperative to chalk out a plan which could provide direction on how the economic sectors will prepare to cope with an epidemic situation. In addition, the impact of COVID-19 on economy has been fairly discussed throughout the pandemic from March (Figure 4). Unfortunately, discussion on this topic is reduced after June when economic activities have been resumed. However, since then, there should have been further discussions on the systematic reopening of economic activities, the adoption of ways to accelerate the economy after lockdown along with maintaining the safety of workers, the performance of economic activities, post-lockdown economy, and so on.

3.1.4. Topic 4- Government assistance to response crisis

Governments of different countries have declared stimulus packages and aids to minimize the impact of the pandemic. The government of Bangladesh has also declared several packages worthy of about $11.5

billion (3.3% of GDP) to boost up the economy and ensure food security, e.g., a) $8.5 billion packages for large industries, small and medium enterprises, b) $589 million packages to pump running capital into the agricultural sector [38]. Furthermore, the government, private organizations, and individual personals have also provided humanitarian aid to the underprivileged and needy people during the pandemic. However, several claims have soared the experience of assistance such as the inequitable distribution of packages, shortage of relief, and corruption in the aid distribution [47]. For obtaining the maximum benefits from such packages, it is necessary to ensure their efficient use and equitable distribution. Therefore, the government should come up with an updated plan for future pandemic or epidemic situation to ensure fairness and equity in the distribution of packages as well as aid and to ensure effective implementation of the developed plan. Besides, this topic is broadly discussed from February to July in newspapers (Figure 4). This period might be possible to link with the lockdown period. In Bangladesh, a nationwide lockdown was declared from March 26, 2020 to May 31, 2020. To support the poor people, industries, business, and economic activities during lockdown, government has provided assistance within this period. Therefore, a detailed discussion has occurred focusing that time period on this topic.

3.1.5. Topic 5- Impact of pandemic on the lifestyle of people

The pandemic has brought a knock-on effect on citizen's lifestyle as well as on the total environment. A new normal has been formed in which people and their surroundings are behaving differently [48]. As part of extensive precautionary measures, practicing the hygiene protocols (e.g., regularly washing of hands, avoidance of face to face interaction), using the masks and shields, maintaining social distance, and so on are exercised within the community [49, 50, 51]. Moreover, restriction on traveling, enforcement of a compulsory quarantine to control the transmission, avoidance of social gathering, and closure of public places (e.g., educational institutions, hotels, restaurants, religious institutions, and commercial places) are some of the countermeasures implemented nationwide in many countries [48, 51]. To mitigate the effect of the pandemic, "online-based education" and "work from home" are some of the adaptive actions taken in response to the closure of educational

institutions and economic activities [49, 52]. In addition, this pandemic has affected the mental health of the people. There are pieces of evidence about the inflation of domestic violence and discrimination towards vulnerable groups, which have already been acknowledged by WHO [34]. Though these topic has also been discussed in news articles throughout the pandemic, those are mostly discussed from February to May (Figure 4). Above all, adequate response plans, considering human rights and alternative course of actions to sustain the continuity of regular activities are required to be developed for confronting such public health crisis.

3.1.6. Topic 6- Regular updates on COVID-19

The World Health Organization (WHO) regularly provides update on worldwide situation of the pandemic through their situation reports and COVID-19 dashboard [53]. In Bangladesh, the local condition is reported by "Institute of Epidemiology, Disease Control and Research (IEDCR)" regularly through their dashboard and daily press releases. The figure of daily new cases, new deaths, testing rates, recovery rates, and area-wise case distributions are documented and informed nationally by IEDCR [28]. This would help to aware people about the outbreak. Due to daily appraisal of the situation, it is easier to trace out the areas facing detrimental conditions and the locations of potential risk zones. The available facilities, infection rates, and hospitalization rates are not same in all areas around the country [32]. They vary temporarily too, which are frequently reported in the newspaper articles. Thus, people comprehend an image of the actual scenario of pandemic and the gaps or opportunities in the region-wise facilities. Moreover, various countries around the world are dynamically attempting to control the outbreak and getting along the diverse stages of pandemic [26]. Detailed analysis of the daily updated data considering such issues is necessary to confirm the current position of each nation in terms of coping with disease outbreaks. From Figure 4, it is clear that this topic has widely been discussed from March to October in an approximately consistent volume in the newspapers.

3.1.7. Topic 7- Expert opinions on COVID-19

The opinions of experts can play an important role while dealing with an epidemic. Newspapers cover the point of views of the experts
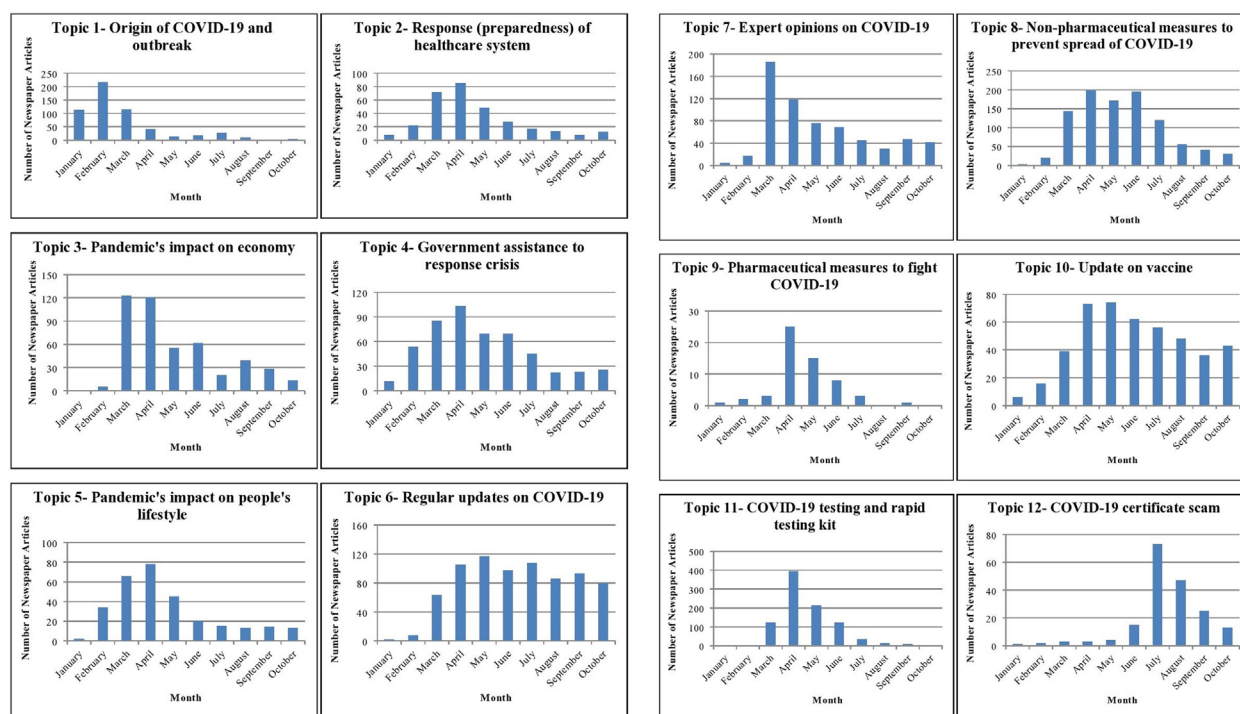

Figure 4. Time series of twelve topics regarding COVID-19 from January to October 2020.

extensively on every aspect of pandemic, including identification of fundamental individual actions to confine the transmission, performance of drugs and vaccines, zoonotic to human-to-human interaction of virus, risks of vulnerable communities, the association of COVID-19 with past epidemics like Malaria, SARS, etc., reproduction period of the virus, cross-cutting issues with the outbreak, preparedness to tackle the second wave, local and global healthcare response, progress and criticisms of treatment facilities, and precautionary measures to overcome the situation [54]. These issues have been discussed with more emphasis in the newspaper articles of Bangladesh after the declaration of COVID-19 as a global pandemic (Figure 4). The opinions of the geneticists, sociologists, and psychologists on the reformation of the virus, the opportunities and problems of the new normal, and the potential previous experiences to combat the pandemic may help to think forward considering a holistic approach.

3.1.8. Topic 8- Non-pharmaceutical measures to prevent the spread of COVID-19

Since COVID-19 is a highly infectious disease having no specific treatment yet, governments of all countries have enforced numerous non-pharmaceutical measures to prevent the spread of virus which has been noticeably discussed in the media (Figure 4). Like other countries, the government of Bangladesh has also implemented several measures which include diagnosis of the suspected cases, quarantine of possible carriers and isolation of the infected patients, deployment of forces, local or regional lockdown, restrictions on traffic movements within the national and regional territory, suspension of all domestic and international flights, general leave grants at all offices, curbing the educational and business operations, shutting down of non-essential businesses and factories, restriction on the religious and communal gathering, enhancing public awareness, and enforcement of social distancing [38, 55]. However, there exist numerous questions about the fruitful implementation of these strategies. Hence, more researches need to be conducted to determine effective containment strategies. Also, precise guidelines are required to be formulated for implementing the plans properly. Besides, in March, after the detection of the first case in Bangladesh, a lot of discussions have taken place to enforce the non-pharmaceutical measures for preventing the transmission. This has brought pressure on the government (Figure 4). Later the government has taken a large number of actions to prevent the nationwide outbreak. However, if the discussions have done from January, the attention of the government would have been grabbed earlier, consequently, the preparations and measures could be performed in due time. This could have enormously helped to enclose the outbreak better.

3.1.9. Topic 9- Pharmaceutical measures to fight against COVID-19

Development of effective medicines and vaccines, management of ICU, improvement of healthcare facilities, and medical support for COVID-19 patients are some of the pharmaceutical measures to fight against COVID-19. Exploration of effective medicine and vaccines is the most demanding one as no known wholly successful therapy or remedy is found for the treatment of COVID-19 as of date [56, 57]. Many researchers across the world are struggling to generate a potent vaccine. Some of the vaccines are showing satisfactory results in their experimental stages. Applying the experiences from the previous epidemics, several cures are in practice, on a trial and error basis. The application of Hydroxychloroquine (previously used in the treatment of Malaria) in patients with COVID-19 has been claimed to be useful in some countries [57]. Again the treatment with Hydroxychloroquine alone and in combination with Azithromycin has been effective in reducing COVID-19 mortality [58]. The most progressing therapy for COVID-19 patients is Remdesivir so far, but it is not permitted by all countries and currently is undergoing randomized trials [59]. Moreover, Oseltamivir and Corticosteroids are not commonly recommended due to their lack of efficacy in COVID-19 treatment [59]. The success of pharmaceutical measures is still in a deadlock condition. Fruitful result is absent; therefore, this topic is

not being highlighted with a growing interest in the newspaper coverage (Figure 4).

3.1.10. Topic 10- Update on vaccine

Most of the non-pharmaceutical measures are carried out to lessen the transmission of COVID-19 and keep the situation under control. However, many nations have failed to do so. Furthermore, some countries are experiencing the second wave of the pandemic like China, South Korea, Germany, Iran, New Zealand after relaxing the lockdown [36, 60]. Therefore, the development of effective vaccines is required to bring a sustainable solution. Several companies of the United States, United Kingdom, Germany, China, and so on are endeavoring to develop the vaccine [61]. The WHO has reported that twenty-five potential COVID-19 vaccines are at clinical trials internationally; several of them showed promising results in trial phase-two and are ready to enter into phase-three [62]. Newspapers always demonstrate updates on the progress of vaccines. These updates might provide a better hope to the people and bring them psychological quietism. Discussion on this topic has been incremented in the newspapers from April and consistently been done till the end of October (Figure 4). It might be for the update on the research activities of vaccines was not much available before March.

3.1.11. Topic 11- COVID-19 testing and rapid testing kit

This topic covers all dimensions linked to the testing facilities of COVID-19 encompassing the testing capacities, availability of testing kits, sample collection systems and centers, availability of laboratories, the efficiency of the testing kits, time needed to deliver the test reports, financial aspects of testing, and so on [63]. The unavailability of a competent remedy yet makes the testing capacity an even more critical issue. As the higher number of infected people diagnoses and treats duly, the lower the chance of transmission via them. During the onset of COVID-19 in Bangladesh, there is skepticism about the availability of testing kits, test sample collection system, and availability of laboratories. Later, the sample collection places are anticipated as hotspots for further virus spreading and thus, become one of the major concerns.

To facilitate the testing procedure, Gonoshasthaya Kendra has introduced an indigenous COVID-19 Rapid Antibody DOT Test kit. They have claimed that this kit could rapidly and accurately detect COVID-19 in the human body at the least testing cost. However, the government has rejected the kit after examining its efficiency at detecting the novel coronavirus infection. Hence, more researches have to be brought in light regarding the efficiency of the overall testing procedure. The government should formulate a new, time-worthy, and modern guideline considering the introduction of new medicines and testing facilities during an emergency period like the present unexpected pandemic. These issues have extensively been discussed from March to June (Figure 4).

3.1.12. Topic 12- COVID-19 certificate scam

Two hospitals– JKG and Regent Hospital– have been accused of issuing thousands of spurious negative coronavirus test reports to patients. This has turned into one of the highlighted topics of discussion in the newspapers from the beginning of July. Since then, the government has taken necessary steps to identify and seal these types of hospitals. Also, legal actions are being imparted against the owners and people responsible for the scam. These types of fraudulent reports have aggravated the pandemic situation and intensified the risk of people. Availability of effective laws, proper enforcement of regulations, regular audit and monitoring, good governance, and provision of capable manpower behind these tasks would play an important role to control these scams. Such topic is emphasized more in July as this scam has come into the spotlight in this month (Figure 4).

3.2. Pandemic management framework

The highlighted contents in the local newspaper have connection within themselves and they could be categorized under a broader
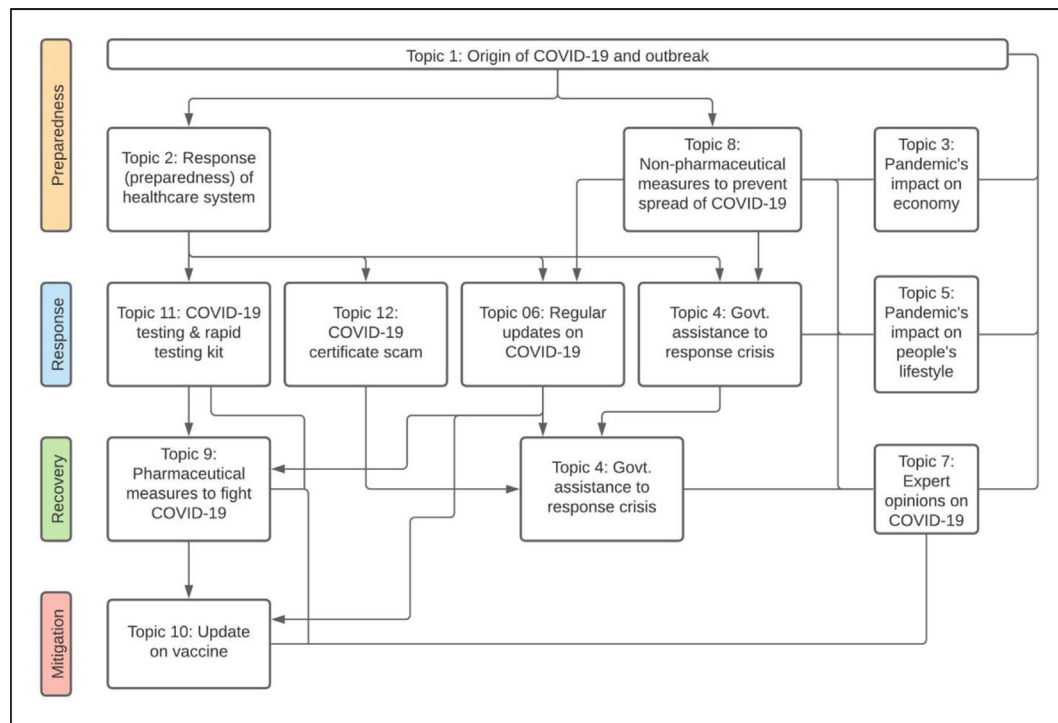
Figure 5. Linkages of topics under pandemic management framework.

framework of pandemic management as demonstrated in Figure 5. The learning from each topic could serve to recommend strategies for the management of pandemics. Based on the discussion of issues under each topic, a pandemic management framework is proposed here to combat any biological disaster in the future through identifying the beneficial and detrimental strategies at different stages of a pandemic. This framework includes four stages: preparedness, response, recovery, and mitigation like WHO [11].

Nevertheless, more comprehensive strategic actions to cope with future pandemics or epidemics focusing overall situation are recommended here. The four stages are elaborately described below with the help of the COVID-19 pandemic as a case (Figure 6).

3.2.1. Stage 1- Preparedness

The intention of this stage is to accomplish a decent standard of readiness to respond to any emergent pandemic situation. Reliable early warning is a prerequisite and significant component of preparedness for taking preventive actions for controlling the spread and fighting against the pandemic. After receiving the early warning, the risk exposure of pandemic needs to be estimated precisely, addressing safety margin to the estimation. The government then should carry out various preventive measures (e.g., travel restriction, detention of possible carriers to counter the spread of the virus) which may vary with the type of epidemic and its outbreak. Furthermore, it is indispensable to strengthen the technical and managerial capacity of the stakeholders and prepare the healthcare
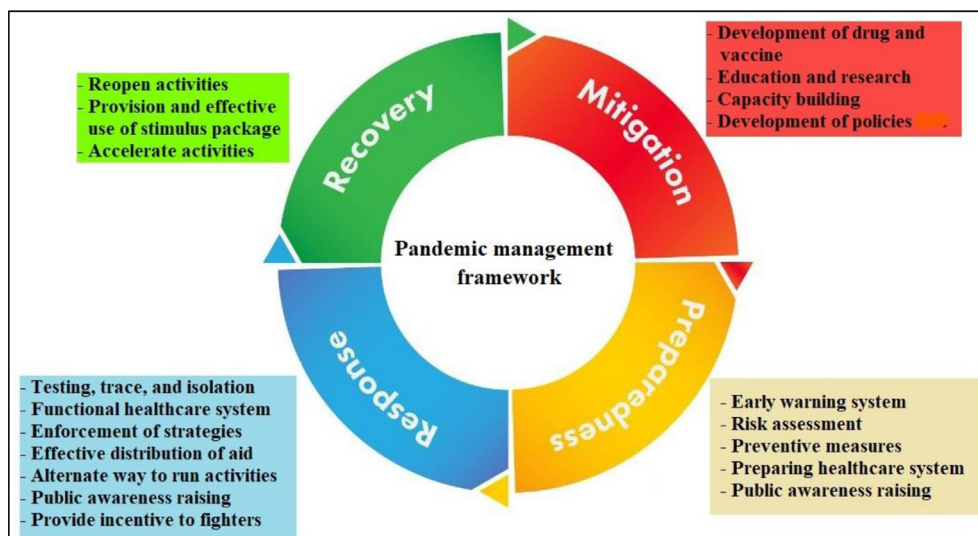

Figure 6. Pandemic management framework.

system to be able to endure the worst scenario. Public awareness is unconditionally important to prepare people for surviving a pandemic. In the case of the COVID-19 pandemic, Bangladesh received early warning with the detection of the virus in China and other neighboring countries and its transmission through human interactions as described under **Topic 1**. Nevertheless, the lack of prompt response, early readiness, and precise estimation of the pandemic's risk, COVID-19 hit Bangladesh severely. On the contrary, other countries such as New-Zealand, Vietnam, and Taiwan could successfully assess the risks and accordingly took suitable precautionary measures which helped them to control the outbreak systematically.

3.2.2. Stage 2- Response

This stage desires to take immediate actions against a pandemic or any biological disaster from the very beginning for minimizing its short-term effect on human health, resources, and activities. Therefore, from the early stages, it is decisive to conduct adequate testing to trace the infected persons and isolate them based on the nature of the epidemic. Adequate testing kits, laboratories, and well-managed sample collection systems are prerequisites to carry out these activities in case of COVID-19 as described under the **Topic 2, 9,** and **11**. A well-functioning and equipped healthcare system also requires for both the provision of convenient treatment to diagnosed patients as well as the utmost protection to front-line health workers. Furthermore, the government should provide sufficient attention to the underprivileged, unemployed, and vulnerable social groups by providing sufficient aid and relief.

Containment strategies (e.g., lockdown, shutdown, and curfew) need to be imposed by the government considering the scenario. To diminish the impact on economic, educational, and other sectors, alternative adaptive ways (e.g., online classes, work from home, mobile banking, online shopping) should be employed for sustaining the activities. Furthermore, special incentives should be allocated for the doctors, nurses, health workers, policymakers, administrators, and other front-line workers to encourage them for participating in the emergent response. From the newspaper coverage analysis, it is evident that the government of Bangladesh has taken almost all the above-mentioned initiatives to some extent during this pandemic. However, many problems, questions, mismanagement, and challenges (**Topic 12**) are raised regarding the implementation of these actions.

3.2.3. Stage 3- Recovery

In this stage, a collective effort is required to bring the country back to the typical situation as before the pandemic and to reduce the long-term effect of the disaster. To attain this objective, the government should provide stimulus packages for diverse sectors according to their needs. Equitable distribution and effective usage of the allocated packages will help to recover the impact of a pandemic. In addition, the government should also develop plans to reopen the obstructed activities step-by-step and accelerate the activities through ensuring safety. Necessary actions (e.g., providing loans, subsidizing interest, giving monetary compensation) also need to be enforced to recover the loss of people due to a pandemic. From the content analysis, it is found that the government of Bangladesh has taken a large number of stimulus packages and has started to reopen activities. However, effective use of the packages should also be assured to obtain maximum benefit. Also, safety issues often undermined while reopening activities, which can worsen the situation. More discussion among the government and the people should be welcomed regarding the recovery stage in Bangladesh right now.

3.2.4. Stage 4- Mitigation

This stage includes the activities, which would eliminate the likelihood of the reoccurrence of a pandemic and reduce its associated risks. The potential mitigation measures could be the development of remedies and vaccines, increase spending on research activities, the advancement of education, the formulation of policies and long-term contingency plans to counter any pandemic and epidemic, the formation and

implementation of contemporary laws, local capacity building, improving the technical and infrastructural aspects of the healthcare system, enhancing public awareness, and so on. From the newspaper content analysis, it is clear that Bangladesh is far from the mitigation stage. However, the government of Bangladesh should take necessary actions considering this stage advertently, as epidemics and pandemics are appearing more frequently in the country.

4. Conclusion

This research investigates the local newspaper coverage of COVID-19 by employing an automated content analysis to identify the highlighted topics relevant to the ongoing pandemic crisis. The origin and outbreak of COVID-19, response of the healthcare system, impact on the economy, impact on lifestyle, government assistance, regular updates, expert opinions, pharmaceutical measures, non-pharmaceutical measures, updates on vaccines, testing facilities, and local unusual activities within the system have been found as the most discussed topics in the newspapers. Among them, the origin and scenario of the outbreak, non-pharmaceutical measures to tackle the condition, response of the healthcare system towards the pandemic, and impact of the pandemic on economies and lifestyle are the noticeable discussion area within the pandemic period. The underlying messages of each topic can provide a conducive learning and point out strategies to cope with future epidemics and pandemics.

Economy and lifestyle have come to a standstill condition due to COVID-19 while government assistance and alternative options to conduct regular activities are fetching some hope. Despite some vaccines being in successful experimental stages, there exists no remarkable pharmaceutical support like drugs or vaccines to fight the virus yet. Under such circumstances, noticeable unusual activities like fake COVID-19 certifications, inequitable distribution of government aids, delay in offering treatment, and so on have been found within the healthcare management system of Bangladesh. To prevent such putrefactive activities, implementation of long-term plans and adequate legal actions are required from the government. Also, more researches are recommended to determine the efficient testing facilities and healthcare policies and plans. Based on the findings of our research, a four-stage strategic framework for pandemic management has been proposed in this paper incorporating the strategies under preparedness, response, recovery, and mitigation stages for confronting any biological disaster. That could help to adapt with any future epidemics and develop a long-term contingency plan for any pandemic to mitigate its adverse effects.

In future researches, the incorporation of more newspaper articles along with people's sentiments and reactions at different stages of pandemic could provide a better understanding on the impact of COVID-19. However, this paper contributes as a methodological literature using a content analysis approach and invites future research on public reactions towards different aspects of a pandemic and its management planning. This research would be helpful for policymakers to prepare a stage-wise action plan to combat epidemics and to mitigate the long-run impact of COVID-19.

Declarations

Author contribution statement

Sadia Afroj: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Imtiaz Mahmud Nafi: Analyzed and interpreted the data; Performed the experiments.

Md. Musleh Uddin Hasan: Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

[1] B. Armocida, B. Formenti, S. Ussai, F. Palestra, E. Missoni, The Italian health system and the COVID-19 challenge, Lancet Publ. Health 5 (5) (2020) e253.

[2] E. Shim, A. Tariq, W. Choi, Y. Lee, G. Chowell, Transmission potential and severity of COVID-19 in South Korea, Int. J. Infect. Dis. 93 (2020) 339–344.

[3] D.W.-K. Chan, A reflection on the anti-epidemic response of COVID-19 from the perspective of disaster management, Int. J. Nurs. Sci. 7 (3) (2020) 382–385.

[4] WHO, Emergencies Preparedness, Response, 2020.

[5] A. Goenka, L. Liu, M.-H. Nguyen, Infectious diseases and economic growth, J. Math. Econ. 50 (2014) 34–53.

[6] M. Lenzen, M. Li, A. Malik, F. Pomponi, Y.-Y. Sun, T. Wiedmann, F. Faturay, J. Fry, B. Gallego, A. Geschke, J. Gómez-Paredes, K. Kanemoto, S. Kenway, K. Nansai, M. Prokopenko, T. Wakiyama, Y. Wang, M. Yousefzadeh, Global socio-economic losses and environmental gains from the Coronavirus pandemic, PloS One 15 (7) (2020), e0235654.

[7] K.M. Smith, C.C. Machalaba, R. Seifman, Y. Feferholtz, W.B. Karesh, Infectious disease and economics: the case for considering multi-sectoral impacts, One Health 7 (2019) 100080.

[8] S. Boukerche, R. Mohammad-Roberts, Fighting Infectious Diseases: the Connection to Climate Change, 2020. https://blogs.worldbank.org/climatechange/fighting -infectious-diseases-connection-climate-change. (Accessed 23 August 2020).

[9] M. Chandelier, A. Steuckardt, R. Mathevet, S. Diwersy, O. Gimenez, Content analysis of newspaper coverage of wolf recolonization in France using structural topic modelling, Biol. Conserv. 220 (2018) 254–261.

[10] D. Curseu, M. Popa, D. Sirbu, I. Stoian, Potential impact of climate change on pandemic Influenza risk, in: I. Dincer, A. Hepbasli, A. Midilli, T.H. Karakoc (Eds.), Global Warming: Engineering Solutions, Springer US, Boston, MA, 2010, pp. 643–657.

[11] WHO, Core Competences in Disaster Nursing Version 2.0, 2009. Geneva.

[12] N. Donthu, A. Gustafsson, Effects of COVID-19 on business and research, J. Bus. Res. 117 (2020) 284–289.

[13] M. Nicola, Z. Alsafi, C. Sohrabi, A. Kerwan, A. Al-Jabir, C. Iosifidis, M. Agha, R. Agha, The socio-economic implications of the coronavirus pandemic (COVID-19): a review, Int. J. Surg. 78 (2020) 185–193.

[14] A. Maxmen, Journalist's Toolbox, Media and Social Media Coverage, 2020.

[15] WHO, Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19), World Health Organization, 2020.

[16] H. Qi, S. Xiao, R. Shi, M.P. Ward, Y. Chen, W. Tu, Q. Su, W. Wang, X. Wang, Z. Zhang, COVID-19 transmission in mainland china is associated with temperature and humidity: a time-series analysis, Sci. Total Environ. (2020) 138778.

[17] G. Schwitzer, G. Mudur, D. Henry, A. Wilson, M. Goozner, M. Simbra, M. Sweet, K.A. Baverstock, What are the roles and responsibilities of the media in disseminating health information? PLoS Med. 2 (7) (2005) e215.

[18] S. Bhatia, V. Athreya, R. Grenyer, D.W. MacDonald, Understanding the role of representations of human-leopard conflict in Mumbai through media-content analysis, Conserv. Biol. 27 (3) (2013) 588–594.

[19] S. Billett, Dividing climate change: global warming in the Indian mass media, Clim. Change 99 (2010) 1–16.

[20] S.K. Jacobson, C. Langin, J.S. Carlton, L.L. Kaid, Content analysis of newspaper coverage of the Florida panther, Conserv. Biol. 26 (1) (2012) 171–179.

[21] P.C. Bauer, B. Pablo, K. Ackermann, V. Aaron, Is the left-right scale a valid measure of ideology? Individual-level variation in associations with "left" and "right" and left-right self-placement, Polit. Behav. (3) (2016) 1–31.

[22] D.M. Blei, Probabilistic topic models, Commun. ACM 55 (2012) 77–84.

[23] H. Chen, X. Huang, Z. Li, A content analysis of Chinese news coverage on COVID-19 and tourism, Curr. Issues Tourism (2020).

[24] M.E. Roberts, B.M. Stewart, D. Tingley, E.M. Airoldi, The structural topic model and applied social science, ICONIP (2013) 2013.

[25] M.J. Westgate, P.S. Barton, J.C. Pierson, D.B. Lindenmayer, Text analysis tools for identification of emerging topics and research gaps in conservation science, Conserv. Biol. 29 (6) (2015) 1606–1614.

[26] worldometer, Countries where COVID-19 Has Spread, 2020.

[27] IECDR, Bangladesh Covid-19 Update, Institute of Epidemiology, Disease Control and Research (IEDCR), 2020.

[28] IEDCR, Institute of Epidemiology, Disease Control and Research (IEDCR), Covid-19 Update, 2020. https://iedcr.gov.bd/.

[29] S. Anwar, J.T. Mourosi, M.F. Khan, M.O. Ullah, O.M. Vanakker, Chikungunya outbreak in Bangladesh (2017): clinical and hematological findings, PLoS Neglected Trop. Dis. (2020).

[30] M.M. Khatun, M.S. Siddik, M.A. Rahman, S. Khaled, Content analysis of Covid-19 and agriculture news in Bangladesh using topic modeling algorithm, Curr. Appl. Sci. Technol. 21 (2) (2021) 296–314.

[31] S. Prabhakaran, Topic modeling visualization – how to present the results of LDA models?. https://www.machinelearningplus.com/nlp/topic-modeling-visualizat ion-how-to-present-results-lda-models/?fbclid=IwAR1VF6ORKOh6zEVyOThMw U9ugIikCzkur7a1JeiMLA28tgVaBa-OR2IXWLs, 2018.

[32] F.D. Gennaro, D. Pizzol, C. Marotta, M. Antunes, V. Racalbuto, N. Veronese, L. Smith, Coronavirus diseases (COVID-19) current status and future perspectives: a narrative review, Int. J. Environ. Res. Publ. Health 17 (2020).

[33] D. Kang, H. Choi, J. Kim, J. Choi, Spatial epidemic dynamics of the COVID-19 outbreak in China, Int. J. Infect. Dis. 94 (2020) 96–102.

[34] WHO, Coronavirus Disease 2019 (COVID-19): Situation Report – 94, 2020. www .who.int/docs/default-source/coronaviruse/situation-reports/20200423-sitrep- 94-covid-19.pdf. (Accessed 25 August 2020).

[35] WHO, WHO Director-General's Opening Remarks at the media Briefing on COVID-19 - 11 March 2020, 2020. www.who.int/dg/speeches/detail/who-director-gener al-s-opening-remarks-atthe-media-briefing-on-covid-19—11-march-2020. (Accessed 23 August 2020).

[36] K. Leung, J.T. Wu, D. Liu, G.M. Leung, First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment, Lancet 395 (10233) (2020) 1382–1393.

[37] M.A. Shereen, S. Khan, A. Kazmi, N. Bashir, R. Siddique, COVID-19 infection: origin, transmission, and characteristics of human coronaviruses, J. Adv. Res. 24 (2020) 91–98.

[38] M.T. Islam, A.K. Talukder, M.N. Siddiqui, T. Islam, Tackling the Pandemic COVID-19: the Bangladesh Perspective, 2020. Preprints 2020, 2020040384.

[39] A.K. Mohiuddin, Covid-19 Situation in Bangladesh, 2020. Preprints 2020, 2020050094.

[40] M. Bodrud-Doza, M. Shammi, L. Bahlman, A.R.M.T. Islam, M.M. Rahman, Psychosocial and socio-economic crisis in Bangladesh due to COVID-19 pandemic: a perception-based assessment, Front. Publ. Health 8 (341) (2020).

[41] TFE, Coronavirus to Shrink 2020 Global Output by 5.2pc, World Bank, The Financial Express, 2020.

[42] R. Lalon, Mojib, COVID-19 vs Bangladesh: Is it Possible to Recover the Impending Economic Distress amid This Pandemic? SSRN, 2020.

[43] IMF, Country News: Bangladesh, 2020. www.imf.org/en/Countries/BGD. (Accessed 15 August 2020).

[44] I.M. Fund, Country News: Bangladesh, 2020. https://www.imf.org/en/Countries/ BGD.

[45] M. Sakamoto, S. Begum, T. Ahmed, Vulnerabilities to COVID-19 in Bangladesh and a reconsideration of sustainable development goals, Sustainability 12 (13) (2020) 5296.

[46] LAW, COVID-19 in Bangladesh: A Visual Guide to the Economic Impact, 2020. http s://databd.co/stories/covid-19-in-bangladesh-a-visual-guide-to-the-economic-imp act-11064. (Accessed 20 August 2020).

[47] M. Noman, Govt Cracks Down on Corruption in Relief Programme, 2020. https ://tbsnews.net/bangladesh/crime/govt-cracks-down-corruption-relief-programme -68410.

[48] S. Saadat, D. Rawtani, C.M. Hussain, Environmental perspective of COVID-19, Sci. Total Environ. 728 (2020) 138870.

[49] A. Haleem, M. Javaid, R. Vaishya, Effects of COVID 19 pandemic in daily life, Curr. Med. Res. Pract. 10 (2) (2020) 78–79.

[50] M. Xiang, Z. Zhang, K. Kuwahara, Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected, Prog. Cardiovasc. Dis. (2020). S0033-0620(20)30096-7.

[51] L. Renzo, P. Gualtieri, F. Pivari, L. Soldati, A. Attinà, G. Cinelli, C. Leggeri, G. Caparello, L. Barrea, F. Scerbo, E. Esposito, A. De Lorenzo, Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey, J. Transl. Med. 18 (1) (2020) 229.

[52] G. Basilaia, D. Kvavadze, Transition to online education in schools during a SARS-CoV-2 coronavirus (COVID-19) pandemic in Georgia, Pedagog. Res. 5 (4) (2020).

[53] WHO, Archived: WHO Timeline - COVID-19, 2020. www.who.int/news-room/detail/27-04-2020-who-timeline—covid-19. (Accessed 22 August 2020).

[54] J.B.N. Nuzzo, Global Health Now: COVID-19 Expert Reality Check, 2020. https://www.globalhealthnow.org/2020-02/coronavirus-expert-reality-check.

[55] N.M. Zafri, S. Afroj, M.A. Ali, Effectiveness of containment strategies to control vehicular traffic on roads in Dhaka, Bangladesh during COVID-19 pandemic: use of google map based real-time traffic data, SSRN (2020).

[56] H. Li, S. Zheng, F. Liu, W. Liu, R. Zhao, Fighting against COVID-19: innovative strategies for clinical pharmacists, Res. Soc. Adm. Pharm. (2020). S1551-7411(20)30328-4.

[57] M.I. Rabby, Current drugs with potential for treatment of COVID-19: a literature review: drugs for the treatment process of COVID-19, J. Pharm. Pharmaceut. Sci. 23 (1) (2020) 58–64.

[58] S. Arshad, P. Kilgore, Z.S. Chaudhry, G. Jacobsen, D.D. Wang, K. Huitsing, I. Brar, G.J. Alangaden, M.S. Ramesh, J.E. McKinnon, W. O'Neill, M. Zervos, C.-T.F. Henry Ford, Treatment with hydroxychloroquine, azithromycin, and combination in patients hospitalized with COVID-19, Int. J. Infect. Dis. 97 (2020) 396–403.

[59] J.M. Sanders, M.L. Monogue, T.Z. Jodlowski, J.B. Cutrell, Pharmacologic treatments for coronavirus disease 2019 (COVID-19): a review, JAMA (2020).

[60] WHO, World Health Organization, Emergencies Preparedness, Response, 2020.

[61] C. Felter, What Is the World Doing to Create a COVID-19 Vaccine?, 2020. https://www.cfr.org/backgrounder/what-world-doing-create-covid-19-vaccine.

[62] A. Kane, The First Phase 3 Coronavirus Vaccine Trial in the US Is Expected to Begin Next week. Here's How the Vaccine Works, 2020. https://edition.cnn.com/2020/07/24/health/moderna-vaccine-barney-graham-gupta/index.html.

[63] S. Anwar, M. Nasrullah, M.J. Hosen, COVID-19 and Bangladesh: challenges and how to address them, Front. Publ. Health 8 (154) (2020).