Comparison of public response to containment measures during the initial outbreak and resurgence of COVID-19 epidemic in China: an infodemiology study

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Comparison of public response to containment measures during the initial outbreak and resurgence of COVID-19 epidemic in China: an infodemiology study

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Abstract

Background: Monitoring public responses is crucial to inform policy measures to prepare for COVID-19 resurgence around the world.

Objective: To assess and compare public responses towards containment measures during the initial outbreak and resurgence of COVID-19 epidemic in China.

Methods: We collected all COVID-19 related posts from Sina Weibo (China's Twitter) during the initial outbreak in China and resurgence in Beijing. With a Python script, we constructed subsets of Weibo posts focusing on three containment measures: lockdown, test-trace-isolate, and suspension of gatherings. Baidu's open source sentiment analysis model, and Latent Dirichlet Allocation model, a widely-used machine learning algorithm, were used to assess public's attention, sentiment, and frequently discussed topics on each containment measure.

Results: During the initial outbreak, the amount of Weibo posts escalated dramatically following Wuhan lockdown, a high proportion of posts showed negative sentiment towards all three containment measures, and discrimination-related topics arose. Compared to the initial outbreak, the public expressed less attention and less negative sentiment on containment measures, and were more supportive towards containment measures during the COVID-19 resurgence. The public shifted their focus to the impacts of containment measures on their daily lives or work.

Conclusions: As China's response strategy switched from lockdown to a targeted response in the COVID-19 resurgence, public responses became more rational. When COVID-19 resurges, more targeted test-trace-isolate strategies for high-risk population should be promoted to balance epidemic control and its impacts on daily lives and the economy.

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Comparison of public response to containment measures during the initial outbreak and resurgence of COVID-19 epidemic in China: an infodemiology study

Abstract

Background: The COVID-19 cases resurged around the world in the second half of 2020. Not much is known about the change of public responses to containment measures from the initial outbreak to resurgence. Monitoring public responses is crucial to inform policy measures to prepare for COVID-19 resurgence.
Objectives: To assess and compare public responses towards containment measures during the initial outbreak and resurgence of COVID-19 epidemic in China.
Methods: We collected all COVID-19 related posts from Sina Weibo (China's Twitter) during the initial outbreak in China and resurgence in Beijing. With a Python script, we constructed subsets of Weibo posts focusing on three containment measures: lockdown, test-trace-isolate, and suspension of gatherings. Baidu's open source sentiment analysis model, and Latent Dirichlet Allocation topic modeling, a widely-used machine learning algorithm, were used to assess the public's engagement, sentiment, and frequently discussed topics on each containment measure.
Results: A total of 8,985,221 Weibo posts were collected. In China, the containment measures evolved from the fully lockdown for general population during the initial outbreak, to a more targeted response strategy for high-risk population during COVID-19 resurgence. Between the initial outbreak and resurgence, average daily proportion of Weibo posts with negative sentiments decreased from 57% to 47% for lockdown, from 56% to 51% for test-trace-isolate, and from 55% to 48% for suspension of gathering. Among the top 3 frequently discussed topics on lockdown measure, discussions on containment measures accounting for around 32% in both periods, but the second top topic shifted from expressing negative emotions (11%) to its impacts on daily lives or work (26%). The public expressed the high level of panic (21%) in the initial outbreak but virtually zero panic (1%) in the resurgence. The more targeted test-trace-isolation measure got the greatest support (60%) among all three containment measures in the initial outbreak, and its supporting rate reached 90% during the resurgence.
Conclusions: Compared to the initial outbreak, the public expressed less engagement and less negative sentiment on containment measures, and were more supportive towards containment measures during the resurgence. The targeted test-trace-isolate strategies were more acceptable for the public. When COVID-19 resurges, more targeted test-trace-isolate strategies for high-risk population should be promoted to balance epidemic control and its impacts on daily lives and the economy.

Keywords: COVID-19, social media, public response, engagement, sentiment, topic modeling, LDA.

Introduction

In December 2019, Coronavirus disease 2019 (COVID-19) emerged in Wuhan, and propagated rapidly across China and the world [1]. In response, many countries implemented stringent large-scale containment measures such as lockdowns, quarantines, and suspension of mass gatherings. Following these containment measures, the number of new COVID-19 cases decreased significantly from its peak in the first half of 2020 [2-6]. In China, the government adopted a swift national-wide lockdown in late January 2020 when is Chinese New Year holiday, which included: stay-at-home orders, transportation block, closure of shops and schools, suspension of gatherings, and suspension of work after the national Spring Festival holiday (the Chinese New Year), when most Chinese would travel across cities or provinces for family gathering. The lockdown measure aimed to prevent population movement and mass gatherings in order to limit community transmission. As the epidemic went under the control, many provinces lifted containment measures starting from late February 2020 [7].

Although very few COVID-19 cases were thereafter reported in China [7], smaller scale resurgences occurred. On June 11th, a confirmed case, not linked to international travel, was found in Beijing, ending the city's almost two-month span of zero incidence of locally infected cases [8-10]. During the resurgence, Beijing adopted a more targeted response strategy, instead of the city-level lockdown during the initial outbreak. This targeted response strategy, namely "test-trace-isolate", principally consisted of nucleic acid testing for people who had contacts with known cases, tracing close contacts of confirmed or suspected cases, and isolating vendors and customers of Xinfadi market (the epicenter of the Beijing resurgence). By quickly identifying Xinfadi Market as the epicenter, most businesses and schools in Beijing were allowed to maintain operations. Also, instead of suspending all modes of transportation, restrictions were promptly applied to passengers/goods entering or leaving Beijing, which prevented the virus from spreading outside Beijing. The health code system was also widely used to identify the exposure risk of population [11]. One month later, there were no new cases identified with total 335 confirmed cases, and on July 19th, Beijing lifted its response strategy. Around the world, there has also been a resurgence of COVID-19 cases since August 2020, and evidence-based response strategies are thus needed to fully prepare for the situation [6, 12-15].

Public response may change from the initial outbreak to COVID-19 resurgence, and needs to be monitored. Previous studies showed that the public frequently discussed the containment measures on social media, including lockdown, test-trace-isolate, suspension of gatherings, personal protection, social distancing, travel restrictions, and workplace closures [16-18]. At the early stage of the COVID-19 epidemic, the public in many countries complied with containment measures, but their compliance gradually weakened as the epidemic progressed [19]. Studies also found that both Weibo and Twitter users expressed more negative sentiments in the early stage of COVID-19 epidemic [20-22]. In late 2020, many countries faced resurgences of COVID-19 and restarted containment measures. In India, Twitter users held a positive approach to the second lockdown, but the majority became a negative approach to the third lockdown [23]. In the Philippines, the negative sentiments increased due to food shortage and helplessness during the lockdown [24]. Prolonged containment measures may lead to decreasing risk perception, increasing negative sentiment, and fatigue with sustaining containment measures [25-27]. Therefore, it is necessary to continuously monitor the public's response to containment measures, and design effective public communication strategies. Previous studies have shown that public risk perception and negative sentiments (such as depression, anxiety, and frustration) were highly correlated with the implementation of containment measures [16, 26, 28, 29]. However, to our knowledge, none of these studies has assessed public responses to containment measures during COVID-19 resurgences, and compared them across different stages of the epidemic.

With the protraction of epidemics, containment measures need to be adjusted accordingly, and it is imperative to gain timely feedbacks on containment measures from the public. Social media has been increasingly recognized as a platform for social surveillance [7, 30]. Compared to surveys, social media not only allows for the monitoring of fluctuations in public sentiment and response over a longer period, but also suffers from less recall bias. Using machine learning approach based on social media data, this study aims to assess and compare public responses to containment measures during the initial outbreak and resurgence of the COVID-19 epidemic in China, including the level of public engagement, sentiments expressed, and frequently discussed topics. This study presents first-hand data of the evolution of public responses as the COVID-19 epidemic progresses, thus helps inform adjustment on containment measures. Understanding the shifts of public responses could be essential for policymakers to prepare for future resurgence of COVID-19 globally.

Methods

Study design

This is a comparative study based on social media data. With over 500 million users, Sina Weibo (China's Twitter) is the most influential social media platform in China [31]. Weibo allows users to share information and/or opinions in real-time by sending Weibo posts, and has been widely used to identify public concerns during the COVID-19 epidemic. We compared public response on containment measures between the initial outbreak and COVID-19 resurgence by the following indicators: 1) the number of relevant Weibo posts, 2) the prevalence of negative sentiment in Weibo posts, and 3) the proportion frequently discussed topics on Weibo. All data in this study is publicly available, and this study is exempt from ethics approval.

Data collection

Weibo posts that contain specific words can be retrieved by Sina Weibo's keyword search function. We programmed a crawler in Python (https://www.python.org/) to collect publicly available Weibo posts using keyword search. Since COVID-19 spread across China in the initial outbreak and only propagated in Beijing during the resurgence, we retrieved all COVID-19 related Weibo posts in China for the initial outbreak and posts in Beijing for the resurgence, respectively. For both surges of the epidemic, we collected Weibo posts sent from one week before the outbreak to when epidemic areas began to lift their responses (January 13th - February 28th for the initial outbreak and June 4th - July 20th for the resurgence). Totally we collected 8,985,221 Weibo posts, and the dataset can be downloaded at https://github.com/xinyuuzhou/weibo_covid-19_dataset.

Data Preprocessing

The initial pool of Weibo posts was preprocessed using a Python script to drop duplicates, and then to remove hashtags, links, uniform resource locators, and @usernames from each post to clean the text [32, 33]. We extracted the last user's comment if it was a repost, and we also removed Weibo posts that were irrelevant to the public's response by matching patterns with Python [34]. Finally, keyword matching was used from all COVID-19 related Weibo posts to extract Weibo posts targeting three primary containment measures: lockdown, test-trace-isolate, and suspension of gatherings (Table 1). The flowchart for data collection and preprocessing is shown in Multimedia Appendix 1.

Table 1: Keywords on containment measures of COVID-19 epidemic

Containment measures	Keywords
Lockdown	"□□"(city lockdown), "□□"(village lockdown), "□□"(block road), "□□"(close), "□□"(public health response), "□□"(stop traffic), "□□□□"(temporarily closed)
Test-trace-isolate	"□□□□"/"□□"(body temperature monitoring), "□□"(test), "□□"(trace), "□□"(isolate), "□□"(enforce/enforcement), "□□"(control)
Suspension of gathering	"□□"(suspension of gathering), "□□"(call off), "□□"(cancel), "□□"(put off school opening or returning to work), "□□"(postpone), "□□"(prolong vacation)

Data analysis

We analyzed public engagement, sentiment, and frequently discussed topics towards each of the three containment measures, and compared those from the COVID-19 resurgence with the initial outbreak. *Public engagement* toward containment measures was assessed using the daily number of related Weibo posts, which was compared with the daily number of locally new COVID-19 cases, according to the National Health Commission of China and Beijing Municipal Health Commission. *Public sentiment* toward containment measures was analyzed by the Baidu open-source Sentiment Analysis Application Programming Interface, and measured by proportion of Weibo posts with negative sentiment. *Frequently discussed topics* about containment measures on social media were identified by Latent Dirichlet Allocation (LDA) topic modeling combined with manual annotation.

Topic modeling is an unsupervised machine learning technique that can automatically identify underlying topics or clusters by identifying groups of words that often co-occur in a textual data set (i.e. Weibo posts) [9, 17, 35]. LDA is a widely-used topic modeling algorithm to identify the most common topics in social media[35, 36]. In LDA, each document (i.e. a Weibo post) is assumed to contain a mixture of topics, and each topic can be captured by a mixture of words. It aims to map the given documents to the set of topics so that the words in each document can be mostly captured by those topics. We applied the LDA topic modeling by separating all documents into 30 machine-generated topics, and

every Weibo post was assigned to a topic that it most likely belonged to according to the LDA model. LDA outputs provide keywords of the 30 LDA-generated topics for each containment measure during the initial outbreak and resurgence (Multimedia Appendix 2).

Since LDA is an unsupervised text classification algorithm based on the "bag-of-words model", sometimes it may misclassify documents or misidentify topics [37-39]; therefore, it is important to manually assess representative documents (in our case, Weibo posts). In this study, LDA outputs was verified and improved by two independent researchers to analyze key words generated by the LDA model and manually review sample posts for each topic. If the Weibo posts in one of the machine-generated 30 topics were found to contain several exclusive subtopics, this topic needed to be manually reviewed. Finally, a random sample of Weibo posts (>10%) and their assigned topics were reviewed by two independent researchers for quality control.

Results

We compared the containment measures during the initial COVID-19 outbreak in China and the resurgence in Beijing, China (Figure 1). They included lockdown, test-trace-isolation, and suspension of gathering measures. Generally, these measures evolved from the fully lockdown for general population during the initial outbreak, to a more targeted response strategy for high-risk population during its resurgence.

Public engagement on containment measures

The COVID-19 epidemic received much engagement from the public nationally. During both initial outbreak and resurgence in China, test-trace-isolate measures received most engagements from the public, and suspension of gatherings received relatively low engagement; one difference between the two periods is that lockdown measures captured high engagement during the initial outbreak but the lowest engagement during resurgence (Figure 2). In both periods, the number of Weibo posts on containment measures increased dramatically after outbreak announcement and implementation of containment measures, remained high for around 1-2 weeks, and then fell to a low level. From one week before to one week after the confirmation of human-to-human transmission (January 20th, 2020) in China, average daily number of Weibo posts increased from 14 to 4168 for lockdown measure, from 69 to 2003 for suspension of gathering measure, from 340 to 6298 for test-trace-isolation measure, respectively. Similarly, average daily number of Weibo posts during the week before the COVID-19 resurgence (June 11th, 2020) were 41 for lockdown measure, 118 for suspension of gathering measure, and 179 for test-trace-isolation measure, respectively. As a comparison, it reached 256 for lockdown measure, 321 for suspension of gathering measure, and 803 for test-trace-isolation measure in the week after the resurgence. And Weibo activity reached the peak around 1-2 weeks before the peak of COVID-19 cases, indicating Weibo seemed to track policy changes (e.g. lockdown) rather than actual case numbers.

Public sentiment on containment measures

Negative sentiment towards all three containment measures during the COVID-19 resurgence (average daily proportion of Weibo posts with negative sentiment: 47% for lockdown, 51% for test-trace-isolate, 48% for suspension of gathering) was lower than the initial outbreak (average daily proportion: 57% for lockdown, 56% for test-trace-isolate, 55% for suspension of gathering) (Figure 3). During the initial outbreak, nearly 80% of the public immediately expressed negative sentiments towards lockdown and suspension of gathering measures following the Wuhan lockdown, and around 60% expressed negative sentiments towards test-trace-isolation measure. Then, negative sentiments quickly started to decrease for around one week, and oscillated at a lower level. However, for test-trace-isolate, the proportion of negative sentiments varied in a smaller range than other two containment measures did. One exception is the spike in negative sentiment about lockdown on February 6th, 2020, which might relate to concerns about lacking medications or treatments for patients with other diseases; this accounted for a large proportion of posts with negative sentiment on that day. During the COVID-19 resurgence in Beijing, negative sentiment towards containment measures was relatively lower and less variant than initial outbreak.

Frequently discussed topics on containment measures

Topics related to lockdown measure: For the initial outbreak, the top 3 topics on lockdown were attitudes towards Wuhan lockdown (16.42%, 5915/36027), discussions on other containment measures excluding lockdown (14.21%, 5120/36027), and expressing negative emotions caused by the epidemic, such as fear, worry, depression and panic (11.35%, 4090/36027) (Figure 4). Among posts of attitudes towards Wuhan lockdown, 42% (2473/5915) of posts showed

support for the policy, while 4% (220/5915) opposed the policy, along with 12% (720/5915) who thought the lockdown action should have been implemented earlier. For COVID-19 resurgence in Beijing, the leading three topics were public containment measures (33.10%, 867/2619), impacts on daily life (26.00%, 681/2619), and nucleic acid tests for COVID-19 (8.40%, 220/2619). Since more targeted responses had been employed during the resurgence, containment measures excluding lockdown became the main focus of Weibo posts, whereas posts about lockdown shrunk from 16.42% to 5.88%. After the resumption of work, people paid greater engagement to how containment measures would affect their daily lives or work, and thus the proportion of relevant posts increased from 10.88% to 26.00%. Consequently, there were discussions about the impact of containment measures on the economy and industry. Noticeably, people expressed more biases by ascribing the emergence and spread of the epidemic to Wuhan residents during the initial outbreak; in contrast, this was barely mentioned during the COVID-19 resurgence in Beijing. Other topics during the initial outbreak included appealing for personal protection (10.36%), lockdowns outside Wuhan (6.68%), people leaving Wuhan (6.51%); shortages in the supply of medical equipment, including masks, were not widely discussed (3.11%). Topics such as vaccines and nucleic acid tests only emerged during the resurgence.

Topics related to test-trace-isolate measure: For the initial outbreak, 48.44% (30826/63644) of posts on test-trace-isolate measure were opinions about epidemic control, which expressed hope or trust in swiftly controlling the epidemic and contained suggestions about specific containment measures and descriptions of spreading status (Figure 5). During the resurgence, the percentage of posts expressing opinions on epidemic control decreased to 27.13% due to public confidence in effective response measures. The second popular topic during the initial outbreak was quarantine and protection measures, which were only mentioned in 1.62% of posts during the resurgence. In the initial outbreak, 7.8% of posts expressed attitudes about test-trace-isolate, while in the resurgence, 46.39% of users expressed their attitudes. This further illustrates how the discussion's focus shifted from epidemic control status to targeted response measures. Interestingly, public attitudes towards test-trace-isolate measure differed between these two periods of the epidemic in China. In the initial nation-wide outbreak, only 60% (3921/6506) of posts supported the test-trace-isolate strategy. However, during the resurgence in Beijing, posts supporting the test-trace-isolate policies increased to 90% (3853/4292). Posts displaying panic fell from 21% to 1%, and posts related to queries also decreased from 15% to 5%. Users expressing reluctance to be tested or quarantined accounted for 4% in the two periods. Additionally, different topics emerged during the two periods. During the initial outbreak, some posts (2.86%) discussed medical equipment and health professionals, while during the resurgence, people discussed the impact of test-trace-isolate on schooling, work, daily lives, and the status of the epidemic worldwide.

Topics related to suspension of gatherings measure: Among posts on suspension of gatherings measure, 38.46% (7487/19466) and 23.92% (834/3487) mentioned cancellation of travel plans and small-scale gatherings during the initial outbreak and resurgence, respectively (Figure 6). The proportion of posts describing suspension of mass gathering events increased dramatically from 3.07% in the initial outbreak to 31.09% in the resurgence, which indicates that the public response was much more sensitive to the suspension of massive gathering events, such as sports and concerts, during the resurgence. Other common topics during these two epidemic periods included travel restrictions, closing public places, and eliminating unnecessary daily outings. In addition, 14.05% (2735/19466) of posts discussed extending the Spring Festival vacation and postponing returning to work during the initial outbreak, among which, 55% of users supported the extension of vacation. In the resurgence, discussions surrounding population movement issues emerged, such as visas and immigration.

Discussion

Principal Findings

Through social media surveillance, we analyzed and compared the level of public engagement, sentiment expressed, and frequently discussed topics around three primary containment measures during the initial outbreak and the resurgence of COVID-19 epidemic in China. As the epidemic control strategy switched from lockdown to a targeted response during the COVID-19 resurgence, public responses became more rational. During the initial outbreak, the amount of Weibo posts escalated dramatically following Wuhan lockdown, a high proportion of posts showed negative sentiment towards all three primary containment measures, and discrimination-related topics arose. During the resurgence, however, the public showed less engagement and less negative sentiment, were more supportive towards containment measures, and shifted their focus to the impacts of containment measures on their daily lives or work.

Monitoring public responses to epidemic control strategies is crucial to obtain rapid feedback and inform strategy adjustments during an epidemic. Previous studies showed that social mobilization and community engagement were central to the Ebola response in West Africa [40-42]. During the COVID-19 epidemic, especially the initial outbreak, Chinese Weibo users raised questions about the epidemic's source, shortages of medical equipment, and discrimination

against Wuhan residents. A considerable number of Weibo posts expressed panic or had queries regarding containment measures. This is worth noting, since studies showed that panic and queries around containment measures and discrimination may inhibit community engagement and dampen epidemic control [19]. When COVID-19 resurged, public concerns on containment measures changed to focus on impacts on daily life. Policymakers should pay close attention to these changes in public response to track the most vital needs of the population during the different epidemic stages, as well as to address public concerns through timely effective communication [43, 44]. This can improve public compliance and engagement with containment measures and facilitate their implementation [45, 46].

During COVID-19 resurgence in Beijing, a more targeted response strategy was applied to the high-risk population, and the general population was less impacted. Frequently discussed topics on Weibo during the resurgence reflected that the lives of the public were returning to normal; there were no longer topics regarding discrimination and the shortage of supplies, and negative sentiment towards all containment measures were lower during the resurgence than the initial outbreak. The shifts in discussed topics and public sentiment might also be related to the reduced stringency of these containment measures. As shown in previous studies, stricter measures were followed by higher negative sentiment [16]. The public may become fatigued to containment measures when the epidemic resurges. In our study, public responses were more sensitive to the suspension of massive gathering events during the resurgence than the initial outbreak. Therefore, governments should balance containment strategies' benefits to their impacts on daily lives and the economy to formulate tailored response strategies during COVID-19 resurgence.

As more information about COVID-19 and its control has become available, governments have gained options for tailoring their response strategies to its resurgence. Using the test-trace-isolate for high-risk populations strategy, Beijing flattened the case curve and put the epidemic under control within one month. Our study indicates that this targeted response strategy better matches public concerns. With the normalization of the epidemic, people cared more about their life and economics under the epidemic, such as going back to school or work, going to concerts, traveling, immigration, and sports events. The targeted response strategy focuses on high risk populations and has less restrictions on most people's lives, which might help reduce the negative sentiment among the public during COVID-19 resurgence. A modeling study predicted that, compared with the community-wide lockdown strategy, the targeted response strategy would be less costly[47], and could help revive industries and the economy. China's economy data showed that its GDP shrank 6.8% in Q1 with a full lockdown, but grew by 3.2% in Q2 and by 4.9% in Q3 of 2020 with test-trace-isolate targeting high-risk populations [48]. Therefore, more targeted response strategies should be promoted during COVID-19 resurgence.

Overall, the public reaction to initial outbreak showed a dramatic escalation in public engagement with more negative sentiments following the lockdown policy, and as a comparison, targeted containment measures during the COVID-19 resurgence got more rational responses and greater support. The public expressed the high level of panic (21%) in the initial outbreak but virtually zero panic (1%) in the resurgence. Only 4% of the public expressed reluctance to be tested or quarantined in both initial outbreak and the resurgence, which would be an important floor on public health efforts to achieve universal compliance. The targeted test-trace-isolation measure got the greatest support among all three containment measures in the initial outbreak, and its supporting rate reached around 90% during the resurgence. The evolution of public responses towards containment measures indicated that targeted test-trace-isolate strategies were more acceptable for the public. Governments should take public responses on social media into consideration, and take more targeted test-trace-isolate strategies to prepare for the future resurgence of COVID-19.

Limitations

This study has several limitations. First, Weibo is more widely used by younger people, and some users simply read Weibo posts but do not post their own content. Therefore, caution should be used when interpreting the study findings in the context of the general public. Python was used to collect all relevant Weibo posts for analysis and therefore, the data used in this study are valid to reflect the opinions and responses of the Weibo users. Second, as an unsupervised text classification algorithm based on the "bag-of-words model," LDA may lead to misclassification of Weibo posts. However, such misclassification is random - it doesn't lean towards any direction (positive or negative) in particular [49]. Therefore, it does not cause bias in interpretation in a comparative study. To control for this potential bias, we randomly sampled and manually classified Weibo posts to correct misclassification and improve accuracy. Future research should explore real-time social media surveillance with more advanced machine learning techniques (e.g. Bidirectional Encoder Representations from Transformers), and conduct long-term, multilingual, and multi-platform public response surveillance towards the COVID-19 epidemic.

Conclusions

Compared to the initial outbreak, the public became more rational during the COVID-19 resurgence. The public expressed less engagement and less negative sentiment on containment measures, were more supportive towards containment measures, and shifted their focus to the impacts of containment measures on their daily life or work during the resurgence. The targeted test-trace-isolate strategies were more acceptable for the public. This study highlighted that epidemic control strategies should be more targeted when COVID-19 resurges, such as test-trace-isolate strategies targeting high-risk populations, to balance epidemic control and its impacts on daily life and economy.

Authors' contribution

Zhiyuan Hou and Leesa Lin conceptualized and designed the study. Xinyu Zhou collected the data. Yi Song, Xinyu Zhou, Hao Jiang, Qian Wang, Zhiqiang Qu, and Linyao Lu analyzed the data. Xinyu Zhou and Yi Song drafted the initial manuscript. Zhiyuan Hou, Leesa Lin, and Mark Jit revised the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Declaration of interests

We declare no competing interests.

Access to data

All data are publicly available. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Figure legend

Figure 1. Timeline of containment measures during the initial outbreak and the resurgence of COVID-19 epidemic in China. Containment measures relevant to lockdown, test-trace-isolate, and suspension of gathering are shown in time order.

Figure 2. Numbers of Weibo posts on containment measures and new COVID-19 cases during the initial outbreak and the resurgence of COVID-19 epidemic in China. The lines show the daily number of Weibo posts regarding lockdown, test-trace-isolate, and suspension of gathering. The bars show the daily number of new COVID-19 confirmed cases in China and Beijing.

Figure 3. Percentage of Weibo posts with negative sentiment on containment measures during the initial outbreak and the resurgence of COVID-19 epidemic in China.

Figure 4. Percentage of posts on frequently discussed topics on lockdown measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to lockdown measure. Pie charts show the proportion of various attitudes towards some topics during the initial outbreak.

Figure 5. Percentage of posts on frequently discussed topics on test-trace-isolate measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to test-trace-isolate measure. Pie charts show the proportion of various attitudes towards test-trace-isolate between initial outbreak and resurgence.

Figure 6. Percentage of posts on frequently discussed topics on suspension of gatherings measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to suspension of gatherings measure. Pie charts show the proportion of various attitudes towards some topics during the initial outbreak.

Multimedia Appendix

Multimedia Appendix 1. Flowchart of data collection and preprocessing

Multimedia Appendix 2: LDA outputs for each containment measure

Reference

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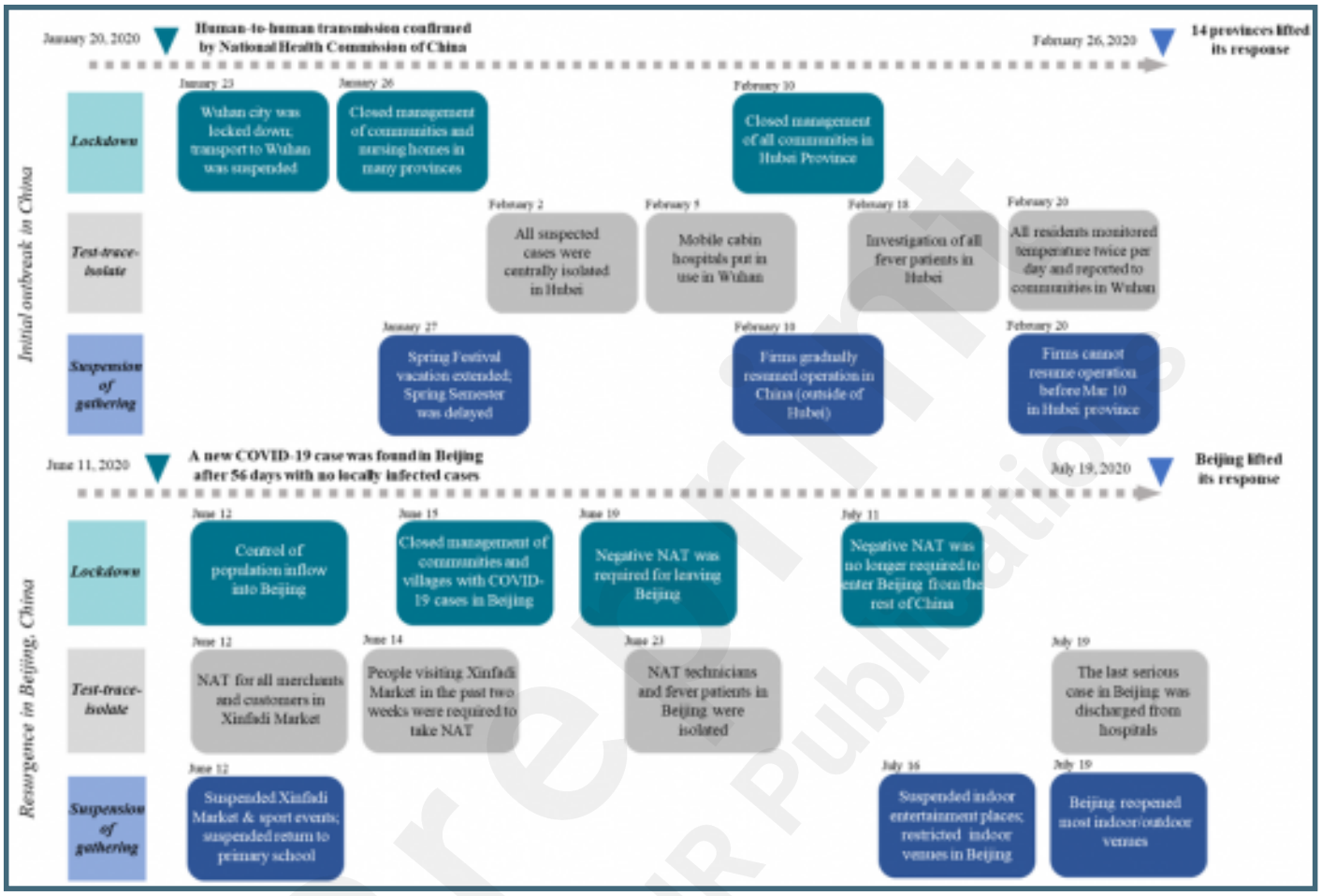
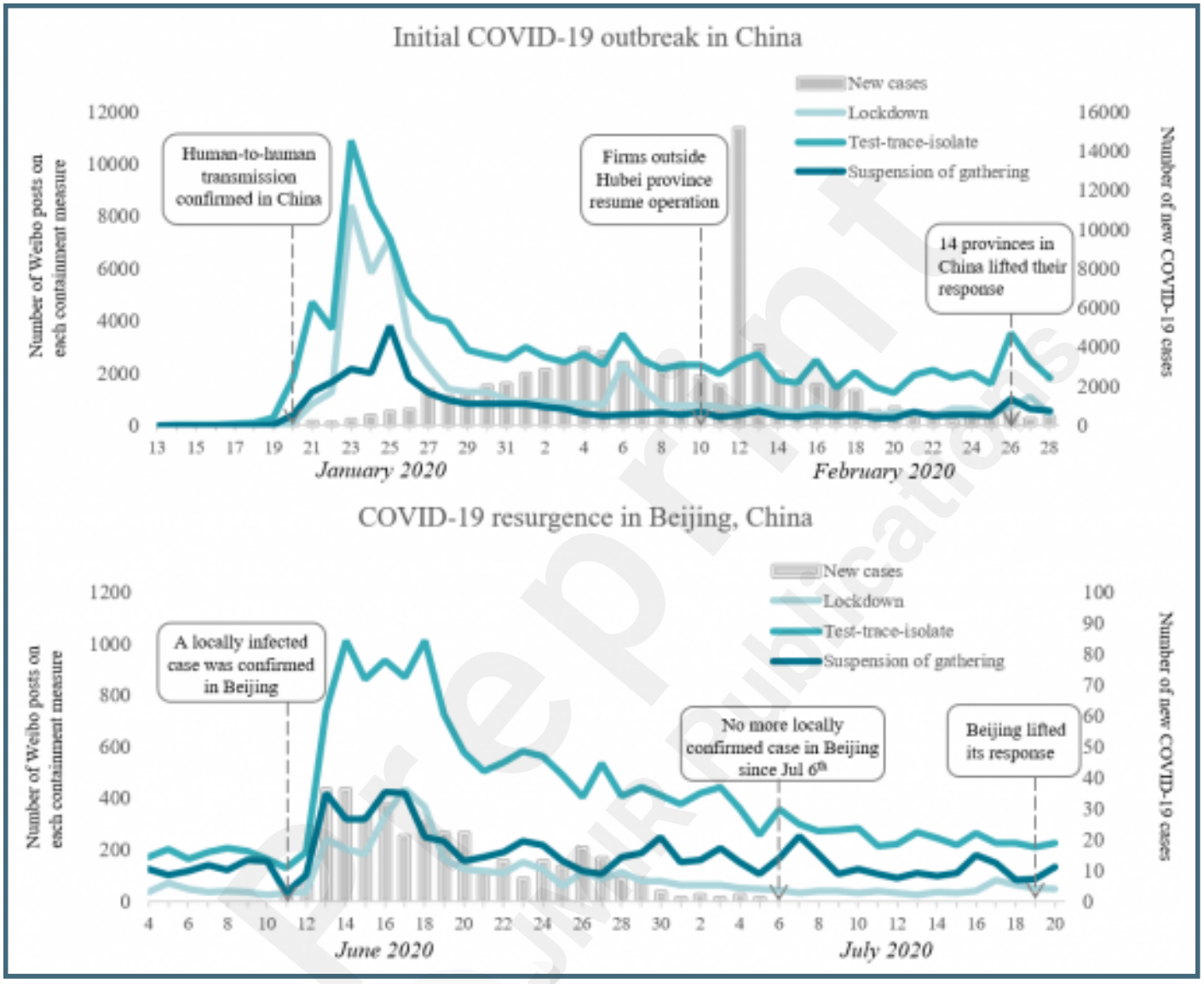
Supplementary Files

Figures

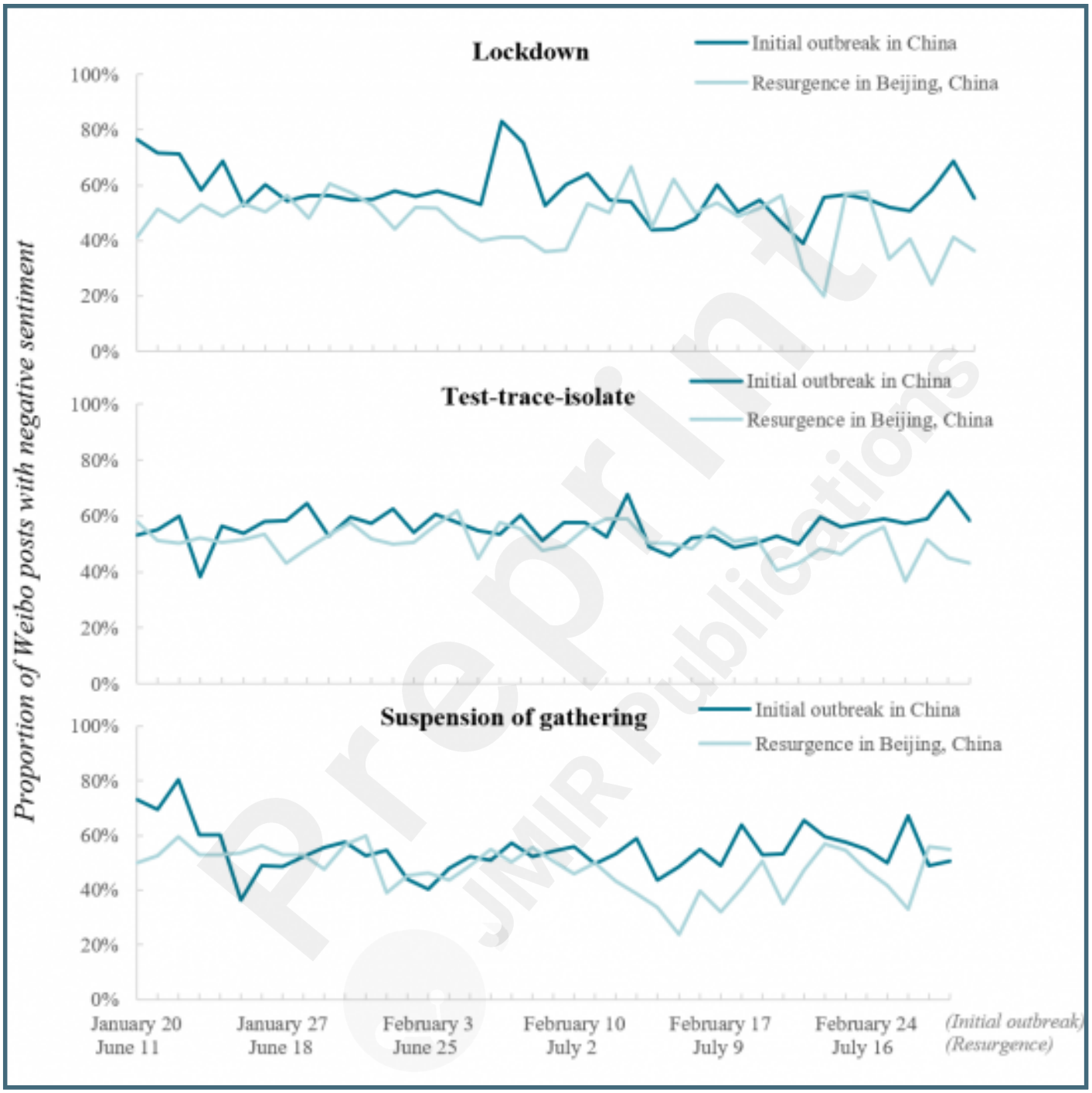
Timeline of containment measures during the initial outbreak and the resurgence of COVID-19 epidemic in China. Containment measures relevant to lockdown, test-trace-isolate, and suspension of gathering are shown in time order. *NAT: nucleic acid testing.



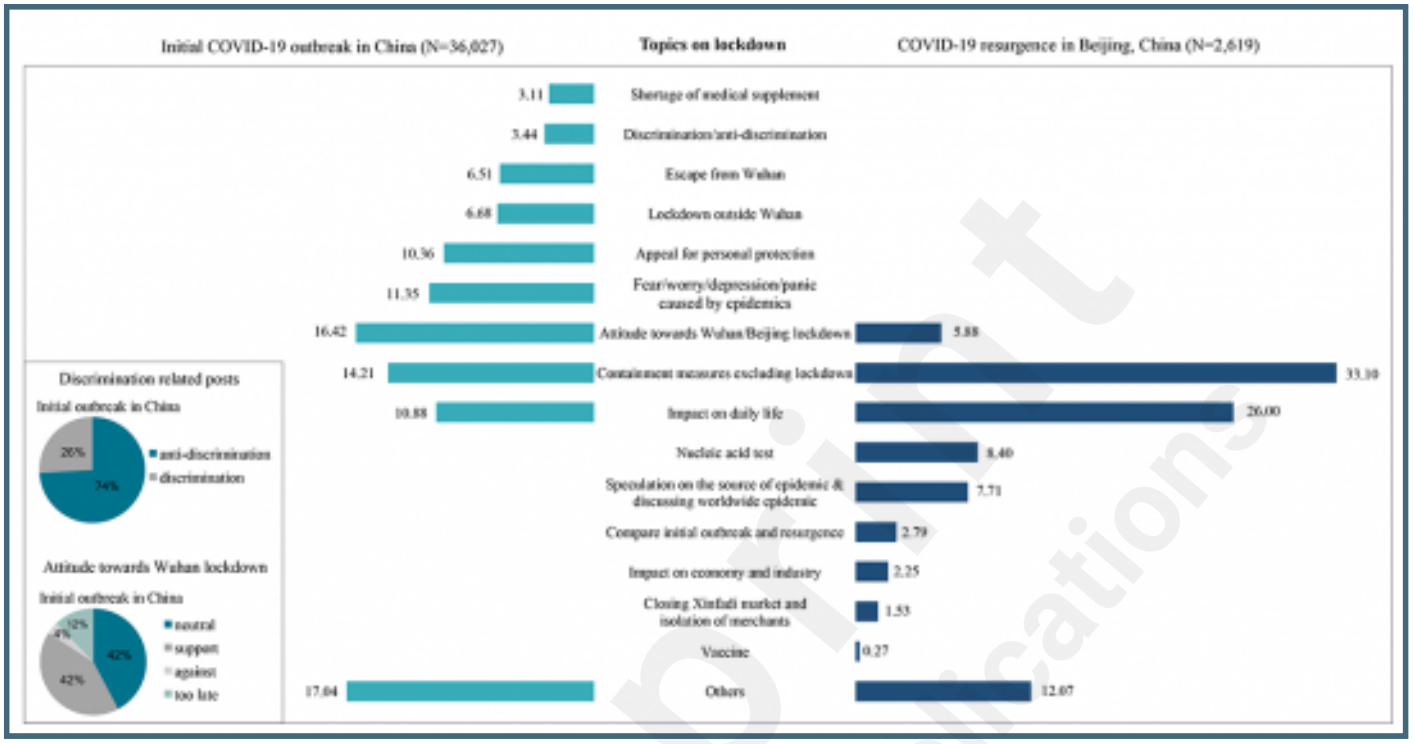
Numbers of Weibo posts on containment measures and new COVID-19 cases during the initial outbreak and the resurgence of COVID-19 epidemic in China. The lines show the daily number of Weibo posts regarding lockdown, test-trace-isolate, and suspension of gathering. The bars show the daily number of new COVID-19 confirmed cases in China and Beijing.



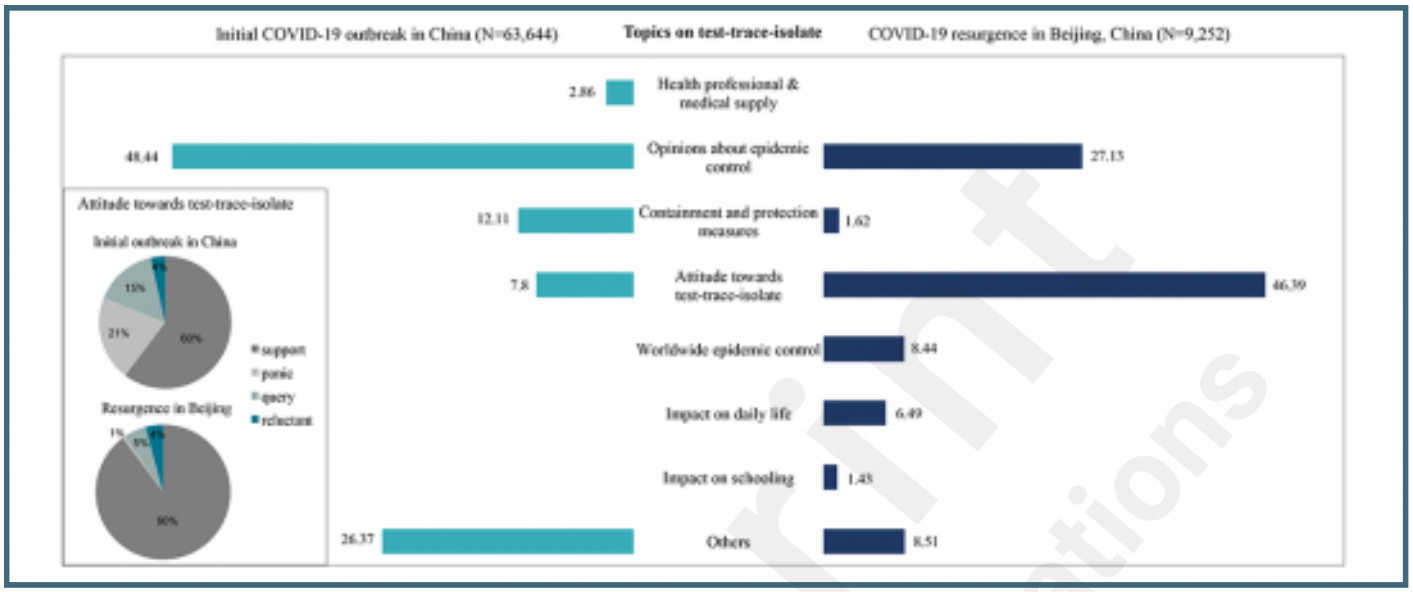
Percentage of Weibo posts with negative sentiment on containment measures during the initial outbreak and the resurgence of COVID-19 epidemic in China.



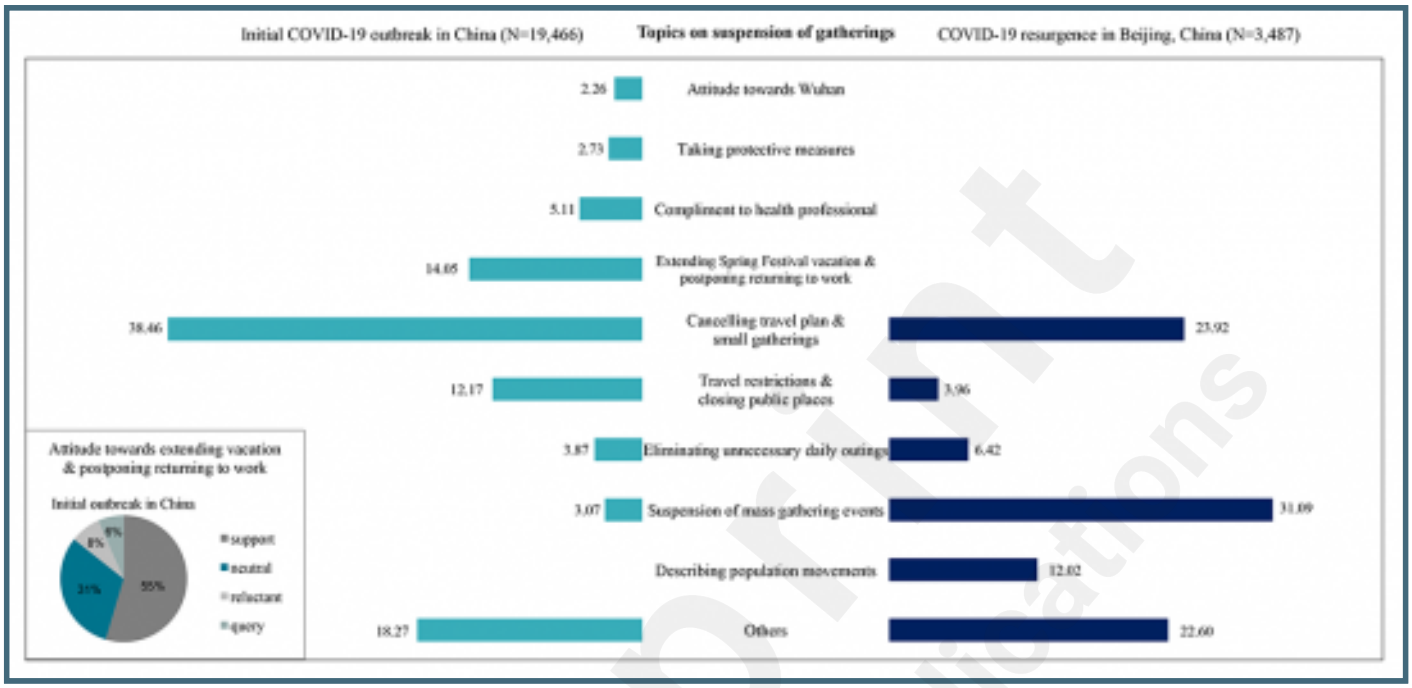
Percentage of posts on frequently discussed topics on lockdown measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to lockdown measure. Pie charts show the proportion of various attitudes towards some topics during the initial outbreak.



Percentage of posts on frequently discussed topics on test-trace-isolate measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to test-trace-isolate measure. Pie charts show the proportion of various attitudes towards test-trace-isolate between initial outbreak and resurgence.



Percentage of posts on frequently discussed topics on suspension of gatherings measure during the initial outbreak and the resurgence of COVID-19 epidemic in China. The columns show the percentage of posts on each topic among all posts related to suspension of gatherings measure. Pie charts show the proportion of various attitudes towards some topics during the initial outbreak.



Multimedia Appendixes

Flowchart of data collection and preprocessing.
URL: http://asset.jmir.pub/assets/a5d6e6796beb46bcc6efc6d1011a1200.png

LDA outputs for each containment measure.
URL: http://asset.jmir.pub/assets/5dfdb24aca341b50cec0dfaaca464291.docx