

1 **Early surveillance and public health emergency disposal measures**
2 **between novel coronavirus disease 2019 and avian influenza in China:**
3 **a case-comparison study**

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13

14 **Abstract**

15 **Background:** The novel coronavirus disease 2019 (COVID-19) outbreak is spreading
16 rapidly throughout China and the world. Hence, early surveillance and public health
17 emergency disposal are considered crucial to curb this emerging infectious disease.
18 However, studies that investigated the early surveillance and public health emergency
19 disposal for the prevention and control of the COVID-19 outbreak in China are
20 relatively few. We aimed to compare the strengths and weaknesses of early
21 surveillance and public health emergency disposal for prevention and control between
22 COVID-19 and H7N9 avian influenza, which was commended by the international
23 community, in China.

24 **Methods:** A case-comparison study was conducted using a set of six key time nodes
25 to form a reference framework for evaluating early surveillance and public health

26 emergency disposal between H7N9 avian influenza (2013) in Shanghai, China and
27 COVID-19 in Wuhan, China.

28 **Findings:** A report to the local Center for Disease Control and Prevention, China, for
29 the first hospitalized patient was sent after 6 and 20 days for H7N9 avian influenza
30 and COVID-19, respectively. In contrast, the pathogen was identified faster in the
31 case of COVID-19 than in the case of H7N9 avian influenza (12 days vs. 31 days).
32 The government response regarding COVID-19 was 10 days later than that regarding
33 avian influenza. The entire process of early surveillance and public health emergency
34 disposal lasted 5 days longer in COVID-19 than in H7N9 avian influenza (46 days vs.
35 41 days).

36 **Conclusions:** The identification of the unknown pathogen improved in China
37 between the outbreaks of avian influenza and COVID-19. The longer emergency
38 disposal period in the case of COVID-19 could be attributed to the government's
39 slower response to the epidemic. Improving public health emergency management
40 could lessen the adverse social effects of emerging infectious diseases and public
41 health crisis in the future.

42

43 **Keywords:** COVID-19; Emerging infectious diseases; H7N9; Emergency
44 management; China

45

46 **Contributors:**

47 TZ, WS, and LL designed the project, processed and analyzed the data, and wrote the
48 manuscript. YW, GB, RD, and QW edited the manuscript. All authors revised the
49 draft.

50

51 **Introduction**

52 In the past 20 years, China has experienced several public health crises due to
53 infectious disease outbreaks, such as severe acute respiratory syndrome in 2003,
54 H1N1 swine influenza in 2009, and H7N9 avian influenza in 2013, seriously
55 impacting health, economy, and global security. (1-3) These outbreaks challenged the
56 health emergency management in several countries, especially developing countries,
57 including China. (4, 5) In late December 2019, the novel coronavirus disease 2019
58 (COVID-19) emerged in Wuhan City, China, and rapidly spread throughout China and
59 the world. (6) Prior to March 5, 2020, the Chinese government reported 80,409
60 confirmed cases and 3,012 fatalities due to COVID-19. (7)

61 COVID-19 and H7N9 avian influenza are emerging infectious diseases that share
62 similar characteristics (Table 1), such as probable development of severe respiratory
63 diseases and susceptibility regardless of age. However, the socioeconomic losses were
64 higher in COVID-19 than in H7N9 avian influenza. An effective public health
65 emergency management reduces the adverse impact of emerging infectious diseases
66 (8). This management relies on the early surveillance and timely information
67 dissemination available in a given period. (9) The following three key responses are
68 often analyzed to evaluate the efficiency of public health emergency disposal: (1) time
69 taken by the hospital to report an emerging infectious disease, (2) time taken to
70 identify the pathogen, and (3) time taken by the government to respond. (10-12)The
71 World Health Organization declared a Public Health Emergency of International
72 Concern on January 30, 2020. (13) Since then, China established and strengthened the
73 national and local surveillance systems as well as emergency responses to prevent and
74 control the spread of COVID-19. (14) Comparing the infectious disease surveillance
75 and public health emergency disposal between different outbreaks in China could

76 assist in improved public health strategies and decision-making by the government to
77 prevent and control future epidemics, both in China and the world. To the best of our
78 knowledge, few studies have been conducted to investigate the early disease
79 surveillance and public health emergency disposal between other epidemics and
80 COVID-19 in China.

81 In the present study, we aimed to compare the key time nodes of early
82 surveillance and public health emergency disposal to prevent and control between
83 COVID-19 and H7N9 avian influenza.

84

85 **Table 1. Characteristics of the H7N9 avian influenza and coronavirus disease**
86 **2019 in China.**

Characteristics	H7N9	COVID-19
Country of origin	China	China
First case in China	February 2013 in Shanghai	December 2019 in Wuhan
Viral genome	Negative segmented RNA	Positive single-stranded RNA
Pathogen identification	CDC, China; March 29, 2013	CDC, China; January 7, 2020
Human-to-human transmission	Limited	High
Genesis/source	Domestic poultry	Unclear (so far)
Method of diagnosis in China	Real-time PCR	Real-time PCR
Vaccines in China	Not yet available	Not yet available

87

88 **Methods**

89 **Data collection**

90 Data regarding the public health emergency disposal of the novel COVID-19 in
91 Wuhan City, China, were obtained from published literature, secondary statistical data,
92 WHO reports, (3) official websites (e.g., National Health Commission of the People's
93 Republic of China [<http://en.nhc.gov.cn/>], Chinese Center for Disease Control and
94 Prevention [CDC] [<http://www.chinacdc.cn/en/>], Health Commission of Hubei
95 Province, and Wuhan Municipal Health Commission), and credible media reports in
96 China (CCTV, People's Daily, CBN, YiMagazine). Data regarding H7N9 avian
97 influenza in Shanghai, China, were obtained from our published literature. (15)

98 **Comparative analysis**

99 We compared the six key time nodes during the entire period from the detection
100 of the first case to the launch of the health emergency response between COVID-19 in
101 Wuhan City and H7N9 avian influenza in Shanghai. They were as follows:
102 hospitalization of the first case, hospital report to the local CDC, laboratory
103 identification of the pathogen, technical recheck of the pathogen, confirmation and
104 notification of the pathogen, and launch of emergency disposal through the Chinese
105 government.

106 We further evaluated the following three crucial periods during the public health
107 emergency disposal of emerging infectious diseases: time taken by the hospital to
108 report a case to the local CDC, time taken to identify the pathogen i.e., organization of
109 the CDC laboratory to detect and recheck the pathogen, and time taken by the
110 government to respond i.e., implementation of the emergency response once the
111 pathogen is confirmed. Moreover, we calculated the number of days during each time
112 node using the hospitalization time reference of the first case as the benchmark. The
113 duration between detecting the first case and report the first death was also analyzed
114 in the study.

115 **Results**

116 The comparison of three crucial periods between COVID-19 in Wuhan City and
117 H7N9 avian influenza in Shanghai are shown in Table 2 and Figure 1. The entire
118 process of early surveillance and public health emergency disposal was 5 days longer
119 in the case of COVID-19 than in the case of H7N9 avian influenza (46 days vs 41
120 days). The details regarding the comparative analysis using the set of six key time
121 nodes and three crucial time periods are as follows.

122 **Hospital to CDC reporting period**

123 **H7N9 avian influenza**

124 The first patient was hospitalized at the Fifth People's Hospital of Shanghai
125 affiliated to Fudan University on February 21, 2013. Subsequently, two patients were
126 admitted. (16, 17)

127 *The doctor on duty in the emergency department observed that a paternal*
128 *relationship existed between the follow-up case and the first case and believed that*
129 *there was a possibility of transmission. Hence, in the early hours of February 26,*
130 *2013 at 1:10 a.m., he reported his findings to the doctor on duty who was also the*
131 *chief of the infection department of the said hospital. He believed that the above*
132 *situation was consistent with the possibility of clustered unexplained pneumonia cases*
133 *and immediately called the attention of the administrators in charge of the hospital.*
134 *Subsequently, the hospital gained expert consultation and undertook protective*
135 *measures. At 2:30 a.m. of the same day, the hospital administrators contacted the*
136 *chief administrative official of the local CDC by telephone and requested the start of*
137 *epidemiological survey and sampling.* (18)

138 **Coronavirus disease 2019 (COVID-19)**

139 The Wuhan Municipal Health Administration announced on January 11, 2020

140 that the first confirmed case of novel coronavirus pneumonia was detected on
141 December 8, 2019. (18) A literature published in *The Lancet* reported that the first
142 case was detected on December 1, 2019. (19) Based on the principle of caution, this
143 article used December 8, 2019 as the onset time of the first case of the epidemic and
144 considered that this patient was hospitalized at that time.

145 *On the morning of December 26, 2019, Dr. Jixian Zhang, a doctor from Hubei*
146 *Hospital of Integrated Traditional Chinese and Western Medicine in Wuhan City,*
147 *observed an abnormality in a couple's lung computed tomography (CT) scan and an*
148 *abnormality in their son's CT scan as well. Hence, the next day, the hospital reported*
149 *four abnormal CT findings to the local CDC including another case. (20)*

150

151 Hence, the time taken by the hospital to report the first case of H7N9 (2013) in
152 Shanghai and COVID-19 (2019) in Wuhan was 6 and 20 days, respectively.

153 **Pathogen identification period**

154 **H7N9 avian influenza**

155 The local CDC conducted an epidemiological survey and sampling at 4:00 a.m.
156 on February 26, 2013 and informed the hospital at 10:30 a.m. that adenovirus,
157 syncytial virus, Legionella, H1N1, highly pathogenic avian influenza virus,
158 Mycoplasma, and seasonal influenza virus tested negative. The hospital subsequently
159 sent the samples to the P3 Laboratory of Shanghai Public Health Clinical Center. On
160 March 22, the Shanghai Public Health Clinical Center preliminarily confirmed the
161 pathogen as a new type of avian influenza virus. On March 29, 2013, the National
162 CDC isolated a new type of avian influenza virus from samples collected from
163 patients.

164 **COVID-19**

165 The local CDC was unable to identify the pathogen on December 26, 2019 and
166 subsequently sent the samples to various testing institutions, including Shanghai
167 Public Health Clinical Center and the Chinese Academy of Sciences (Wuhan Virus
168 Institute). Various testing institutions had identified the novel coronavirus and the
169 complete genome sequence between December 30, 2019 and January 5, 2020. (20) On
170 January 7, 2020, the National CDC isolated a new type of coronavirus from the
171 patients' samples. (22)

172

173 Hence, the time taken to identify the pathogen in the cases of H7N9 (2013) in
174 Shanghai and COVID-19 (2019) in Wuhan was 31 and 12 days, respectively.

175 **Government response period**

176 **H7N9 avian influenza**

177 On March 31, 2013, the National Health Administration confirmed that the
178 pathogen was a new type of avian influenza virus. On April 2, 2013, the government
179 of Shanghai launched a level-three response to public health emergencies.

180 **COVID-19**

181 On January 8, 2020, the National Health Administration confirmed that the
182 pathogen was a novel coronavirus. On January 22, 2020, the government of Hubei
183 Province launched a level-two response to public health emergencies. (22)

184 Hence, the time taken by the government to respond in the cases of H7N9 (2013)
185 in Shanghai and COVID-19 (2019) in Wuhan City was 4 and 14 days, respectively.

186 We compared the government's emergency response process between outbreaks
187 of Shanghai H7N9 avian influenza in 2013 and Wuhan COVID-19 in 2019. The time
188 taken from the detection of the first case to the implementation of public health
189 emergency response was 41 and 46 days for H7N9 avian influenza and COVID-19,

190 respectively. The hospital to CDC reporting period was 14 days slower in the case of
191 COVID-19 than in the case of H7N9 avian influenza. The time taken to identify the
192 pathogen was 19 days faster in the case of COVID-19 than in the case of H7N9 avian
193 influenza. Lastly, the time taken by the government to respond was 10 days slower in
194 the case of COVID-19 than in the case of H7N9 avian influenza (Figure 2).

195 **Table 2. Comparison of the key time nodes of emergency disposal between H7N9 avian influenza (2013) in Shanghai and coronavirus**
 196 **disease 2019 in Wuhan.**
 197

Key time nodes	Three crucial periods	Shanghai H7N9 avian influenza (2013)		Wuhan novel coronavirus pneumonia (2019)	
		Dates and events	Cumulative time (day)	Dates and events	Cumulative time (day)
1) Hospitalization of the first patient	Hospital to CDC reporting period	On February 21, the Fifth People's Hospital Affiliated to Fudan University (Shanghai) admitted a patient	1	On December 8, as confirmed by the Wuhan Health and Medical Commission on January 11 (based on <i>The Lancet</i> paper, Wuhan's first new coronavirus case was confirmed on December 1)	1
2) Hospital reporting to the local Center for Disease Control and Prevention (CDC)		On February 26, the Fifth People's Hospital Affiliated to Fudan University (Shanghai) submitted a report to the District CDC and requested for an epidemiological investigation	6	On December 27, the Hubei Hospital of Integrated Traditional Chinese and Western Medicine (Wuhan) reported four abnormal cases to the District CDC	20
3) Laboratory identification of the pathogen	Pathogen identification speed	On March 22, the P3 Laboratory of Shanghai Public Health Clinical Center initially identified it as a new avian influenza virus	30	On January 5, a novel coronavirus was initially identified by various institutions including Shanghai Public Health Clinical Center	29
4) Technical recheck of pathogen		On March 29, the National CDC isolated a new type of avian influenza virus from the patients' samples	37	On January 7, the National CDC isolated a novel coronavirus from the patients' samples	31
5) National confirmation of the pathogen	Government response period	On March 31, the National Health Administration confirmed that the pathogen was a new type of avian	39	On January 8, the National Health Administration confirmed that the pathogen was a novel coronavirus	32

influenza virus

**6) Local government
launched
emergency
response**

On April 2, Shanghai launched a level-three response to public health emergencies

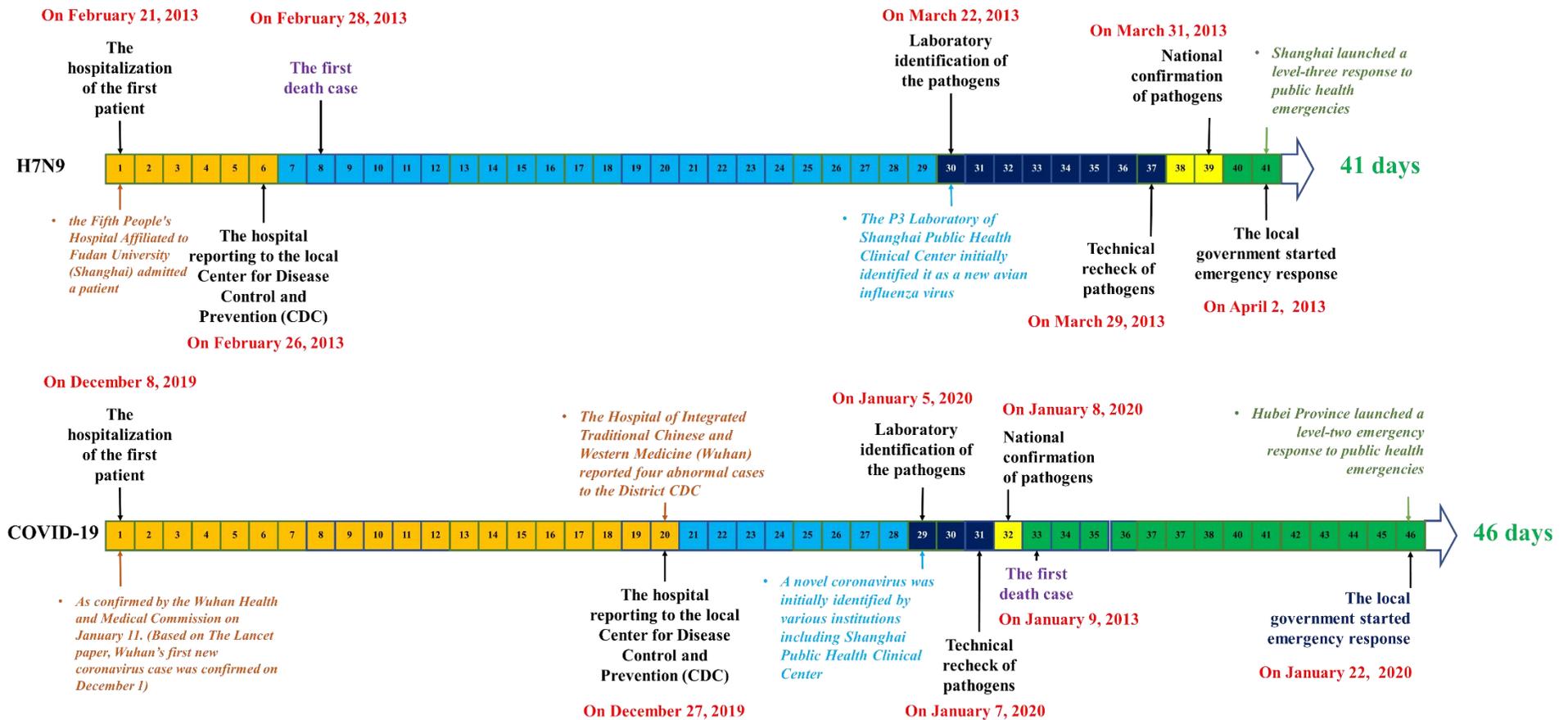
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On January 22, Hubei Province launched a level-two emergency response to public health emergencies

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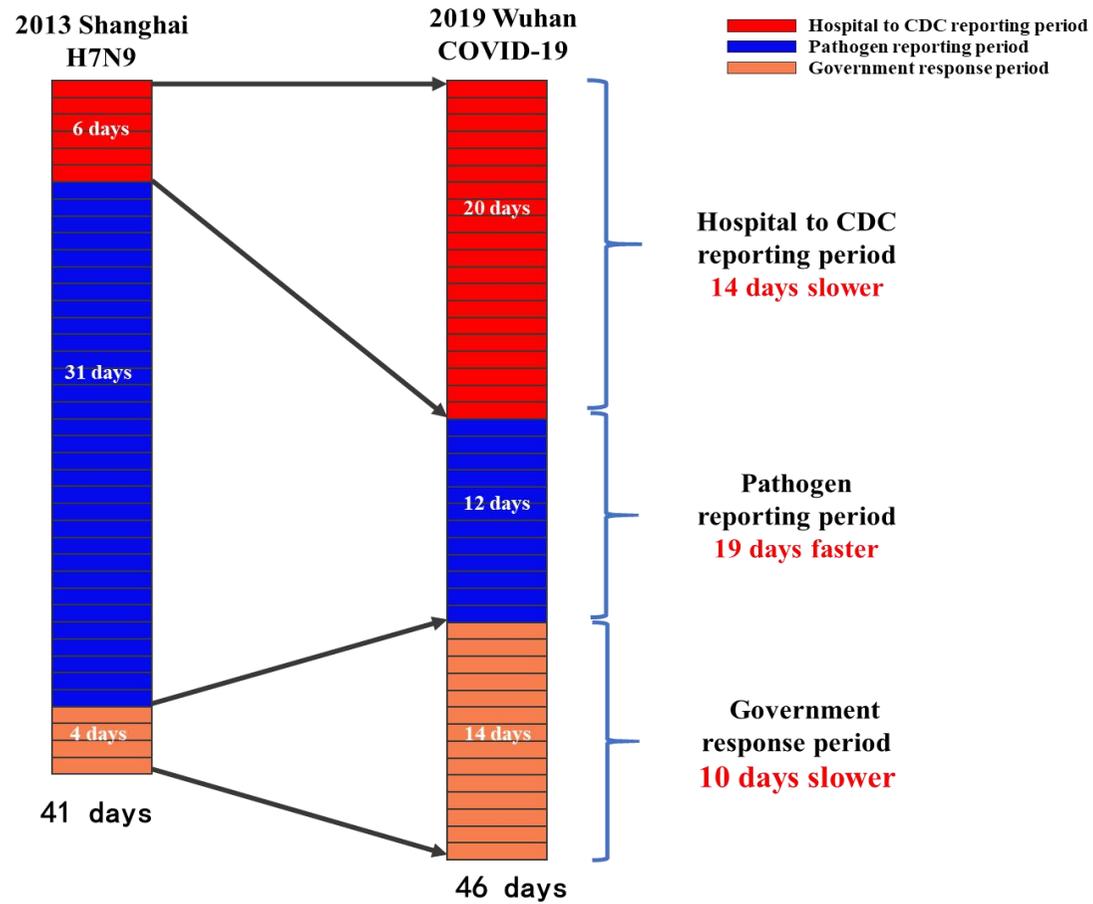
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202 **Figure 1. Comparison of the emergency disposal timeline between H7N9 avian influenza (2013) in Shanghai and coronavirus disease**

203 **2019 in Wuhan.**



204

205 **Figure 2. Comparison of three critical emergency disposal speed between H7N9 avian influenza (2013) in Shanghai versus coronavirus**
 206 **disease 2019 in Wuhan.**

207

208 **Discussion**

209 To the best of our knowledge, this was one of the few studies conducted in
210 China to compare the strengths and weaknesses of public health emergency disposal
211 between COVID-19 and H7N9 avian influenza. In this case-comparative study, the
212 time taken to detect unknown pathogens had improved between the outbreaks of
213 H7N9 avian influenza and COVID-19, whereas the time taken for hospitals to report a
214 case to the local CDC and the government's emergency response was significantly
215 slow.

216 In this study, we mainly investigated three crucial periods that influence the
217 efficiency of emergency management to public health crises. During the emergency
218 response process for H7N9 avian influenza (2013) in Shanghai, the maximum time
219 was taken to technically identify and recheck the pathogen. The technical
220 identification of pathogen took 24 days and the rechecking took 7 days, which
221 accounted for 76% of the whole emergency process. In contrast, the time taken to
222 technically identify and recheck the pathogen in the case of COVID-19 was reduced
223 to just 12 days, accounting for 24% of the whole emergency process.

224 Laboratory identification was 19 days faster in the case of COVID-19 than in the
225 case of H7N9 avian influenza, whereas the total disposal time was 5 days longer in
226 the case of COVID-19 than in the case of H7N9 avian influenza. This could be
227 attributed to the decrease in the reporting periods of certain hospitals and the increase
228 in responding periods of the local governments. The time taken by the hospital to
229 report a case to the local CDC was 14 days slower during COVID-19 than during
230 H7N9 avian influenza (19 days vs. 5 days, respectively). Furthermore, the response
231 period of the local government launching emergency management was 14 days during
232 COVID-19, which was 10 days longer than that during H7N9 avian influenza.

233 Combining the hospital to CDC reporting period and government response period of
234 H7N9 avian influenza with the pathogen identification period of COVID-19 would
235 result in the entire epidemic control taking less than 22 days. Moreover, Hubei
236 Province could thus launch an emergency response on December 30, suggesting that
237 approximately 27 cases of COVID-19 would be detected in Hubei Province and the
238 number of close contacts would be approximately 1350 by early March 2020. The
239 Wuhan Municipal Infectious Diseases Hospital alone had 350 beds, which was
240 sufficient to handle full admission. Subsequently, the local CDC also had sufficient
241 capabilities to screen and isolate most of the patients in close contacts with the
242 infected patients.

243 The 5-day longer emergency period during COVID-19 could possibly be
244 attributed to the hospital to CDC reporting period and government response period
245 constrained by the following objective conditions:

246 (1) At the beginning stage of the epidemic, H7N9 appeared a larger threat. The
247 duration between the first identified case and the first reported death was only 7 days
248 (on February 28, 2013, the first death case was observed). For COVID-19, this
249 duration was 32 days instead. On January 9, local medical institutions and disease
250 control departments were instructed to speed up and implement isolation and
251 precautionary measures. (20)

252 (2) Because of underreporting of cases considering the challenges in data
253 collection and shortage of testing kits and reagents in Hubei Province. Furthermore,
254 the local medical supplies, beds, and facilities were insufficient, which were even
255 exacerbated by the lockdown of the province, preventing the reach of supplies from
256 several other hospitals.

257 This study has several potential limitations. First, the assessment coverage was at

258 the city level; thus, comparison between the national level and the grassroots level was
259 not assessed in this study. The grassroots level is the first gateway of public health
260 emergency, and the effective measures and emergency responses taken by the
261 grassroots level are considered important. Second, we used six-time nodes to evaluate
262 the process of the government's emergency response, which is relatively limited when
263 evaluating the possibility of an epidemic of major infectious diseases. Third, the data
264 are based on China's official and authoritative reports, coupled with retrospective
265 studies, which inevitably had information bias. Considering all these limitations, the
266 findings should be interpreted with caution before additional studies are conducted.

267 **Conclusions**

268 The identification of the unknown pathogen has significantly improved in China
269 between the outbreaks of H7N9 avian influenza and COVID-19. However, the time
270 taken for epidemic reports from certain hospitals to reach the local CDC as well as the
271 decision-making process by the local government in Hubei Province was reduced,
272 which might be one of the vital factors for widespread COVID-19 cases. These issues
273 need to be addressed urgently to prepare for public emergencies to prevent and control
274 future epidemics of emerging infectious diseases in China and the world.

275 **Conflict of interests**

276 The authors declare no competing financial interest.

277 **Acknowledgment**

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