

1 **Modes of contact and risk of transmission in COVID-19 among close** 2 **contacts**

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37 **Abstract**

38 **Background**

39 Rapid spread of SARS-CoV-2 in Wuhan prompted heightened
40 surveillance in Guangzhou and elsewhere in China. Modes of contact and
41 risk of transmission among close contacts have not been well estimated.

42 **Methods**

43 We included 4950 close contacts from Guangzhou, and extracted data
44 including modes of contact, laboratory testing, clinical characteristics of
45 confirmed cases and source cases. We used logistic regression analysis to
46 explore the risk factors associated with infection of close contacts.

47 **Results**

48 Among 4950 close contacts, the median age was 38.0 years, and males
49 accounted for 50.2% (2484). During quarantine period, 129 cases (2.6%)
50 were diagnosed, with 8 asymptomatic (6.2%), 49 mild (38.0%), and 5
51 (3.9%) severe to critical cases. The sensitivity of throat swab was 71.32%
52 and 92.19% at first to second PCR test. Among different modes of contact,
53 household contacts were the most dangerous in catching with infection of
54 COVID-19, with an incidence of 10.2%. As the increase of age for close
55 contacts and severity of source cases, the incidence of COVID-19
56 presented an increasing trend from 1.8% (0-17 years) to 4.2% (60 or over
57 years), and from 0.33% for asymptomatic, 3.3% for mild, to 6.2% for

58 severe and critical source cases, respectively. Manifestation of
59 expectoration in source cases was also highly associated with an
60 increased risk of infection in their close contacts (13.6%). Secondary
61 cases were in general clinically milder and were less likely to have
62 common symptoms than those of source cases.

63 **Conclusions**

64 In conclusion, the proportion of asymptomatic and mild infections
65 account for almost half of the confirmed cases among close contacts. The
66 household contacts were the main transmission mode, and clinically more
67 severe cases were more likely to pass the infection to their close contacts.
68 Generally, the secondary cases were clinically milder than those of source
69 cases.

70 **Introduction**

71 In December 2019, the outbreak of Coronavirus Disease 2019
 72 (COVID-19) caused by Severe Acute Respiratory Syndrome Coronavirus
 73 2 (SARS-CoV-2) emerged in Wuhan, Hubei Province, China, and has
 74 now developed into a global pandemic¹. As of 15 March, worldwide a
 75 total of 153,517 people have been infected including 5,735 deaths, with
 76 81,048 cases and 3,204 deaths in China².

77 The viral, epidemiological, and clinical characteristics of the disease have
 78 been documented³⁻¹¹. However, some questions important for control of
 79 the epidemic remain outstanding¹⁰. For example, what is the
 80 transmissibility of the virus? What patients are more likely to spread the
 81 virus? What mode of contacts is most likely to cause transmission? What
 82 is the incidence of complete asymptomatic infection?

83 These questions are addressed in this follow-up study of 4,950 persons
 84 with close contact with confirmed COVID-2019 patients in Guangzhou,
 85 China.

86 **Methods**

87 **Study Oversight**

88 This is a prospective cohort study of all 4,950 persons who had a close
 89 contact (or close contacts in short) with confirmed COVID-2019 patients

(or source cases in short) identified between January 13 and March 6, 2020, in Guangzhou, Guangdong Province, China. A total of 129 cases were diagnosed with 42 before quarantine and 87 during the quarantine.

Data Sources

Close contacts include such unprotected contacts as living in the same household, face-to-face working together, sharing the same classroom, visit or stay in the same hospital ward, taking the same car or aeroplane, sharing neighbouring seats in the same train or ship as a diagnosed COVID-19 patient. It also includes giving direct care to a diagnosed patient. The full definition and whole list of forms of close contacts were showed in Appendix 1. When a COVID-19 patient was diagnosed then his or her close contacts were traced, and his or her close contacts may be locals or non-locals, if he or she had a history of travel or business. Thus, the source cases of close contacts included both local and non-local patients.

Between January 13, and March 6, 2020, 347 cases¹² were diagnosed in Guangzhou and their 4,950 close contacts were identified and enrolled in the study. Standard questionnaires were used to collect data at the time of enrollment, which was also the start of quarantine¹³. The registration form (Appendix 2-Table a) was completed for each close contact. All close contacts were put under quarantine for 14 days from the last contact or

111 longer for some cases if collection of samples for PCR testing was
112 delayed. We recorded the last date of contact, the date of the start of
113 quarantine, the date symptoms appeared, the date of each sampling, and
114 the date of first positive PCR result. Temperature and symptoms
115 monitoring were conducted every day and recorded in a standard form
116 (Appendix 2-Table b).

117 Throat swab samples were collected and a real time RT-PCR testing
118 performed once every two days. In one patient, the PCR testing was
119 performed ten times as previous tests were consistently negative and has
120 not released from quarantine. A close contact was released from
121 quarantine if he had no symptoms and PCR testing was negative for two
122 consecutive samples. For those who were diagnosed with COVID-19,
123 treatments followed and quarantine continued till recovery.

124 Data on demographic factors, risk factors, exposure history, mode of
125 contact, symptoms, radiological and laboratory findings, severity of
126 disease, treatments, and prognoses were collected on all close contacts
127 (data form in Appendix 2). The information of source cases was also
128 obtained through monitoring data from Guangzhou CDC. Close contacts
129 confirmed COVID-19 (or secondary cases in short) and their source cases
130 are individually linked (details in Appendix 2) and their relations and
131 contact modes were determined accordingly. For the 161 source cases

132 who did not live in Guangzhou, so we could not know their severity of
133 COVID-19, and could not linked their information with secondary cases.

134 **Definitions**

135 A source case is a person diagnosed with COVID-2019 a close contact
136 person has made close contact with. Close contacts may have made
137 contact with one or more patients.

138 The diagnosis of SARS-CoV-2 infection was made, according to the 6th
139 National Criteria for Diagnosis of COVID-2019 in China¹⁴. As the study
140 participants were all close contacts, a COVID-2019 case was referred to a
141 person who had both a positive result for the virus' nucleic acid and
142 symptoms and/or abnormal radiological/laboratory findings before,
143 during or even after the 14 days of quarantine. Asymptomatic infection
144 must have not clinical symptoms, must be positive for the virus' nucleic
145 acid, and have or be free of radiological and/or laboratory alterations that
146 indicate viral infection.

147 Fever was defined as an axillary temperature of 37.5°C or above. Severity
148 of the disease includes 5 categories: asymptomatic, mild, moderate,
149 severe and critical. Mild cases were those who had mild symptoms but no
150 radiological alterations. Moderate cases are those who had both
151 symptoms and radiological alterations. Severe cases were those who had

any of the following: breathing rate $\geq 30/\text{min}$, or oxygen saturation level $\leq 93\%$ at rest, or oxygen concentration level $\text{PaO}_2/\text{FiO}_2 \leq 300\text{mmHg}$ ($1\text{mmHg}=0.133\text{kPa}$), or lung infiltrates $>50\%$ within 24 to 48 hours. Critical cases are those who had respiratory failure requiring mechanical ventilation, septic shock, or multiple organ dysfunction/failure.

The mode of contact was classified into 5 categories: public transport vehicles, healthcare settings, households, multiple, and others. Tourists in the ship cruise were put in a special exposure group called “Dream Cruise”. The multiple contact includes those who were exposed to more than one mode of contact (e.g. household and public transport vehicles).

Diagnosis of RT-PCR test, radiological and blood examination

Throat swab samples were collected by trained CDC staff and transported and stored in -70°C refrigerators in biological safety level 2 laboratories. Samples of cluster cases were also sent to China CDC for re-examination. RT-PCR testing was performed by qualified staff and results were identified through open reading frame 1ab (ORF1ab) and nucleocapsid protein (N) in accordance with the protocol established by China CDC¹³. Details on laboratory processes are provided in Appendix 3. Radiological and blood examinations were conducted in tertiary hospitals designated for treating COVID-19 patients according to national standards¹⁴.

172 **Statistical analysis**

173 The infection rate was estimated by dividing the number of diagnosed
 174 cases with the number of close contact persons and compared among
 175 different contact groups. Categorical variables were described in number
 176 and percentage (%), and continuous variables in median and interquartile
 177 range (IQR). Differences in proportions were tested by using the χ^2 test.
 178 Univariate and multivariable logistic regressions were performed to
 179 adjust for potential factors that may affect the risk of developing
 180 COVID-19, and odds ratio (OR) and 95% confidence interval (95% CI)
 181 were estimated.

182 Analyses were all performed with the SAS software (version 9.4 for
 183 Windows, SAS Institute, Inc., Cary, NC, USA). Statistical tests were
 184 two-sided, and *P* values of less than 0.05 were considered to indicate
 185 statistical significance.

186 **Ethics Approval**

187 Ethics approval was obtained from the Ethics Committee of Southern
 188 Medical University. Data collection and analysis of close contacts and
 189 source cases were also required by the National Health Commission of
 190 the People's Republic of China to be part of a continuing public health
 191 outbreak investigation. Written informed consent was waived in light of

192 the urgent need to collect data.

193 **Results**

194 **Baseline characteristics of close contacts**

195 By the end of the Mar 6, 2020, all the 4950 close contacts were enrolled.
 196 Males accounted for 2484 (50.2%). The median (IQR) age was 38.0 years
 197 and 783 (15.8%) were under 18 years (Table 1). Exposure in public
 198 transports was the commonest type of close contact. On average, 2.4 PCR
 199 tests were performed for each person. 129 (2.6%) cases were identified
 200 with 8 (6.2%) being asymptomatic throughout and 5 (3.9%) being
 201 clinically severe or critical.

202 The 4950 close contacts were quarantined for an average of 4.0 days,
 203 with 2.0 days for cases and 4.0 days for non-cases (Table 1 and Figure 1).
 204 In 20 persons, quarantine was unnecessary as they last contacted a patient
 205 14 days ago and were free of symptoms and PCR test negative at the time
 206 they were identified. In 340 persons, quarantine was longer than 14.0
 207 days because the PCR tests were delayed (Figure 1). There was on
 208 average 1.0 day from the start of quarantine to the first PCR testing,
 209 suggesting a slight delay in collecting samples for laboratory diagnosis
 210 (Table 1). PCR diagnosis was made within 14 days of quarantine for all
 211 129 cases but two for whom it was on the 16th day; all the 8
 212 asymptomatic cases were diagnosed within 10 days of quarantine (Figure

213 1).

214 There were on average 11.0 days from the last contact to the start of
 215 quarantine (Table 1), suggesting quarantine could in theory start 11.0 days
 216 earlier than it actually did. The delay from the last contact to quarantine
 217 was on average 1.0 day with over 3 days for 11 cases (Table 1 and Figure
 218 2). In symptomatic cases, there was on average 1.0 day from the last
 219 contact to symptoms onset, with 31 cases having already developed
 220 symptoms before the last contact and 22 cases over 3 days after the last
 221 contact (Table 1 and Figure 2). In 33 cases for whom the date of
 222 symptoms onset was clear and the first PCR test was negative, we
 223 estimated that there were on average a delay of 2.0 days from symptoms
 224 to first PCR positivity and in 22 (66.7%) cases symptoms appeared 7.0
 225 days prior to PCR positivity (Figure 2).

226 **Mode of contact and risk of transmission**

227 The age of close contacts was linearly associated with an increasing risk
 228 of getting infected after close contact with source patients (Table 2). The
 229 incidence was 1.8%, 2.2%, 2.9%, and 4.2% respectively for 0-17, 18-44,
 230 45-59, and 60 or above age-groups ($P=0.0016$ for trend). Females seemed
 231 as likely as males to catch the infection after close contacts with patients
 232 ($P=0.1202$).

233 Among different modes of contact, household contacts and multiple
234 contacts (with 70% including household contacts) were most dangerous
235 in catching the infection and associated with an incidence of COVID-19
236 10.2% and 13.0%, respectively (Table 2). Healthcare settings contacts
237 and public transport vehicles, the other two common forms of contacts,
238 were associated with a risk of 1.0% and 0.1%, which were only about 10%
239 and 1%, respectively, of the risk of household contacts ($P<0.0001$).

240 Furthermore, clinically more severe patients were more likely to pass the
241 infection to their close contacts than less severe ones ($P<0.0001$ for
242 trend). Asymptomatic infection is least likely to pass on the infection,
243 with a chance of 33 per 100,000 contacts. Mild and moderate infections
244 could increase the risk to 3.3% to 5.6%, and severe and critical infections
245 to 6.2%. Manifestation of some symptoms in source patients was also
246 associated with an increased risk of infection in their close contacts. For
247 example, fever could increase the risk by over 100% ($P=0.0103$) and
248 expectoration by 400% ($P<0.0001$), whereas cough, fatigue and myalgia
249 did not statistically significantly increase the risk ($P>0.3700$). In addition,
250 a higher frequency of contact and greater number of patients contacted
251 were highly associated with household contacts and thus were not
252 separately assessed (Table 1S).

253 The above conclusions remained unchanged and statistically significant

254 in multiple regression analyses which included age, sex, mode of contact,
255 severity of source patients and expectoration included in the models
256 (Table 2).

257 **Comparison of source cases and secondary cases**

258 We compared the characteristics between secondary cases and source
259 cases they contacted with to see whether they may differ in the severity of
260 the infection. Among 129 secondary cases, source cases were identifiable
261 only for 121 cases. As compared with their 69 source cases, the 121
262 secondary cases were in general clinically milder and were less likely to
263 have such common symptoms as fever, cough, expectoration, fatigue,
264 myalgia and diarrhea ($P<0.05$). Secondary cases are also less likely than
265 source cases to demonstrate radiological and laboratory alterations related
266 to the infection ($P<0.001$). Most of the differences between them were
267 both clinically important and statistically significant.

268 The clinical differences between source and secondary patients might be
269 due to the fact that secondary cases were diagnosed earlier and the
270 disease is milder at the early stage than source cases. To exclude this
271 possibility, we also compared source cases with secondary cases who
272 were diagnosed before the time of quarantine and not supposed not be
273 early-stage patients. The conclusion remained unchanged (Table 2S).

274 **Validity of PCR for Diagnosis**

275 Among 4950 close contacts, 4653 completed at least one RT-PCR testing.
 276 If a person has no symptoms and the PCR test was negative, further
 277 testing continued to be arranged within 48 hours till he was diagnosed
 278 with the infection or released free of the infection from quarantine. The
 279 series of testing in the same persons allowed us to estimate the sensitivity
 280 and specificity of the PCT testing. The results were shown in (Table 3S).
 281 In brief, the sensitivity was only 71.9% for the first testing and increased
 282 to 92.2% by the second testing, to 96.9% by the third testing, and to 100.0%
 283 by the sixth testing. In contrast, the first testing achieved a specificity
 284 99.96%, which was reduced by less than 0.1% by further testing.

285 **Discussion**

286 Between January 13, and March 6, 2020, 4950 close contacts of
 287 confirmed cases were enrolled in Guangzhou, which is a city with large
 288 confirmed cases of COVID-19 outside Hubei province in China. Here we
 289 evaluated the modes of contact and risk of transmission among close
 290 contacts, provides insights into transmission and control of COVID-19.
 291 To our knowledge, this study is the largest prospective cohort data of
 292 close contacts with COVID-19.

293 Our study provided further evidence that the older aged contacts and

household contacts were more likely to be infected^{3,4,7,15}. The incidence of asymptomatic and mild infections was high (57/129), and the risk of transmission increased as the symptoms of source cases worsen, with range from 0.33% (asymptomatic) to 6.2% (severe and critical). The symptomatic cases with expectoration symptom had a higher transmission capacity. The results provide the evidentiary foundation for evaluating control measures, and guiding the global response.

Household contacts characteristics have been discussed in previous studies^{3,7}, which were the source of person-to-person transmission evidence. And our study further confirmed that due to contact frequently of household, it was considered as a high-risk factor for COVID-19 transmission. The incidence of household contacts estimated 10.2% in our study, and in other study out of Hubei Province was 14.9 %¹⁶, which is consistent with current understanding of COVID-19 transmission. However, other modes of contact have been less reported for guiding persons self-protection and government for strengthened control measures. In our study, 1540 close contacts were Dream Cruise passengers, and the infected incidence was 0.1% (2/1540), which was estimated low. This result was consistent with previous research, and Nishiura H¹⁷ estimated the incidence of infection with COVID-19 on a cruise ship, called Diamond Princess, and the risk of infection among passengers contact occasionally was considered to be very limited.

316 However, the food service workers had a high infected incidence in the
317 cruise ship¹⁸ largely due to their frequent contact to others and had high
318 chance to inhale droplet spread.

319 The risk transmission of other public transport vehicles and healthcare
320 settings was estimated low, which were only about 1% and 10% of the
321 risk of household contacts ($P < 0.0001$). It suggests that control personnel
322 density on public places and distance oneself from others are very
323 effective prevention and control measures¹⁹. Giving that public transport
324 vehicles was at low risk to infected COVID-19, and it is considered
325 feasible to take public transportation when returning to work or school on
326 the premise of low personnel density.

327 The proportion of close contacts confirmed with asymptomatic and mild
328 were high with 44.2 % (57/129). Chowell²⁰ estimated asymptomatic
329 proportion was at 17.9% among 700 infected individuals on Diamond
330 Princess, and Miyama T²¹ estimated at 30.8% among 13 Japanese
331 evacuees from Wuhan City. Taking the results from several studies into
332 account, Chowell²⁰ thinks that asymptomatic or mild cases combined
333 represent about 40% to 50% of all infections. It was consistent with the
334 results of this study.

335 Given the large proportion of asymptomatic and mild infections, we are
336 concerned about the rate at which they infect others. Wendtner²² showed

337 that patients with COVID-19 had high levels of the virus in throat swabs
 338 early in their illness, when their symptoms were mild. But no study had
 339 reported the infection risk of asymptomatic and mild cases to others, and
 340 asymptomatic infections might be seeding new outbreaks²³. In our study
 341 showed that as severity increases, the risk of transmission increases in
 342 COVID-19 patients. Only 1 (1/305, 0.33%) and 19 (19/576, 3.3%) close
 343 contact was infected by asymptomatic and mild source case, and it
 344 suggested the limited transmission capacity in asymptomatic and mild
 345 cases. The symptomatic cases with expectoration symptom had a higher
 346 transmission capacity. These might be associated with more viral load of
 347 SARS-CoV-2 in patients with severe symptoms²⁴.

348 Given the current evidence, due to asymptomatic cases have limited
 349 transmission capacity, then the primary surveillance and control measures
 350 should focus on symptomatic contacts. On the other hand, though a
 351 person with asymptomatic or mild symptoms may not easy to spread
 352 SARS-COV-2, and had a low probability to infect other. While, we
 353 should also be alert for incubation transmission²⁵. Asymptomatic and
 354 mild patients might not aware of their infection and therefore not isolate
 355 themselves or seek treatment, or they might be overlooked by health-care
 356 professionals and thus unknowingly transmit the virus to others. Due to
 357 the imperfect sensitivity of the PCR test (Table 3S), some asymptomatic
 358 contacts may be missed^{26,27}. Thus, based our evidence, two times or more

359 PCR tests were recommended to ensure that almost all patients could to
360 be diagnosed.

361 Previous studies suggested that compared with patients initially infected
362 with SARS-Cov-2 in Wuhan City, the symptoms of patients in out of
363 Wuhan are relatively mild^{28,29}. And a research reported that the symptoms
364 of imported cases (n=15) were severe than those of secondary cases
365 (n=17)³⁰, but due to the small sample size, it may be necessary to verify
366 the phenomenon. Thus, our study compared the severity of symptom
367 between sources cases and their secondary cases. And the severity of
368 clinical symptoms onset was more severe to source cases compared to
369 secondary cases ($P<0.001$). It may be related to the higher Hubei
370 exposure history of source cases (20/33 vs. 21/37) than secondary cases.
371 This phenomenon was also apparent during the transmission of
372 MERS-CoV³¹.

373 Our study has some notable limitations. Firstly, we have not the data to
374 show the prognosis of disease. Because many patients remained in the
375 hospital and the outcomes were unknown at the time of data cutoff, we
376 censored the data regarding their clinical outcomes and thus entire course
377 of the disease cannot be fully demonstrated. Secondly, we used logistic
378 regression analysis instead of cox proportional hazards model, because of
379 the low incidence (2.6%) of COVID-19 among close contacts. In addition,

380 by the end of the cohort, there were 245 close contacts remaining
 381 quarantines, but they were not likely to become COVID-19 cases, thus
 382 there was no censored data. Thirdly, there may be a recall bias of the
 383 symptoms at onset among source cases and secondary cases.

384 In conclusion, our cohort study showed that the proportion of
 385 asymptomatic and mild infections account for almost half of the
 386 confirmed cases among close contacts. The household contacts were the
 387 main transmission mode, and clinically more severe cases were more
 388 likely to pass the infection to their close contacts. In general, the
 389 secondary cases were clinically milder than those of source cases. The
 390 results provide the evidentiary foundation for evaluating control measures,
 391 and guiding the global response.

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398 **Legend of Tables:**

399 Table 1. Baseline characteristics of 4 950 Persons with Close Contact

400 with Confirmed COVID-2019 Cases, Guangzhou, China;

401 Table 2. Modes of contact and risk of transmission among 4 950 Close

402 Contact Persons;

403 Table 3. Comparison of clinical, radiological and laboratory

404 characteristics of COVID-2019 infection between 69 source cases and

405 121 secondary cases.

406 **Supplementary Material:**

407 Table 1S. Modes of contact and risk of transmission among 4 950 Close

408 Contact Persons;

409 Table 2S. Comparison of clinical, radiological and laboratory

410 characteristics of COVID-2019 infection between 36 source cases and 49

411 secondary cases;

412 Table 3S. Sensitivity, specificity, and positive and negative predictive

413 values of sequential nucleic acid tests of throat swabs (n=4653);

414 Figure 1S. Distribution of 1540 Dream Cruises close contact persons by

415 the number of days from start of quarantine to PCR diagnosis or release

416 from quarantine and infection status (day 0 is the day when quarantine

417 starts);

418 Appendix 1: The full detail of close contacts;

419 Appendix 2: COVID-19 Confirmed Case Investigation Form;

420 Appendix 3: Details regarding laboratory confirmation processes.

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498 **Table 1. Baseline characteristics of 4 950 Persons with Close Contact with Confirmed**
 499 **COVID-2019 Cases, Guangzhou, China**

Characteristics	Number	%
Age (median (IQR))	4942	38.0 (25.0, 52.0)
0-17	783/4942	15.8
18-44	2338/4942	47.3
45-59	997/4942	20.2
60 or over	824/4942	16.7
Males	2484/4950	50.2
Modes of contact		
The Dream Cruise passengers	1540/4950	31.1
Other public transport vehicles	818/4950	16.5
Healthcare settings	679/4950	13.7
Households	946/4950	19.1
Multiple locations	92/4950	1.9
Others	875/4950	17.7

Real time RT-PCR testing test

Persons with at least one test	4654/4950	94.0
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Mean no. of test (mean (SD))	2.4	2.0
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Confirmed COVID-2019 cases	129/4950	2.6
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Symptoms of confirmed COVID-2019 cases

Symptomatic	121/129	93.8
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Asymptomatic throughout	8/129	6.2
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Severity of confirmed COVID-2019 cases

Asymptomatic	8/129	6.2
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Mild	49/129	38.0
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Moderate	67/129	51.9
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Severe or critical	5/129	3.9
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Days from last contact to start of quarantine (median (IQR))	4950	11.0 (1.0, 12.0)
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Duration of quarantine (median (IQR)), days	4950	4.0 (3.0, 13.0)
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Confirmed COVID-19	129	2.0 (1.0, 5.0)
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Non-confirmed COVID-19	4533	4.0 (3.0, 13.0)
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Days from last contact to symptoms onset (median (IQR))	121	1.0 (-1.0, 3.0)
Days from last contact to first test (median (IQR))	4654	11.0 (4.0, 13.0)
Confirmed COVID-19	129	2.0 (1.0, 3.0)
Non-confirmed COVID-19	4533	11.0 (5.0, 13.0)
Days from quarantine to first test (median (IQR))	4654	1.0 (0.0, 1.0)
Days from symptoms onset to PCR diagnosis (median (IQR))^a	33	2.0 (0.0, 9.0)

500 a: excluding 88 cases with the first PCR diagnosis positive.

Table 2. Modes of contact and risk of transmission among 4 950 Close Contact Persons

Modes of contact	Number	COVID-2019 Events	Incidence (%)	Unadjusted		Adjusted ^a	
				OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
Age (years) ^b							
0-17	783/4942	14	1.8	0.82 (0.45, 1.48)	0.5054	0.66 (0.35, 1.24)	0.9184
18-44	2338/4942	51	2.2	1.00	-	1.00	-
45-59	997/4942	29	2.9	1.34 (0.85, 2.13)	0.2104	1.03 (0.63, 1.68)	0.1966
60 or over	824/4942	35	4.2	1.99 (1.28, 3.08)	0.0021	2.17 (1.35, 3.50)	0.0014
Sex							

Males	2484/4950	56	2.3	1.00	-	1.00	-
Females	2466/4950	73	3.0	1.32 (0.93, 1.88)	0.1202	1.22 (0.84, 1.77)	0.3027
Modes of Contact							
The Dream Cruises	1540/4950	2	0.1	0.01 (0.00, 0.05)	<0.0001	0.03 (0.01, 0.14)	<0.0001
Other public transport vehicles	818/4950	1	0.1	0.01 (0.00, 0.08)	<0.0001	0.01 (0.00, 0.10)	<0.0001
Healthcare settings	679/4950	7	1.0	0.09 (0.04, 0.20)	<0.0001	0.11 (0.05, 0.25)	<0.0001
Households	946/4950	96	10.2	1.00	-	1.00	-
Multiple modes	92/4950	12	13.0	1.33 (0.70, 2.53)	0.3866	1.45 (0.74, 2.83)	0.3600

Others	875/4950	11	1.3	0.11 (0.06, 0.21)	<0.0001	0.13 (0.07, 0.25)	<0.0001
Severity of source cases ^c							
Asymptomatic	305/2610	1	0.33	0.06 (0.01, 0.40)	0.0042	0.29 (0.04, 2.22)	0.2340
Mild	576/2610	19	3.3	0.58 (0.35, 0.96)	0.0341	0.48 (0.28, 0.82)	0.0068
Moderate	1469/2610	82	5.6	1.00	-	1.00	-
Severe or critical	260/2610	16	6.2	1.11 (0.64, 1.93)	0.7133	1.19 (0.66, 2.15)	0.5611
Symptoms of source cases							
Fever							
No	430/1813	14	3.3	1.00	-	1.00	-

Dry cough	Yes	1383/1813	92	6.7	2.12 (1.19, 3.76)	0.0103	1.77 (0.96, 3.26)	0.0691
	No	726/1813	39	5.4	1.00	-	1.00	-
Expectoration	Yes	1087/1813	67	6.2	1.16 (0.77, 1.74)	0.4817	1.03 (0.66, 1.59)	0.9136
	No	1329/1813	40	3.0	1.00	-	1.00	-
Fatigue	Yes	484/1813	66	13.6	5.09 (3.38, 7.65)	<0.0001	5.22 (3.39, 8.05)	<0.0001
	No	1366/1813	76	5.6	1.00	-	1.00	-

Myalgia	Yes	447/1813	30	6.7	1.22 (0.79, 1.89)	0.3700	1.10 (0.68, 1.79)	0.6881
	No	1517/1813	88	5.8	1.00	-	1.00	-
	Yes	296/1813	18	6.1	1.05 (0.62, 1.77)	0.8510	1.00 (0.56, 1.78)	0.9945

502 a: Age, sex, mode of contact, severity of source cases, symptoms of source cases were included in multivariable logistic regression analysis.

503 P for trend: b was 0.0016 and 0.0007, c was <0.0001 and 0.0006 for unadjusted and adjusted.

504 **Table 3. Comparison of clinical, radiological and laboratory characteristics of COVID-2019**
 505 **infection between 69 source cases and 121 secondary cases**

Characteristics	Events/total (%)		<i>P</i>
	Source cases	Secondary cases	
Hubei Exposure history, yes	48/59 (81.4)	46/87 (52.9)	0.0016
Severity			0.0125
Asymptomatic	1/65 (1.5)	8/121 (6.6)	
Mild	12/65 (18.5)	46/121 (38.0)	
Moderate	45/65 (69.2)	63/121 (52.1)	
Severe	3/65 (4.6)	1/121 (0.8)	
Critical	4/65 (6.2)	3/121 (2.5)	
Highest temperature (°C)			<0.0001
<37.5	4/52 (7.7)	8/45 (17.8)	
37.5-38	27/52 (51.9)	23/45 (51.1)	
38.1-39	15/52 (28.9)	14/45 (31.1)	
>39	6/52 (11.5)	0/45 (0.0)	

Symptoms at onset, yes

Fever	51/61 (83.6)	43/103 (41.7)	<0.0001
Dry cough	38/61 (62.3)	34/103 (33.0)	0.0007
Expectoration	36/61 (59.0)	16/103 (15.5)	<0.0001
Fatigue	16/61 (26.2)	13/103 (12.6)	0.0233
Myalgia	11/61 (18.0)	5/103 (4.9)	0.0067
Diarrhea	9/61 (14.8)	1/103 (1.0)	0.0006
Other lung diseases	15/40 (37.5)	5/35 (14.3)	<0.0001
CT double lung abnormalities	45/61 (73.8)	27/103 (26.2)	<0.0001

Blood biochemical index

(median (IQR))

WBC ($10^9/L$) ^a	5.5 (4.3, 7.0)	5.3 (4.4, 6.4)	0.0148
Ne % ^a	70.1 (58.8, 77.8)	56.8 (49.8, 65.4)	0.0044
Ly % ^b	21.7 (13.8, 29.6)	32.2 (23.4, 40.9)	0.0004

506 WBC: White blood cell count; Ne%: lymphocyte percentage; Ly%: neutrophilic granulocyte
507 percentage;

508 Number of participants with missing values: a=76, b=77.

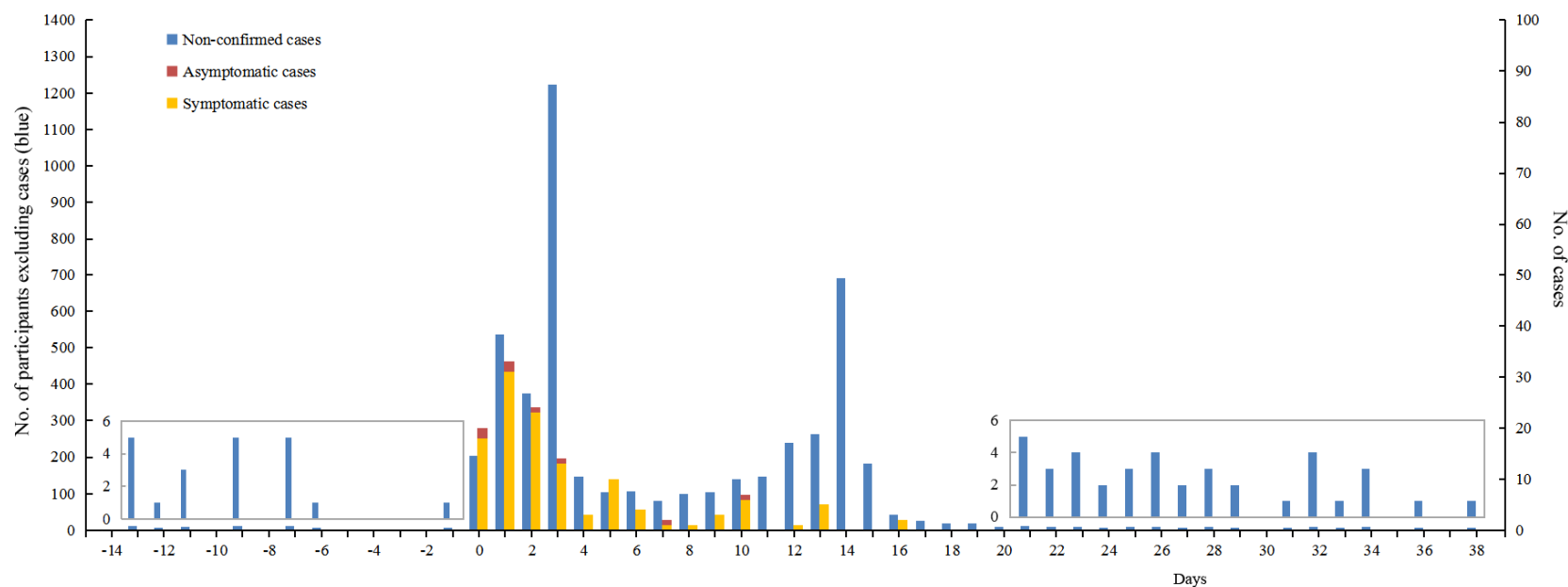


Fig 1. Distribution of 4950 close contact persons by the number of days from start of quarantine to PCR diagnosis or release from quarantine and infection status (day 0 is the day quarantine starts)

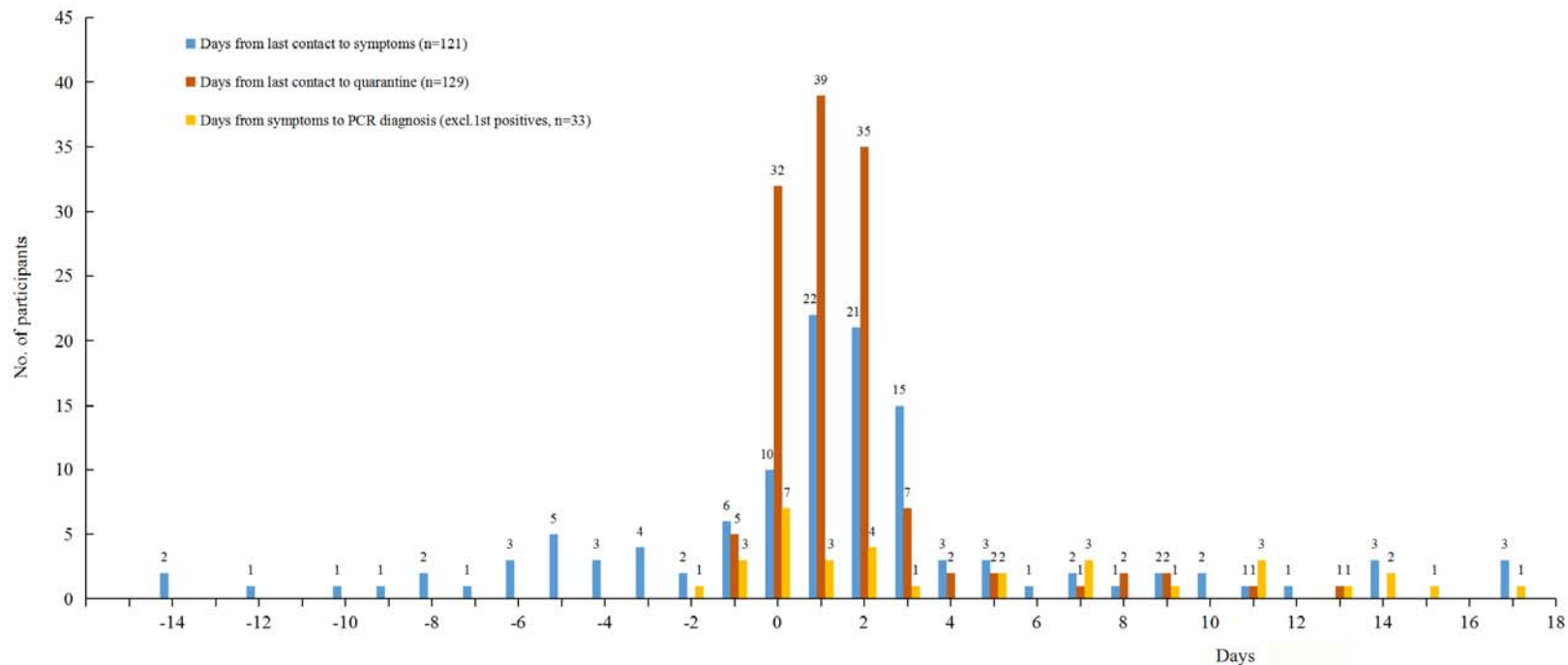


Fig 2. Distribution of days from last contact to symptoms onset and to start of quarantine and days from symptoms onset to PCR diagnosis