

1 **Title Page**

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3 **Little Risk of the COVID-19 Resurgence on Students in China (outside Hubei)**
4 **Caused by School Reopening**

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28 **Little Risk of the COVID-19 Resurgence on Students in China (outside Hubei)**
29 **Caused by School Reopening**

30
31 **Abstract**

32 **Objective:** School reopening has not yet started in China where the COVID-19 outbreak has
33 reached ending stage, largely due to a great concern about COVID-19 infections on students. We
34 attempted to quantitatively evaluate the risk of COVID-19 infections on students caused by school
35 reopening.

36
37 **Study design:** We collected the data of the numbers of teachers, population size and newly
38 confirmed COVID-19 cases in the past 14 days in typical provinces/cities of China, and then
39 analyzed the risk of COVID-19 infections in schools with respect to each province/city.

40
41 **Methods:** A step-by-step procedure was explored to calculate the probability of COVID-19
42 infections on students as transmitted from infected teachers. Two critical assumptions for analysis
43 were proposed: (i) only locally generated cases were counted while imported cases were omitted;
44 (ii) the secondary attack rate of the COVID-19 virus in schools is similar to that in households in
45 China, ranging from 3-10%.

46
47 **Results:** The probability of COVID-19 resurgence within one week on students of primary,
48 middle and high schools in China (outside Hubei) is extremely low ($<0.2\%$) in each
49 province/city, and such probability can be updated daily and weekly based on the newly
50 confirmed cases in the past 14 days. In some areas without newly confirmed cases in the past 14
51 days, the risk is zero.

52
53 **Conclusions:** Our work provides guidance for local governments to make risk level-based
54 policies for school reopening. Currently, the risk of COVID-19 infections on students is extremely
55 low in China (outside Hubei) and therefore school reopening can be initiated without the endanger
56 of infections on students.

57
58 The novel coronavirus diseases (COVID-19) outbreak is going on in China and has resulted in
59 80000 confirmed cases and over 3100 deaths as of 10 March 2020 ¹. Since March 11, China only
60 reported 20 or less new cases, most of which are concentrated in Hubei Province and its capital
61 Wuhan City, the epicenter of the outbreak. As such, China (outside Hubei) has entered a new stage
62 of epidemic prevention and control coupled with a stepwise restoration of social and economic
63 operations ². In particular, it is highly demanding to reopen schools because the delay of schooling
64 time for approximately two months has substantially impacted on more than 100 millions of
65 families in China. Nevertheless, none of schools has reopened so far across the country, largely
66 due to a great concern about the risk of COVID-19 infection on children ³. Here we show by
67 statistical probability analysis that the risk of COVID-19 resurgence caused by school reopening
68 is negligible.

69
70 Our analysis is based on several assumptions as follows. First, a period of the past 14 days was
71 set as a reference for risk assessment, given that the incubation period of COVID-19 ranges from
72 1-14 days with a mean of 5-6 days ². Second, the probability of infection in the coming week is
73 proportional to the number of newly confirmed COVID-19 cases in the past 14 days. Third, only
74 locally generated cases are counted while imported cases are omitted (Note: all travelers entering
75 China are required a quarantine for 14 days ⁴). Forth, only primary, middle and high schools were
76 analyzed while colleges and universities were excluded because their students are from across the
77 country (including Hubei Province and Wuhan City) but not solely locally living. Fifth, we

78 assume that all students are healthy, given that only 0.9% of over 50000 COVID-19 cases in
79 China are aged 0-9 years and 1.2% are 10-19 years⁵; as such, we simply focus on the potential
80 transmission from teachers to students (or between teachers), excluding that from students to
81 students or teachers. Last, we assume the secondary attack rate of the COVID-19 virus in schools
82 is similar to that in households, ranging from 3-10%².

83
84 Under the above assumptions, we collected the data of population size, number of teachers and
85 new COVID-19 cases in the past 14 days in typical provinces/cities (refer to **Table S1**) that have
86 been most affected by the outbreaks and/or are most economically important in China. We then
87 estimated the probability of COVID-19 transmission step by step, as detailed in **Table S2**.
88 Specifically, we first calculated the probability that at least one teacher has been infected and then
89 estimated the probability of the infected teacher(s) to students or teachers (for detail, refer to
90 **Table S2**).

91
92 Results show that the probability in all areas in the coming week (from 13-19 March) is extremely
93 low (except Beijing), ranging from 0.01%-0.13%. If the number of new confirmed cases in the
94 past 14 days is zero (e.g., Henan, Zhejiang, Jiangxi, Anhui, Guangzhou and Shenzhen), then the
95 risk is zero. If new cases as of 9 March were counted, then the probability of COVID-19
96 resurgence from 10-16 March would be a slightly higher, ranging from 0.01-0.37%. The
97 probability for Beijing is highest because of 10 new cases reported on 26 March (refer to **Table**
98 **S1**).

99
100 In summary, our analyses suggest that the probability of COVID-19 resurgence regarding school
101 reopening is low in all provinces/cities outside Hubei (all <0.5%). Such probability can be
102 updated daily or weekly based on the number of new cases in the past 14 days. Furthermore, the
103 overall endanger of COVID-19 infection in students would be extremely low from the clinical
104 point of view, given that in China only a very small proportion of the COVID-19 cases aged under
105 19 years have developed severe (2.5%) or critical disease (0.2%) and that among a total of 1023
106 deaths only one death was from this age group, as revealed by earlier reports of China CDC and
107 WHO^{2,3,5}. In addition, daily temperature monitoring on teachers and inspecting their body status
108 are necessary, and anyone who has symptoms of fever and cough should be immediately isolated
109 away from schools and subject to further clinical diagnosis.

110
111 Our work may provide guidance for provincial governments to make risk level-based,
112 differentiated control measures, by which societal activities, particularly school reopening, are
113 effectively restored and the potential risk of COVID-19 resurgence is strictly controlled. During
114 this process, governments always get ready to immediately react to any new COVID-19 cases or
115 clusters. Furthermore, if parents raise deep concerns about the risk of infections on student by
116 potentially infected teachers given the above control measures, one supplementary strategy that
117 can further reduce the risk is to screen all the teachers with COVID testing kits to identify
118 potentially infected ones. Meanwhile, all the teachers should be informed to avoid any
119 unnecessary clustering activities that might make them to be potentially infected.

120
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138 **Table 1 Probability of COVID-19 resurgence after school reopening^a**

Province /cities	Total cases	Population (10 ⁴)	No. of teachers (10 ⁴)	13-19 March 2020		10-16 March 2020	
				New cases ^b	Probability (%) ^c	New cases ^b	Probability (%) ^c
Guangdong	1353	11346	96.7	2	0.03-0.08	3	0.04-0.13
Henan	1272	9605	99.3	0	0	1	0.02-0.05
Zhejiang	1215	5737	40.8	0	0	0	0
Hunan	1018	6898	53.0	1	0.01-0.04	2	0.02-0.08
Jiangxi	935	4647	42.2	0	0	1	0.01-0.05
Anhui	990	6323	48.7	0	0	1	0.01-0.04
Shandong	759	10047	85.1	3	0.04-0.13	2	0.03-0.08
Jiangsu	631	8050	60.3	0	0	0	0
Fujian	296	3973	32.5	0	0	2	0.02-0.08
Beijing	429	2153	12.3	3	0.03-0.09	13	0.11-0.37
Shanghai	344	2423	11.6	1	0.01-0.02	3	0.02-0.07
Guangzhou	347	1490	10.1	1	0.01-0.03	1	0.03-0.01
Shenzhen	419	1302	NA ^b	0	0	0	0

139 ^a Steps for probability calculation are presented in **Table S2**.

140 ^b Daily new cases are shown in **Table S1**. NA: not available.

141 ^c The secondary attack rate was set as 3%-10% by referring to the estimates on family clusters².

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