## Supplementary Materials

### Section S1

From the previous study, the number of contacts between different age groups in the two cities of Wuhan and Shanghai before and during the outbreak was obtained [1]. Therefore, we calculated the contact ratio among the three population groups, as shown in Figure S1.

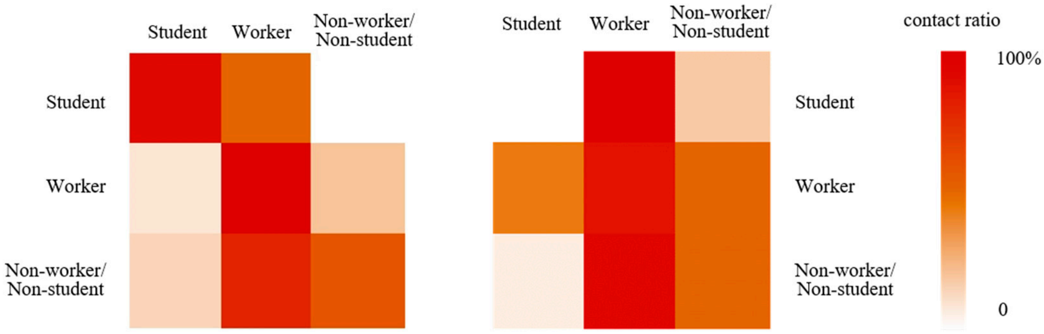


Figure S1: Proportion of contacts between three population groups before the outbreak (left) and during the outbreak (right).

The average monthly growth rates of six typical cities/territories were shown in Table S1.

**Table S1.** The monthly growth rate of confirmed cases at the initial period of the COVID-19 outbreak in different cities/territories (All data were obtained from [2]).

| City/ Territory | Monthly growth rate |
|---|---|
| Hong Kong | 8.4 |
| London | 154.5 |
| Los Angeles County | 97.9 |
| Madrid | 140.9 |
| Singapore | 8.3 |
| Tokyo | 28.4 |

The proportion of the population by age and group in Hong Kong was shown in Table S2 and Table S3. Considering the enrollment rate of 19-24 years old was 51.2% [3] and assuming the total population was 7.5 million, the numbers of students, workers, and non-workers/students were 1.1 million, 4.8 million, and 1.6 million, respectively.

**Table S2.** The proportion of the population by age in Hong Kong [3].

| Age range | Percentage of population |
|---|---|
| 0-3 | 2.5% |
| 4-18 | 11.8 |
| 19-24 | 5.4% |
| 25-64 | 61.0% |
| ⩾65 | 19.4% |

**Table S3.** Percentage of the three population groups (student, worker, non-worker/student) in Hong Kong.

| Population group | Age range | Percentage of population |
|---|---|---|
| Student | 4-18, and part[1] of 19-24 | 14.6% |
| Worker | 19-64 except part of 19-24 | 63.5% |
| Non-worker/student | 0-3, and ⩾65 | 21.9% |

[1] The enrollment rate of 19-24 years old was 51.2%.

According to reference[4], we counted the daily time spent indoors ( except sleep time) of three population groups (student, worker, non-worker/non-student) in public places before the outbreak of COVID-19 in Hong Kong (Table S4).

**Table S4.** Daily time spent (except sleep time) indoors of three population groups (student, worker, non-worker/non-student) in public places before the outbreak of COVID-19 in Hong Kong.

| Place | Value | | | Ref. |
|---|---|---|---|---|
| | Student | Worker | Non-worker/non-student | |
| School | 6.2 | - | - | [4] |
| Workplace | - | 7.4 | - | |
| Supermarket | 0.4 | 0.6 | 1.0 | |
| Public transport | 0.9 | 1.1 | 0.7 | |
| Shopping center | 0.9 | 0.9 | 1.0 | |
| Restaurant | 1.0 | 1.2 | 1.0 | |
| Home | 5.0 | 3.4 | 9.5 | |

The proportion of Hong Kong residents who went to the hospital before the epidemic and during the epidemic were 93.7% and 98.0%, respectively [3]. For insurance estimates, we assume in the article that 90% of people will go to see a doctor. "See doctor" was different from "go to hospital". When the proportion of residents going to hospital was different (25%, 50%, 75%, 100%), the quantitative effect of the final pandemic prevention was definitely different. However, it did not qualitatively affect the results of this study. Taking no intervention as an example, we simulated the proportion of going to hospital scenarios. The results were shown in Figure S2. The hospitalization rate changed from 22.5% to 90%, and the urban COVID-19 infection rate dropped from 77.3% to 74.9%, a drop of only 2.5%. Therefore, we took the median and assumed only a 45% hospitalization rate.

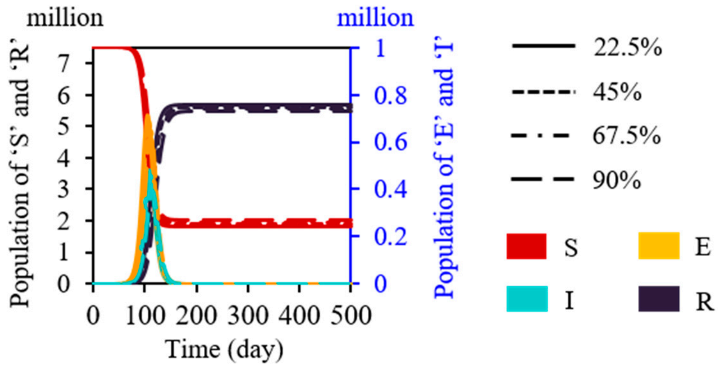


**Figure S2.** Effects of different hospitalization rates on the efficiency of COVID-19 prevention and control.

The impact of the proportions (0, 25%, 50%, 75%, 100%) of both work and class suspension and the proportions (0, 25%, 50%, 75%, 100%) of work and class suspension and stay-at-home orders for non-workers/students was shown in Figure S3.

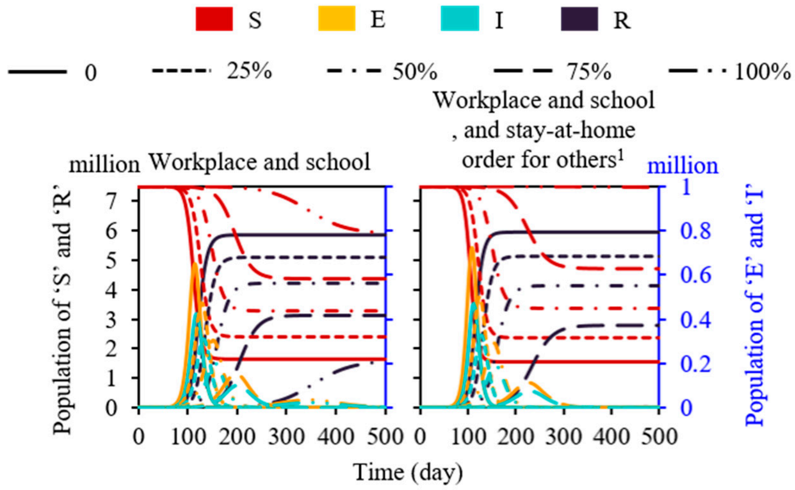


**Figure S3.** Effectiveness the proportion of both work and class suspension and the proportion of work and class suspension and stay-at-home orders for non-workers/students implementations. [1] Non-workers/students.

All residents would do NAT (sensitivity of NAT was 84.8%.) with a constant time interval (Figure S4).

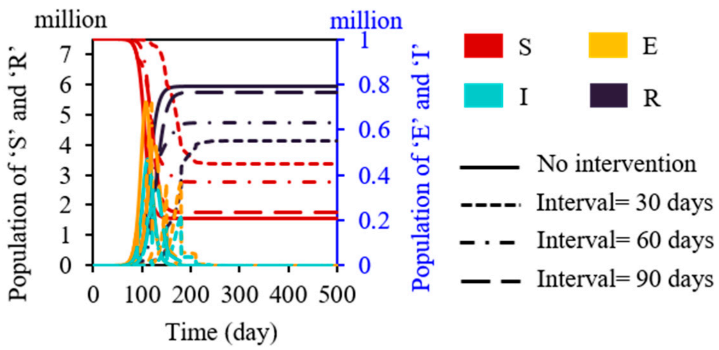


**Figure S4.** Effectiveness of the time to implement of performing NAT.

The time to implement body temperature screening in public places had no significant impact on the infection spread (Figure S5).

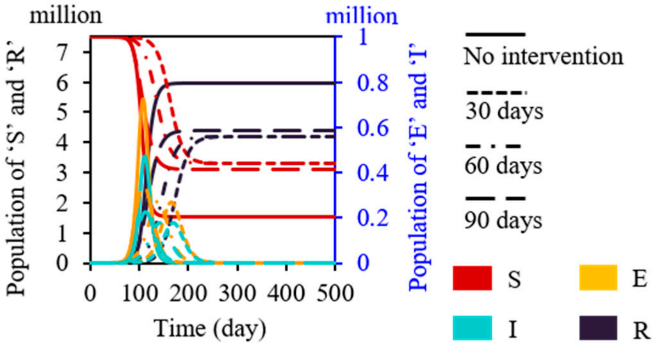


**Figure S5.** Efficiency of the time to implement of body temperature screening[1] in public places[2]. [1] Correctness was 86.0%; [2] Public places including schools, workplaces, supermarkets, public transports, shopping centers, and restaurants.

## References


1. Zhang J, Litvinova M, Liang Y, et al. Changes in contact patterns shape the dynamics of the COVID-19 outbreak in China. *Science* **2020**, *368*(*6498*): 1481-1486.
2. Coronavirus (COVID-19) Dashboard: Situation By Region, Country Territory Area, World Health Organization. Available online: https://covid19.who.int/table/ (accessed on 29 January 2022).
3. Snapshot of Hong Kong. Available online: https://www.censtatd.gov.hk/en/scode460.html (accessed on 29 January 2022)
4. Zhang, N.; Jia, W.; Lei, H.; et al. Effects of human behaviour changes during the COVID-19 pandemic on influenza spread in Hong Kong. *Clin. Infect. Dis.* **2021**, *73*, 1142-1150.


## Section S2. Code of Python

```
alpha = 0.45; Epsilon1 = 1/5; Epsilon2 = 1/3; mu = 2/5; mu1 = 1/2; mu2 = 1/8; gamma = 1/2; A = 1/4; N = 7500000; n = 0

# Students
IA_t = 0; IS_t = 0; ir = 0.03255834; tp = 0.399176570078612; m = 20.83; Ra_t = 0; Rb_t = 0; Rc_t = 0; PS_t = 0; EA_t = 0; ES_t = 0; H_t = 0; n_t = 1/7500000; S_t = 7499999 * 14.5568961553545/100; S_p_s = 0.72; W_p_s = 0.42; N_p_s = 0.04; N_s=7499999 * 14.5568961553545/100;

# Workers
IA_t_w = 0.25; IS_t_w = 0.75; S_t_w = 7499999 * 63.5409306665585/100; ir_w = 0.09059712; tp_w = 0.404246321693265; m_w = 17.41; Ra_t_w = 0; Rb_t_w = 0; Rc_t_w = 0; PS_t_w = 0; EA_t_w = 0; ES_t_w = 0; H_t_w = 0; n_t_w = 1/7500000; S_p_w = 0.07; W_p_w = 0.81; N_p_w = 0.12; N_w=7499999 * 63.5409306665585/100;

# Non-workers/Non-students
IA_t_N = 0; IS_t_N = 0; S_t_N = 7499999 * 21.902173178087/100; ir_N = 0.141558; tp_N = 0.458442057210047; m_N = 8.22; Ra_t_N = 0; Rb_t_N = 0; Rc_t_N = 0; PS_t_N = 0; EA_t_N = 0; ES_t_N = 0; H_t_N = 0; n_t_N = 1/7500000; S_p_N = 0.09; W_p_N = 0.58; N_p_N = 0.32; N_N =7499999 * 21.902173178087/100;

for i in range(1,501):
```

```
print(i)
while n < i :
    # Students
    Ra_t = Ra_t + mu * IA_t
    Rb_t = Rb_t + (1 - alpha) * mu * IS_t
    Rc_t = Rc_t + mu2 * H_t
    IA_t = (1 - mu) * IA_t + Epsilon1 * EA_t
    H_t = (1 - mu2) * H_t + alpha * mu1 * IS_t
    IS_t = (1 - mu + alpha * mu - alpha * mu1) * IS_t + gamma * PS_t
    PS_t = (1 - gamma) * PS_t + Epsilon2 * ES_t
    EA_t = (1 - Epsilon1) * EA_t + A * S_t * (1 - (1 - ir) ** (n_t * tp))
    ES_t = (1 - Epsilon2) * ES_t + (1 - A) * S_t * (1 - (1 - ir) ** (n_t * tp))
    S_t = S_t * (1 - ir) ** (n_t * tp)

    # Workers
    Ra_t_w = Ra_t_w + mu * IA_t_w
    Rb_t_w = Rb_t_w + (1 - alpha) * mu * IS_t_w
    Rc_t_w = Rc_t_w + mu2 * H_t_w
    IA_t_w = (1 - mu) * IA_t_w + Epsilon1 * EA_t_w
    H_t_w = (1 - mu2) * H_t_w + alpha * mu1 * IS_t_w
    IS_t_w = (1 - mu + alpha * mu - alpha * mu1) * IS_t_w + gamma * PS_t_w
    PS_t_w = (1 - gamma) * PS_t_w+ Epsilon2 * ES_t_w
    EA_t_w = (1 - Epsilon1) * EA_t_w + A * S_t_w * (1 - (1 - ir_w) ** (n_t_w * tp_w))
    ES_t_w = (1 - Epsilon2) * ES_t_w+ (1 - A) * S_t_w * (1 - (1 - ir_w) ** (n_t_w * tp_w))
    S_t_w = S_t_w * (1 - ir_w) ** (n_t_w * tp_w)

    #Non-workers/Non-students
    Ra_t_N = Ra_t_N + mu * IA_t_N
    Rb_t_N = Rb_t_N + (1 - alpha) * mu * IS_t_N
    Rc_t_N = Rc_t_N + mu2 * H_t_N
    IA_t_N = (1 - mu) * IA_t_N + Epsilon1 * EA_t_N
    H_t_N = (1 - mu2) * H_t_N + alpha * mu1 * IS_t_N
    IS_t_N = (1 - mu + alpha * mu - alpha * mu1) * IS_t_N + gamma * PS_t_N
    PS_t_N = (1 - gamma) * PS_t_N + Epsilon2 * ES_t_N
    EA_t_N = (1 - Epsilon1) * EA_t_N + A * S_t_N * (1 - (1 - ir_N) ** (n_t_N * tp_N))
    ES_t_N = (1 - Epsilon2) * ES_t_N + (1 - A) * S_t_N * (1 - (1 - ir_N) ** (n_t_N * tp_N))
    S_t_N = S_t_N * (1 - ir_N) ** (n_t_N * tp_N)

    S_t_all = S_t + S_t_w + S_t_N
    E_t_all = EA_t + ES_t + EA_t_w + ES_t_w + EA_t_N + ES_t_N
    I_t_all = IA_t + IS_t + IA_t_w + IS_t_w + IA_t_N + IS_t_N
    R_t_all = Ra_t + Rb_t + Rc_t + Ra_t_w + Rb_t_w + Rc_t_w + Ra_t_N + Rb_t_N + Rc_t_N
    PS_t_all = PS_t + PS_t_w + PS_t_N
    H_t_all = H_t + H_t_w + H_t_N
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```
        n_t = (IA_t + IS_t+ PS_t) * m* S_p_s /N_s + (IA_t_w + IS_t_w + PS_t_w) * m* W_p_s /N_w
              + (A_t_N + IS_t_N + PS_t_N) * m* N_p_s /N_ N

        n_t_w = (IA_t + IS_t+ PS_t) * m* S_p_w /N_s + (IA_t_w + IS_t_w + PS_t_w) * m* W_p_w
              /N_w + (A_t_N + IS_t_N + PS_t_N) * m* N_p_w /N_ N

        n_t_N = (IA_t + IS_t+ PS_t) * m* S_p_N /N_s + (IA_t_w + IS_t_w + PS_t_w) * m* W_p_N
              /N_w + (A_t_N + IS_t_N + PS_t_N) * m* N_p_N /N_ N

        n += 1
print(S_t_all,E_t_all,I_t_all,R_t_all)
```