Modeling the Effect of Age on Quantiles of the Incubation Period Distribution of COVID-19

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Abstract

**Background:** Since the first case of pneumonia with unknown etiology was identified in Wuhan, Hubei province in China in December 2019, the novel coronavirus pneumonia has placed a serious impact on many aspects of the world. Note that the incubation period distribution plays important roles in prevention and control efforts of COVID-19. This study aimed to investigate the conditional distribution of the incubation period of COVID-19 on the age of infected cases, and estimate its corresponding quantiles from information of 2172 confirmed cases from 29 provinces outside Hubei in China.

**Methods:** We collected data including the infection dates, onset dates, and ages of the confirmed cases from the websites of the centres of disease control, or the daily public reports through February 16th, 2020. A maximum likelihood method was developed to account for the biased sampling issue of the data as the epidemic was still ongoing at the time of collecting data.

**Results:** Based on the collected data, we found that the conditional quantiles of the incubation period distribution of COVID-19 varies over ages. In detail, the high conditional quantiles of people in the middle age group are shorter than those of others. We estimated that the 0.95-th quantile related to people in the age group 23~55 is less than 15 days.

**Conclusions:** Observing that the conditional quantiles vary over ages, we may take more precise measures for people of different ages. For example, we may consider carrying out an age-dependent quarantine duration, rather than a uniform 14-days quarantine, in practice. Remarkably, we may need to extend the current quarantine duration for people aged 0 ~ 22 and over 55 because the related 0.95-th quantiles are much greater than 14 days.

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Figures
Figure 1

Scatter plot of the incubation period of COVID-19 versus the ages of confirmed cases. Note that many data points are overlapped.
Figure 2

Histogram of the ages of confirmed cases. The line stands for the fitted density function of normal distribution.
Figure 3

Scatter plot of the number of infected cases versus the infected time. The line stands for the fitted line through the least squares method.
Figure 4

The estimated conditional quantiles of the incubation period distribution of COVID-19. 15.05 is the estimated 0.95-th quantile of the unconditional incubation periods.
Figure 5

The fitted density and distribution functions of the incubation period for three age groups. The age groups are 0-25, 26-60 and over 60. The left indicates fitted density functions. The right indicates fitted distribution functions.
Figure 6

The estimated regression quantiles. The quantiles are 0.05, 0.25, 0.5, 0.75, 0.9, 0.95 from the bottom to top.

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