

Journal Pre-proof

Estimation of the asymptomatic ratio of novel coronavirus infections (COVID-19)

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The number of novel coronavirus (COVID-19) cases worldwide continues to grow, and the gap between reports from China and statistical estimates of incidence based on cases diagnosed outside China indicates that a substantial number of cases are underdiagnosed (Nishiura et al., 2020a). Estimation of the asymptomatic ratio—the percentage of carriers with no symptoms—will improve understanding of COVID-19 transmission and the spectrum of disease it causes, providing insight into epidemic spread. Although

the asymptomatic ratio is conventionally estimated using seroepidemiological data (Carrat et al., 2008; Hsieh et al., 2014), collection of these data requires significant logistical effort, time, and cost. Instead, we propose to estimate the asymptomatic ratio by using information on Japanese nationals that were evacuated from Wuhan, China on chartered flights.

Figure 1 illustrates the flow of the evacuation process. By 6 February 2020 a total of $N=565$ citizens were evacuated. Among them, $pN=63$ (11.2%) were considered symptomatic upon arrival based on (1) temperature screening before disembarkation, and (2) face-to-face interviews eliciting information on symptoms including fever, cough, and other non-specific symptoms consistent with COVID-19. All passengers additionally undertook reverse transcription polymerase chain reaction (RT-PCR) testing, and $m=4$ asymptomatic and $n=9$ symptomatic passengers tested positive for COVID-19.

Employing a Bayes theorem, the asymptomatic ratio is defined as

$$\Pr(\text{asymptomatic} \mid \text{infection}) = \frac{\Pr(\text{infection} \mid \text{asymptomatic}) \Pr(\text{asymptomatic})}{\Pr(\text{infection})},$$

which can be calculated as $m/(n+m)$, as seen in Figure 1. Using a binomial distribution, the asymptomatic ratio is thus estimated at 30.8% (95% confidence interval (CI): 7.7%, 53.8%) among evacuees. As of 6 March 2020, a total of thirty days have elapsed since their departure from Wuhan, and the length of observation is sufficiently longer than the COVID-19 incubation period (Li et al., 2020; Linton et al., 2020). Thus, there is very little probability that the five virus-positive asymptomatic individuals will develop symptoms.

In general, asymptomatic infections cannot be recognized if they are not confirmed by RT-PCR or other laboratory testing, and symptomatic cases may not be detected if they do not seek medical attention (Nishiura et al., 2020b). Estimates such as this therefore provide important insight by using a targeted population to assess prevalence of asymptomatic viral shedding (Kupferschmidt & Cohen, 2020). It should be noted that limited sensitivity of RT-PCR does not affect the estimate of asymptomatic ratio, because the sensitivity is cancelled out from the right-hand side of equation. However, as the weakness of this study, it should be remembered that (i) age-dependence and (ii) other aspects of heterogeneity were ignored, because our samples relied on Japanese evacuees from Wuhan. Despite a small sample size, our estimation indicates that perhaps less than a half of COVID-19-infected individuals are asymptomatic. This ratio is slightly smaller than that of influenza, which was estimated at 56–80% (Hsieh et al., 2014) using similar definitions for symptomatic individuals. There is great need for further studies on the prevalence of asymptomatic COVID-19 infections to guide epidemic control efforts.

Ethical Approval:

Not required.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Conflict of interest:

We declare that we have no conflict of interest.

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Figure legend

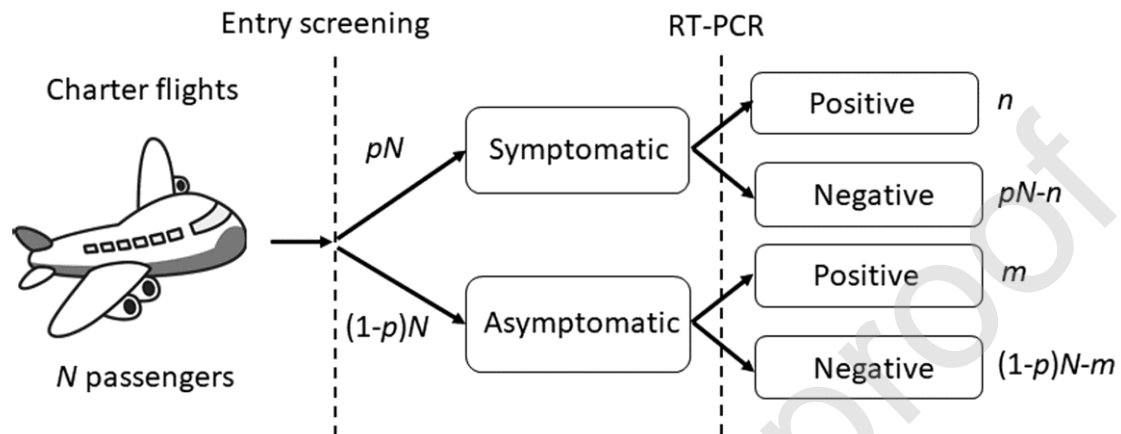


Figure 1. Flow of symptom screening and viral testing for passengers on chartered evacuation flights from Wuhan, China to Japan

The flow of Japanese residents evacuating from Wuhan and screened in Japan. A total of N passengers were evaluated of which a fraction p were symptomatic upon arrival. Among symptomatic and asymptomatic individuals, n and m persons tested positive for the virus via reverse transcription polymerase chain reaction (RT-PCR).