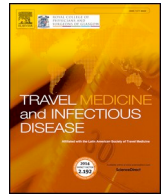




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Does spitting in public play a role in transmitting SARS-CoV-2?



Dear Editor

Respiratory viruses spread from an infected person to susceptible individuals i) by contact including direct person-to-person transfer of infectious secretions and indirect transfer of secretions through fomites, ii) by ballistic spray of large droplets produced during coughing and sneezing (short range transmission) and iii) by inhalation of small airborne droplets or aerosol (long range transmission) [1]. Based on experimental data, SARS-CoV and MERS-CoV have been shown to be transmitted by contact, droplets and aerosol but little evidence is available on the transmission routes of common coronaviruses (229E, OC43, HKU1 and NL63) [1]. In addition, SARS-CoV, MERS-CoV and common coronaviruses can remain infectious on inanimate surfaces for up to nine days [2].

Available data suggests that the early pattern of human-to-human transmission of SARS-CoV-2 is reminiscent of SARS-CoV emergence in 2002. Recent experimental data indicate that aerosol and fomite transmission of SARS-CoV-2 is plausible, since the virus can remain viable and infectious in aerosols for hours and on surfaces up to days (depending on the inoculum shed) [3].

In this comment we discuss the possible role of spitting in the transmission of SARS-CoV-2 in China.

In the West, public spitting is currently commonly associated with a risk of disease and triggers high levels of disgust which go beyond the act itself. In this context, spitting is now seen as both a public health risk and as being offensive [4]. In contrast, spitting is a widely practiced and is an embedded behaviour for a great many people in Asia (Fig. 1-A) [4]. In China, public spitting is not viewed as a problem by the majority of the local population although anti-spitting campaigns (Fig. 1-B) are organised when an international event such as the World Trade Fair or the Beijing Olympics is being hosted in China, and when China cares about how it is viewed externally [4]. Spitting is also common in public toilets in Asia. In a study conducted in Hong Kong in 2018 among 300 Chinese people, 36.4% reported spitting into urinals and 26.4% spat into squat toilets/toilet bowls [5].

The average cough aerosol volume is 38 pL (pL), while the volume of a spit is about 3.0 mL (mL). Therefore, the volume of a spit is about one billion times that of a cough-generated aerosol. In a study conducted among US students who were suffering from acute respiratory



Fig. 1. A. Person spitting (illustration – Christelle Forzale). B. Anti-spitting sign.

illness, the median cough frequency was 18 per 30 minutes (IQR, 5–39) [6]. Thus, a single spit volume is about one million times that of the total daily volume of cough aerosol produced by an individual coughing every 2 min for 18 hours. To our knowledge, the volume of aerosol that is released together with a spit has not been studied; however, it is very likely that it is much greater than that of a cough aerosol.

We used PCR to measure the numbers of RNA copies/mL in calibrated volumes of spit, and of nasopharyngeal secretions obtained using swabs, in ten patients suffering from COVID-19 who were sampled upon admission. The mean number of SARS-CoV-2 copies/mL was 315,116,131 in spit samples and 998,452,298 in nasopharyngeal secretions. The mean number of SARS-CoV-2 copies in a single 3 mL volume of spit is therefore about 945,348,992, while that of a 38.3 pL cough aerosol is about 13 copies, translating into 8260 copies when considering the total daily volume of cough aerosol produced by an individual. Thus, it can be hypothesised that the number of viruses released in a single spit is about 100,000 times greater than the number of viruses released over 18 hours/day through coughing.

We therefore suggest that public spitting in China may have played a significant role in encouraging the transmission of SARS-CoV-2. Further studies are of course, necessary to challenge our hypothesis. Anti-spitting campaigns in China (and elsewhere), in addition to the emotive nature of the issue may finally also make sense from a public health perspective.

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References

- [1] Kutter JS, Spronken MI, Fraaij PL, Fouchier RA, Herfst S. Transmission routes of respiratory viruses among humans. *Curr Opin Virol* 2018 Feb;28:142–51.
- [2] Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect* 2020 Mar;104(3):246–51.
- [3] van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med* 2020 Apr 16;382(16):1564–7.
- [4] Coomber R, Moyle L, Pavlidis A. Public spitting in "developing" nations of the global south: harmless embedded practice or disgusting. Harmful and deviant? In: Carrington K, Hogg R, Scott J, Sozzo M, editors. *The palgrave handbook of criminology and the global south*. Springer International Publishing AG; 2018. p. 493.
- [5] Wu D, Lam TP, Chan HY, Lam KF, Zhou XD, Xu JY, et al. A mixed-methods study on toilet hygiene practices among Chinese in Hong Kong. *BMC Publ Health* 2019 Dec 10;19(1):1654.
- [6] Yan J, Grantham M, Pantelic J, Bueno de Mesquita PJ, Albert B, Liu F, et al. Infectious virus in exhaled breath of symptomatic seasonal influenza cases from a college community. *Proc Natl Acad Sci U S A* 2018 Jan 30;115(5):1081–6.

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