

# Airborne transmission of SARS-CoV-2: ventilation improvement strategies in preparation for school re-opening

David C Lung<sup>1</sup>, MRCPCH (UK), FRCPath, Mike YW Kwan<sup>2</sup>\*, MSc (Applied Epidemiology) (CUHK), FHKAM (Paediatrics),  
CB Chow<sup>3</sup>, MD, FHKAM (Paediatrics)

<sup>1</sup> Department of Pathology, Queen Elizabeth Hospital/Hong Kong Children's Hospital, Hong Kong

<sup>2</sup> Paediatric Infectious Disease Unit, Department of Paediatrics and Adolescent Medicine, Princess Margaret Hospital, Hong Kong

<sup>3</sup> Department of Paediatrics and Adolescent Medicine, The University of Hong Kong, Hong Kong

\* Corresponding author: mike\_kwan@hotmail.com

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## Airborne transmission of COVID-19

Hong Kong has adopted a multifaceted approach to minimise the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the community since 2020. Measures currently implemented, which include mask wearing, social distancing, hand hygiene, and border controls, mainly address transmission by the droplet route. However, airborne transmission of SARS-CoV-2 in confined spaces has been largely overlooked.

Short-range airborne transmission is currently recognised as a predominant route for transmission of SARS-CoV-2.<sup>1</sup> The US Centers for Disease Control and Prevention have also acknowledged the importance of transmission of coronavirus disease 2019 (COVID-19) through inhalation of viruses in the air at distances farther than six feet (2 m).<sup>2</sup> Several important factors contribute to increased risk, including: enclosed space with inadequate ventilation; increased exhalation of respiratory fluid (eg, shouting, singing, exercise); and prolonged exposure (>15 minutes).

Enhancing ventilation in schools has been recognised as an important measure for re-opening of schools in multiple countries.<sup>3</sup> In addition, a recent study in the US has demonstrated that mask wearing can markedly reduce COVID-19 outbreaks at schools.<sup>4</sup>

## Will airborne transmission happen at schools?

After nearly 15 months of prolonged interruption of in-person learning since early 2020 in Hong Kong, the Education Bureau announced the resumption of face-to-face classes for all kindergartens and primary and secondary schools after the Easter holidays on 26 March 2021.<sup>5</sup> However, other than the usual mandatory mask wearing and social distancing measures, there were no enhancements to infection control measures at schools. The compliance with mask wearing advice is often poor, especially in children; at least 13 outbreaks of upper respiratory tract infection, mostly caused by Rhinovirus,

occurred between April and June 2021.<sup>6</sup> This suggests that COVID-19 transmission chains could occur at schools despite the current measures, and that there is an urgent need to examine and enhance ventilation at schools.

Although regulations pertaining to schools in Hong Kong state that “all school premises shall be adequately ventilated and lighted”,<sup>7,8</sup> there is no clear definition or quantification of how well the ventilation should be. In the US, fresh air supply in classrooms (for ages 5-8 and ≥9 years) and other education facilities should be at least 5 L/s per person, in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 62.1-2016.<sup>9</sup> In Hong Kong, standards for new buildings recommend that fresh air provision in normally occupied spaces should exceed the minimum ASHRAE standard by at least 30%.<sup>10</sup> Applied to the school setting, this would be equivalent to 6.5 L/s per person. The World Health Organization has recently stated that indoor ventilation should be 10 L/s per person (around 8-10.4 air changes per hour [ACH] depending on the ceiling height).<sup>11</sup>

## Potential solution

A similar problem was encountered by the catering industry. Prior to March 2021, multiple clusters of COVID-19 cases occurred, resulting in restaurants being forced to suspend dine-in service or shorten business hours. To address the potential airborne transmission of COVID-19 in dine-in catering premises, the Hong Kong SAR Government decided to promote enhancement of ventilation. The current ventilation requirement for restaurants is 17 m<sup>3</sup>/h per person (around 3.8-4.9 ACH depending on ceiling height).<sup>12</sup> Aiming to reduce the risk of airborne transmission of COVID-19 in mask-off indoor settings, the Government set a target of 6 ACH for these premises. A mandatory registration scheme was launched on 18 March 2021, whereby catering business operators were required to report whether their business premises attained ≥6 ACH. For premises unable to meet this requirement, air

purifiers (with high-efficiency particulate arrestance filters or ultraviolet devices) had to be installed before 30 April 2021. The Government also formed a working group to promote compliance and ensure the smooth implementation of these requirements.<sup>13</sup> As of July 2021, most dine-in restaurants met the requirements, and no large clusters of cases in dine-in restaurant settings have been reported since April 2021, despite many individuals confirmed to have COVID-19 visiting multiple restaurants during their infectious period.

Schools, just like restaurants, are subject to the same risk, because compliance with mask wearing advice, especially among children, cannot be guaranteed at all times. Therefore, all possible measures should be optimised before the resumption of schools in September 2021. Air conditioning alone does not ensure adequate ventilation, since most are recirculating air and there may be insufficient fresh air to dilute the indoor air and contaminated particles. It is understandable that changing the heating, ventilation, and air conditioning system at schools may not be always possible, especially within such a short period of time. However, using the experience of restaurants in Hong Kong as an example, alternative means to improve ventilation can be adopted, such as high-efficiency particulate arrestance filters and ultraviolet-C devices.<sup>3,14,15</sup>

With support from the Government and collaboration with architectural and engineering professionals, technology can be implemented to construct buildings with an infection resilient environment, using a combination of ventilation, air cleaning, and environmental monitoring. This approach could greatly reduce the chance of infection of the inhabitants and the environment.<sup>16</sup>

Although a fully vaccinated population is the best defence against COVID-19, this will be unachievable within the short period of time before the next school term begins. It is time for relevant stakeholders to review the latest scientific evidence and international recommendations and to revise current policies, prioritising ventilation in schools as a major infection control measure for the safe re-opening of schools. Schools should act promptly and modify ventilation settings to prepare for the new term and the expected winter surge in COVID-19 cases.

#### Author contributions

All authors contributed to the editorial, approved the final version for publication, and take responsibility for its accuracy and integrity.

#### Conflicts of interest

DC Lung is a member of the “Working Group on Implementing the Requirement on Air Change or Air Purifiers in Dine-in Restaurants under Cap. 599F”. All other authors have disclosed no conflicts of interest.

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