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Research Letter

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Are small airplanes safe with regards to COVID-19 transmission?

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Social distancing is one of the most important safety procedures to be practiced in the severe acute respiratory syndrome coronavirus (COVID-19) era. However, this is not always possible. While the risk of transmission in commercial aircrafts has been investigated (surveys in previous studies[1,2]), no data exist on small planes in general aviation, which are commonly used for training or sightseeing flights, or probably even more important, for private piloting. We therefore investigated the cabin airflow regarding the distribution of the exhaled air between crew members and passengers. An externally connected ventilation system was used to simulate the cockpit in-flight airflow for a four-seater general aviation aircraft (Morane Saulnier MS893E). The airstream was marked with smoke for visualization, and the airflow velocity was measured with a thermal anemometer using three axes at various points. To evaluate the air exchange rate, the circulation coefficient was calculated using the velocities measured. Laboratory results were validated in identical conditions during in-flight measurements without smoke. The aerodynamic characteristics of the nozzle outlets were additionally investigated under laboratory conditions.

Airflow velocity was measured at 8.5 m/s at the nozzle outlet during ground tests and at 10.0 m/s in-flight. The respective calculated cabin air exchange rates were 0.5 and 0.6/min. The visualized airstream in the cockpit demonstrated no crossflows. This indicates that there is no, or minimal, aerosol transport between the two pilots (Figure 1). This was further confirmed by the measurements between the test pilots, which showed an insignificant air velocity component along the axis connecting the two heads.

Figure 1. Visualization of the flow inside the cabin: there is nearly no crossflow between both pilots.

The smoke visualization and airflow measurements both confirmed that there was negligible air flow towards the backseat passengers who received ventilation from the additional nozzles just in front of their seats. These airflow results were similar to those of the nozzles installed in front of the pilots. It was surprising to find that there was only a minimal airflow detected at head height from the front to the rear seats. The main reason for this lies in the cabin's construction. In all the different types of small planes, there are only three different ways in which the air can leave the cockpit: (i) leakages of the side windows and doors, (ii) discharge valves or systems in the side windows or doors and (iii) discharge valves in the cockpit's floor. In non-pressurized cockpits, the former is the most common form of air loss, e.g. in the Morane used for this study's measurements. However, since all small planes share the same construction which forces the airflow towards another direction other than the rear passenger's nose, a similar careful conclusion may be drawn for other small planes.

Since there is no reason for any face-to-face contact during a flight, the risk of virus transmission when a person coughs or sneezes in a well-ventilated sub-compartment should be low. However, any person on-board should be instructed to sneeze or cough towards the side wall of the cockpit, or into the inside crook of their arm, to reduce this risk further. As explained above, the plane's airflow will leave the cabin through the established leakages already identified, and this will also remove any aerosols.

Cars share a similar forward-facing seating arrangement to small planes (e.g. facing in the direction of the flight/journey). However, in contrast to cars, there is no need to talk loudly in the direction of the person one wishes to talk to when flying as modern sophisticated headsets facilitate normal speaking when facing forward, and this forward-facing seating arrangement is common to any aircraft. Therefore, the risk of virus transmission from a strong ventilated airstream which does not cross towards a fellow passenger should be an insignificant risk. Since the ventilation system is not switched on during loading or unloading, the wearing of masks (FFP2/KN95) should be obligatory until the engine and the ventilation system are running.

Our results should not be used to estimate the risk of corona virus transmission in cars. Although the interior layout of the car may seem similar to a small plane, the ventilation system differs significantly. The car's airflow is much lower, but even more important, there are several airflow nozzles (front-side, front-centre, leg area, front window and sometimes even more) which produce a more complex and normally turbulent airstream with significant crossover flows to neighbouring seats. In addition, when driving a car through traffic, the driver normally needs to regularly turn their head sideward, which can also be in the direction of the passenger. Therefore, we conclude that the risk of virus transmission in a car is likely significantly higher than in a small aircraft. However, our literature search did not find any published data concerning the risk of COVID-19 transmission in cars.

When flying in a four-seater plane, it can be concluded that the risk of corona virus transmission is very limited—and even less if the ventilation system is set on 'high'. Further studies should validate these findings for other small aircraft types (2- to 10-seaters). In addition, the safety procedures outlined by Harries *et al*. should be observed when flying in any small general aviation plane. This includes wearing a well-fitted facemask, avoiding touching the face, maintaining hygiene and using alcohol-based sanitizers (especially for the hands) and sneezing into the inside of the crook of the arm.[2]

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Authors' contributions

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