



Wastewater-based epidemiology at airports: COVID-19 and beyond

Davey Jones



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Gatwick to restrict flights all week after Covid outbreak

The outbreak in air traffic control team has resulted in staff shortages

By Jack Simpson, TRANSPORT CORRESPONDENT

25 September 2023 • 6:58pm

Related Topics

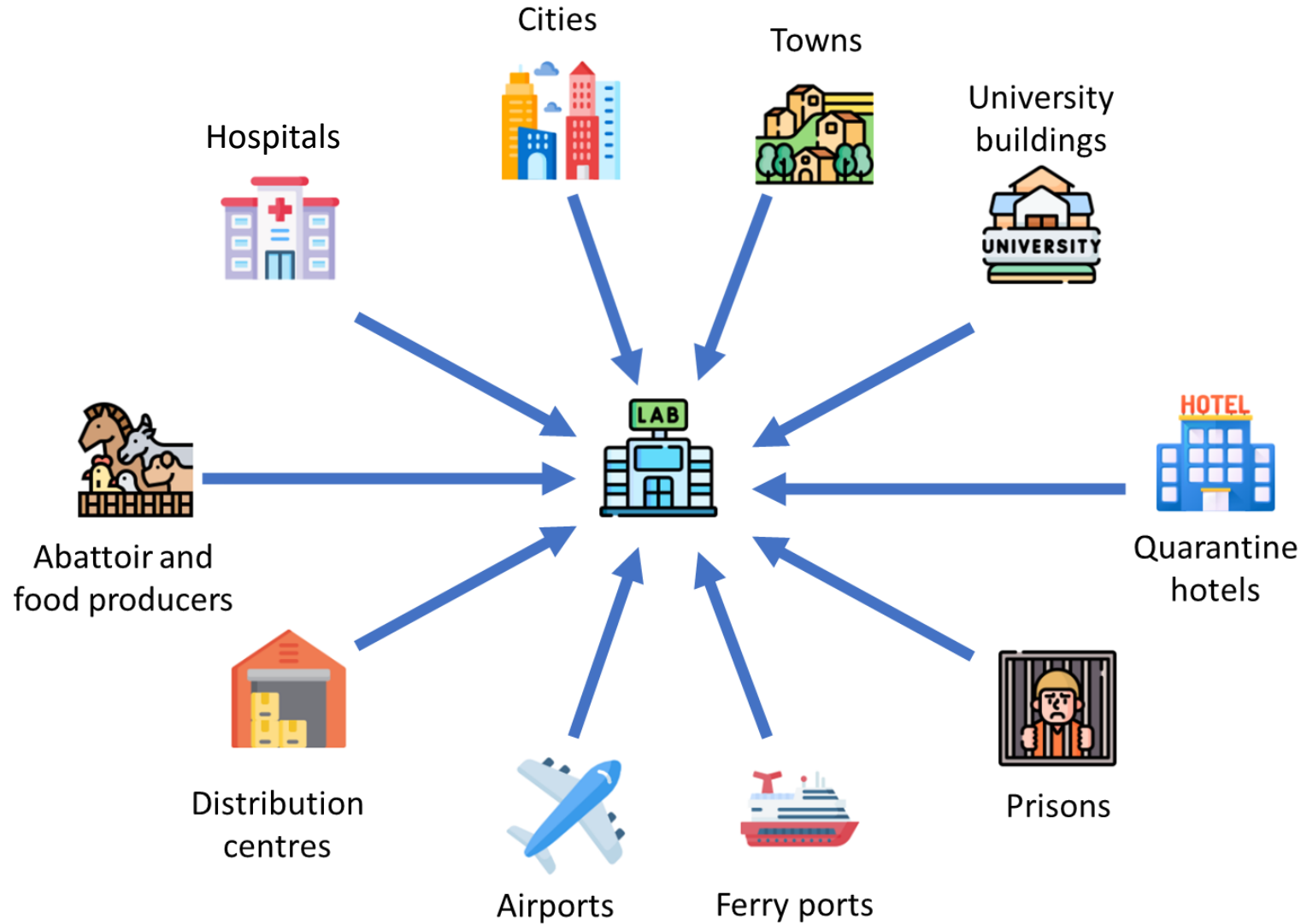
Breaking news, Gatwick airport, Gatwick, Coronavirus, West Sussex



CREDIT: REUTERS

Gatwick has been forced to restrict flights for the rest of the week after an outbreak of

Wastewater-based testing for pathogens in the UK















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Different intelligence approaches for monitoring and tracking pathogens

		Data accuracy	Sample size	Regional accuracy	Response time	Relative cost			Data accuracy	Sample size	Regional accuracy	Response time	Relative cost
	Self-reporting apps	Low	High	Low	Fast	£		Prescription data	Low	Low	Medium	Slow	££
	Internet searches	Low	High	Low	Fast	£		Urban wastewater surveillance	Medium	High	High	Fast	£££
	School/work absences	Medium	Medium	Medium	Medium	££		Hospital/Airport wastewater surveillance	High	High	High	Fast	£££
	Over-the-counter medication sales	High	High	High	Medium	££		Clinical testing	High	Low	High	Medium	£££££
	Tele-health advice calls	Low	Medium	Medium	Medium	£££		'Event-based' testing of outbreaks/incidents	High	Low	High	Fast	££££
	GP surgery visits	Low	Medium	Medium	Slow	££££		Emergency hospital admissions	High	Low	High	Fast	£££

Key priority: We need to better integrate these data streams.

RESEARCH ARTICLE

Wastewater-based monitoring of SARS-CoV-2 at UK airports and its potential role in international public health surveillance

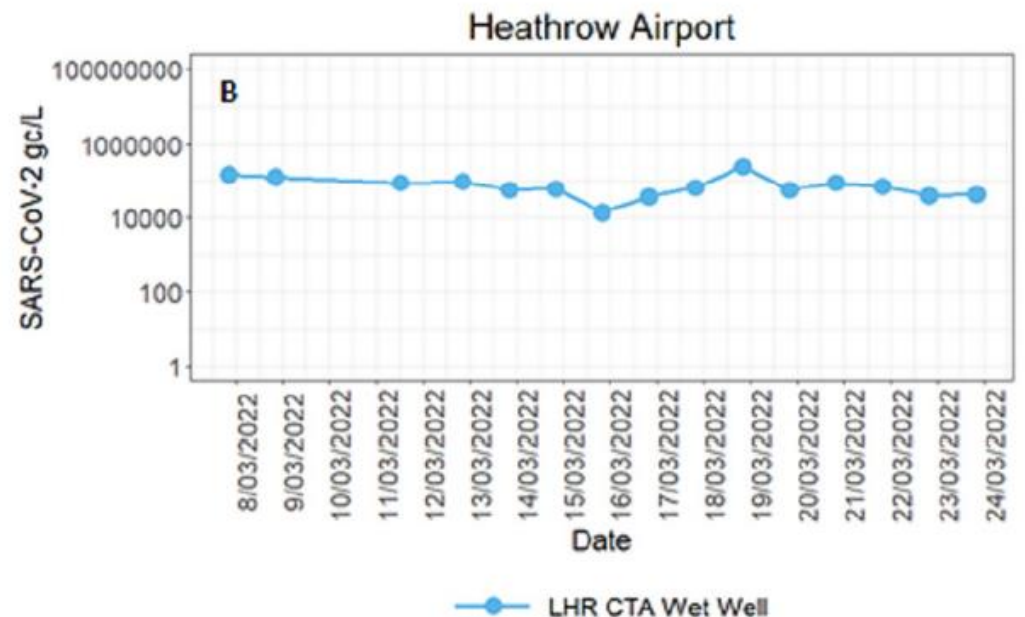
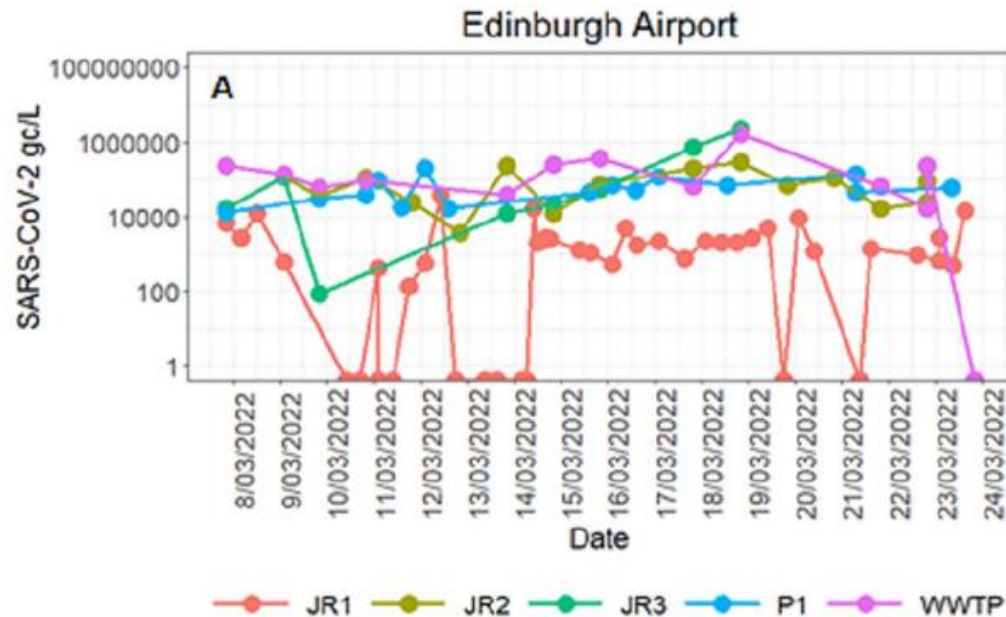
Kata Farkas^{1,2*}, **Rachel Williams**¹, **Natasha Alex-Sanders**¹, **Jasmine M. S. Grimsley**^{3,4}, **Igor Pântea**¹, **Matthew J. Wade**^{3,5}, **Nick Woodhall**¹, **Davey L. Jones**^{1,6}

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Testing wastewater from aircraft and airports

Key results




Implications

- All wastewater samples from the arrival terminals of Heathrow and Bristol airports, and 85% of samples from Edinburgh airport, were positive for SARS-CoV-2.
- High COVID-19 prevalence among passengers and/or airport staff members.
- Samples from aircraft also showed 93% SARS-CoV-2 positivity.
- No difference in viral prevalence was found before and after COVID-19 travel restrictions were lifted.



Rapid Assessment of SARS-CoV-2 Variant-Associated Mutations in Wastewater Using Real-Time RT-PCR

 Kata Farkas,^{a,b} Cameron Pellett,^a Rachel Williams,^a Natasha Alex-Sanders,^a Irene Bassano,^{c,d} Mathew R. Brown,^{c,e} Hubert Denise,^c Jasmine M. S. Grimsley,^{c,f} Jessica L. Kevill,^a Mohammad S. Khalifa,^{c,g} Igor Pântea,^a Rich Story,^{c,h} Matthew J. Wade,^{c,e} Nick Woodhall,^a Davey L. Jones^{a,i}

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ABSTRACT Within months of the COVID-19 pandemic being declared on March 20, 2020, novel, more infectious variants of SARS-CoV-2 began to be detected in geospatially distinct regions of the world. With international travel being a lead cause of

Wastewater analysis of SARS-CoV-2 at airport quarantine hotels



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Inside the quarantine hotels: Guest reveals there are no exercise or cigarette breaks, no MINI-BARS, staff leave food outside door then run away while guards patrol floors to stop people escaping

Wastewater analysis of SARS-CoV-2 at airport quarantine hotels

Key results

TABLE 2 Temporal changes in the detection frequency of the Beta, Gamma, Delta, and Kappa VSMs in wastewater from quarantining hotels using RT-qPCR

Sampling date	SARS-CoV-2 (all variants) ^a	Beta	Gamma	Delta	Kappa
April 2021	56.1% (69/123)	0.8% (1/123)	1.6% (2/123)	5.8% (7/121)	2.5% (3/121)
May 2021	79.8% (83/104)	1.9% (2/104)	5.8% (6/104)	24.0% (25/104)	0% (0/104)
June 2021	50.6% (172/342)	0% (0/342)	1.8% (6/341)	10.2% (35/342)	0% (0/342)
July 2021	53.0% (133/251)	1.2% (3/251)	2.0% (5/251)	16.7% (42/251)	0% (0/251)

^aThe values in parentheses denotes the number of positives relative to the total number of samples.

Implications

- 50-80% of samples were positive for SARS-CoV-2.
- Shows that quarantining hotels work.
- Pre-departure testing is inadequate to prevent entry of infected people.
- RT-qPCR and sequencing both useful for variant detection.
- Cost-effective, unbiased and non-intrusive way to look at variants (pooled samples).





OPEN

Poor air passenger knowledge of COVID-19 symptoms and behaviour undermines strategies aimed at preventing the import of SARS-CoV-2 into the UK

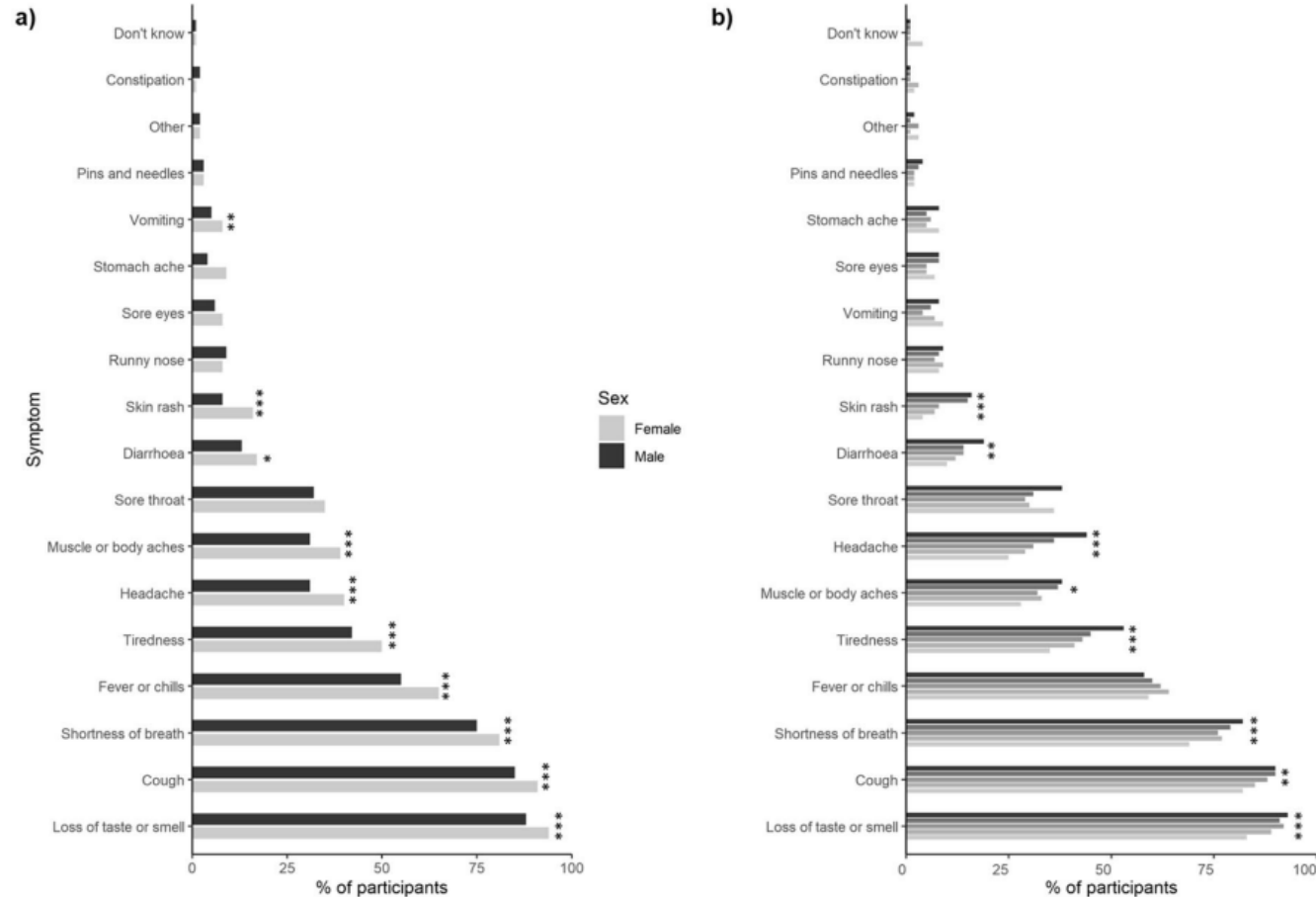
David. L. Jones^{1,2}, Jennifer M. Rhymes^{1,3✉}, Emma Green¹, Charlotte Rimmer¹, Jessica L. Kevill¹, Shelagh K. Malham⁴, Andrew J. Weightman⁵ & Kata Farkas^{1,4}

Air travel mediates transboundary movement of SARS-CoV-2. To prepare for future pandemics, we sought to understand air passenger behaviour and perceived risk during the COVID-19 pandemic. This study of UK adults ($n = 2103$) quantified knowledge of COVID-19 symptoms, perceived health risk of contracting COVID-19, likelihood of returning to the UK with COVID-19 symptoms, likelihood to obey self-quarantining guidelines, how safe air travellers felt when flying during the pandemic ($n = 305$) and perceptions towards face covering effectiveness. Overall knowledge of COVID-19

COVID-19: Passenger knowledge and behaviour

Key results

Participant knowledge on different symptoms of COVID-19.



Implications

- Most passengers had poor knowledge of the symptoms of COVID-19.
- Individuals have flown when they know they have COVID-19.
- Many will not self-isolate when returning to the UK.
- Better point-of-departure testing.
- Better point-of-entry testing.
- Better messaging.

COVID-19: Passenger knowledge and behaviour

Key results

Individuals who have previously returned to the UK on a flight while showing signs of illness (non-COVID-19 related).

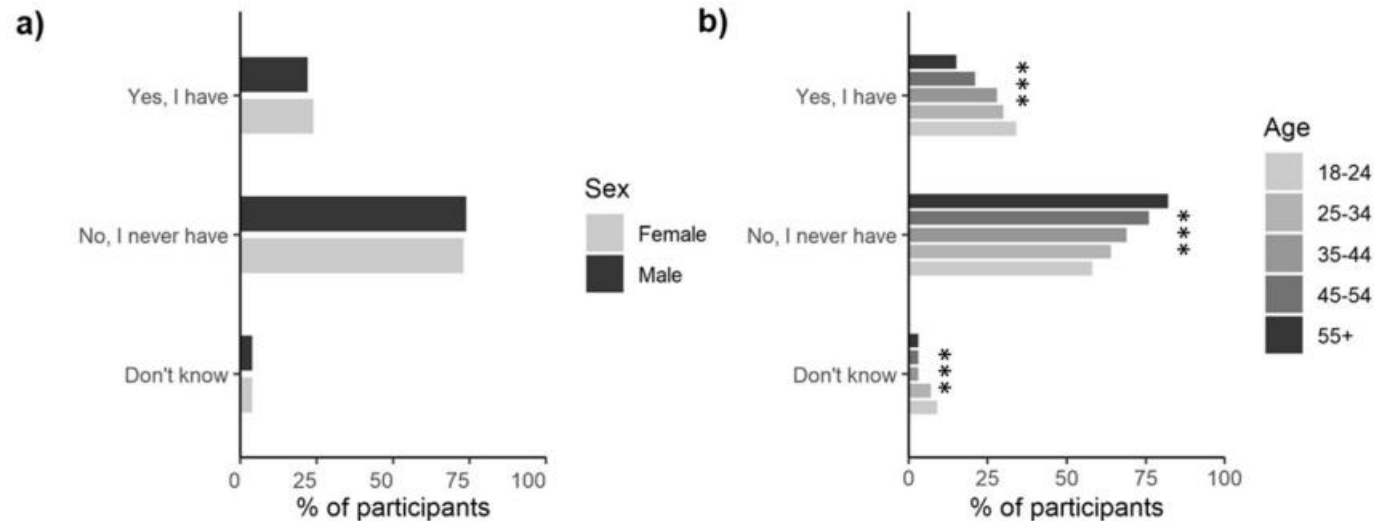


Figure 4. Proportion of participants stratified by either (a) gender, or (b) age ($n = 2103$). *, **, and *** represent significant differences between the gender or age categories for a particular symptom at the $P < 0.05$, $P < 0.01$ or $P < 0.001$ level, respectively.

Implications

- Most passengers had poor knowledge of the symptoms of COVID-19.
- Individuals have flown when they know they have COVID-19.
- Many will not self-isolate when returning to the UK.
- Better point-of-departure testing.
- Better point-of-entry testing.
- Better messaging.

COVID-19: Passenger knowledge and behaviour

Key results

Individuals who said that they would self-isolate for the full 10-day period on return to the UK from a country included on the UK's quarantine.

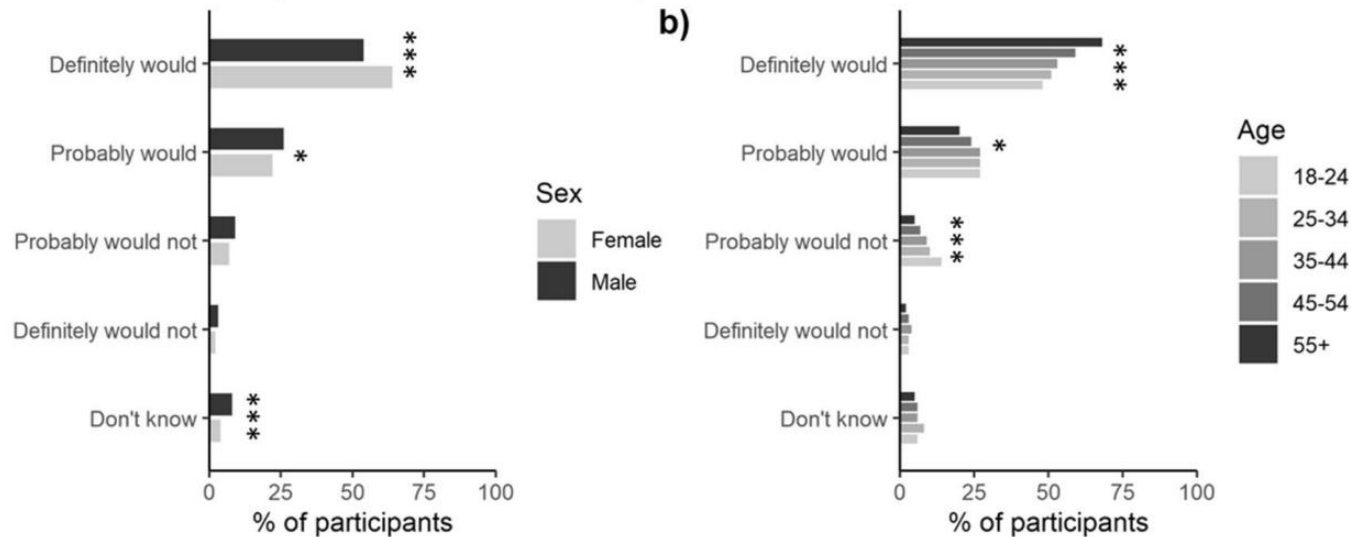


Figure 6. Proportion of participants stratified by either (a) gender, or (b) age ($n = 2103$). *, **, and *** represent significant differences between the gender or age categories for a particular symptom at the $P < 0.05$, $P < 0.01$ or $P < 0.001$ level, respectively.

Implications

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- Better point-of-departure testing.
- Better point-of-entry testing.
- Better messaging.



Suitability of aircraft wastewater for pathogen detection and public health surveillance



Davey L. Jones^{a,b,*}, Jennifer M. Rhymes^{a,c}, Matthew J. Wade^{d,e}, Jessica L. Kevill^a, Shelagh K. Malham^f, Jasmine M.S. Grimsley^{e,g}, Charlotte Rimmer^a, Andrew J. Weightman^h, Kata Farkas^{a,g}

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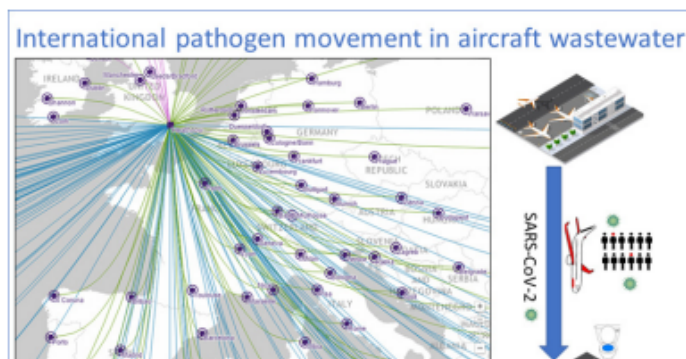
^g The London Data Company, London EC2N 2AT, UK

^h Microbiomes, Microbes and Informatics Group, School of Biosciences, Cardiff University, Cardiff CF10 3AX, UK

HIGHLIGHTS

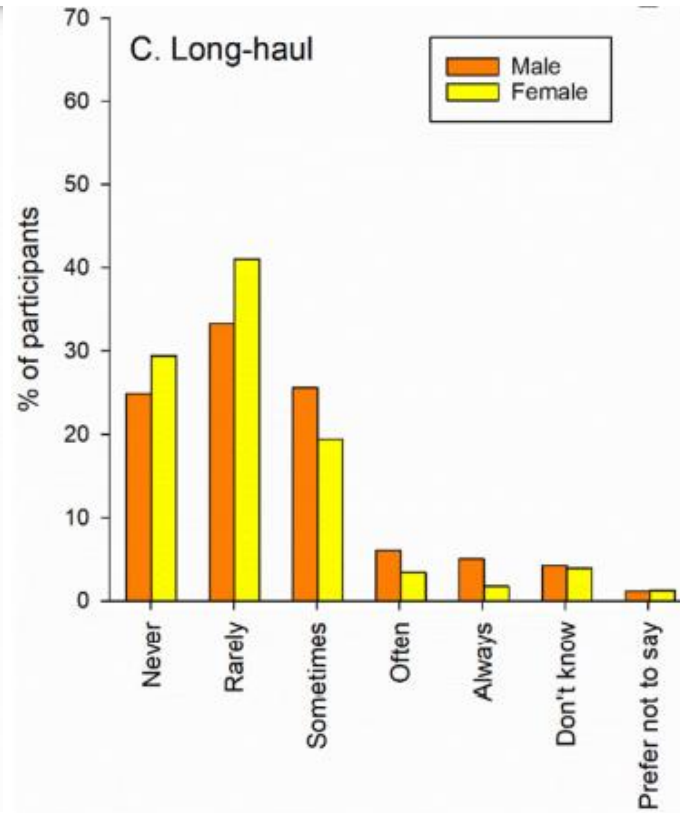
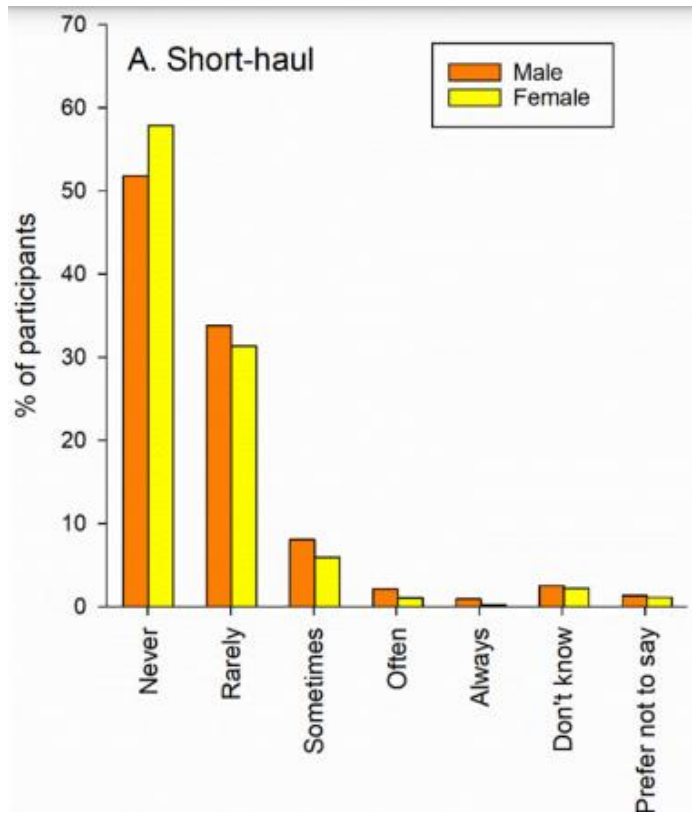
- Air travel is important for long distance human pathogen transport.
- We surveyed the toilet habits of individuals on short- and long-haul flights.
- We estimate that wastewater captures 8–14 % of infected individuals entering the UK.
- Wastewater may prove useful for public health surveillance at national borders.

GRAPHICAL ABSTRACT



Defecation habits of aircraft passengers

Key results

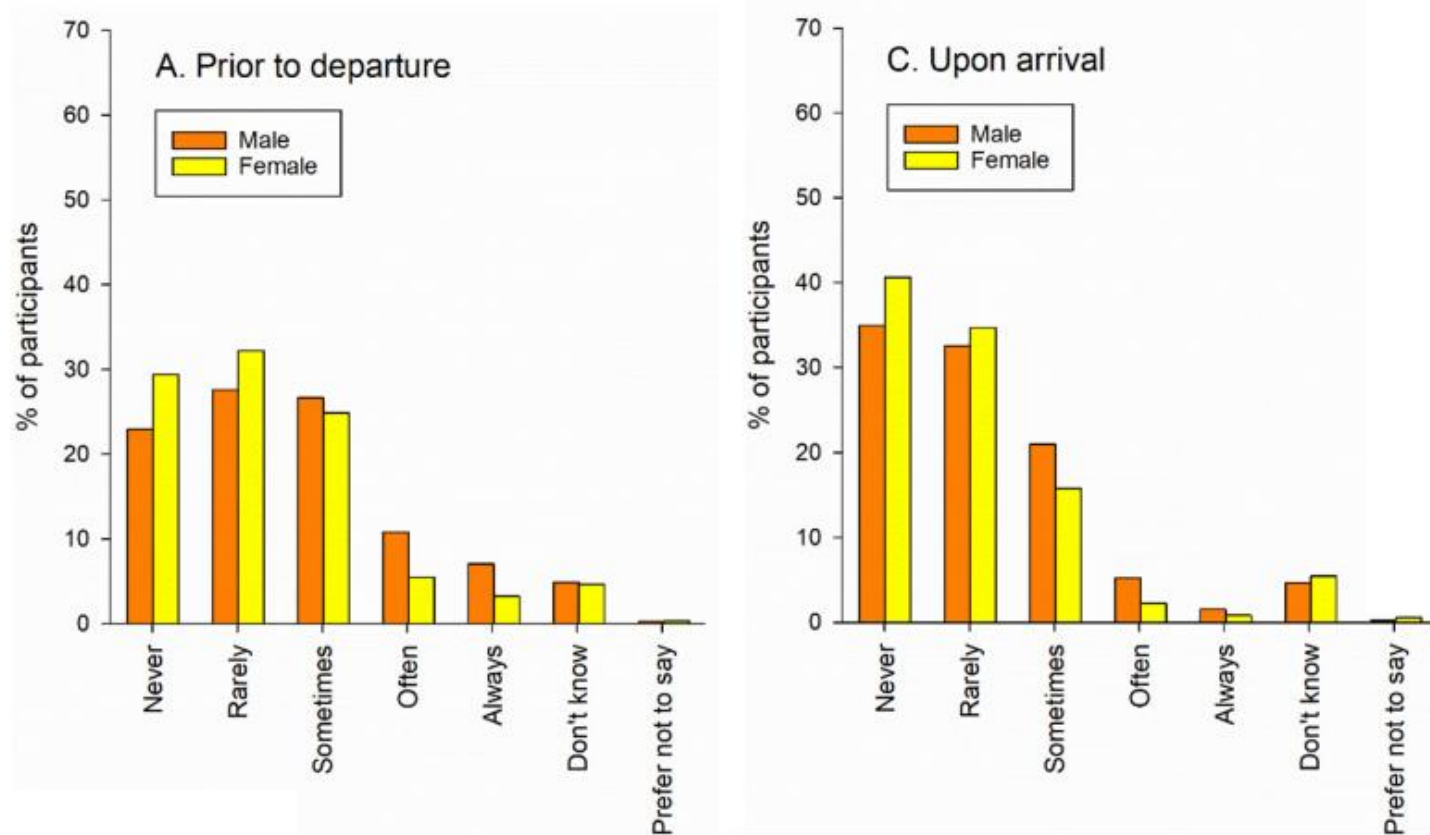


Implications

- More people likely to defecate on long-haul flights (suitable for WBE).
- Short-haul flights have multiple stops (unsuitable for WBE).
- Enteric viruses/bacteria and protozoal parasites will increase the frequency as increased diarrhoea and vomiting symptoms.

Defecation habits of passengers in the terminal

Key results

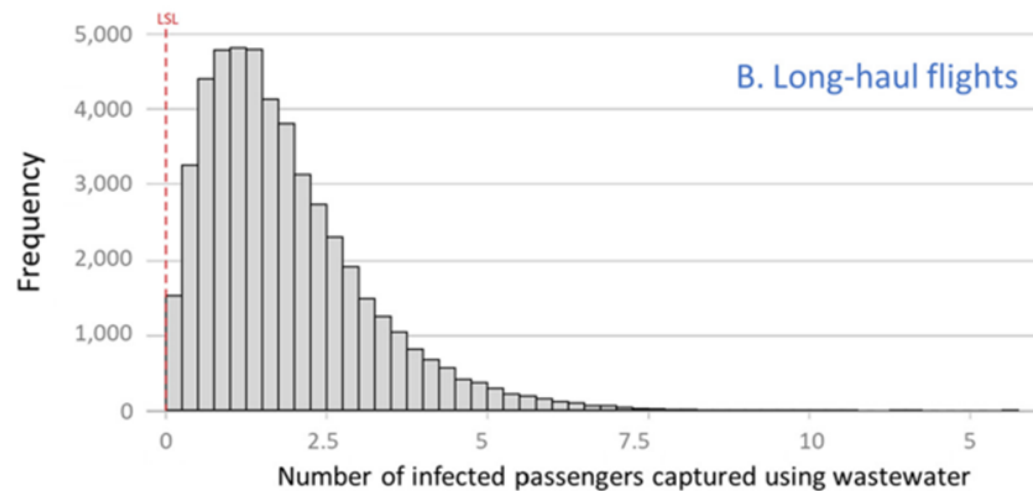
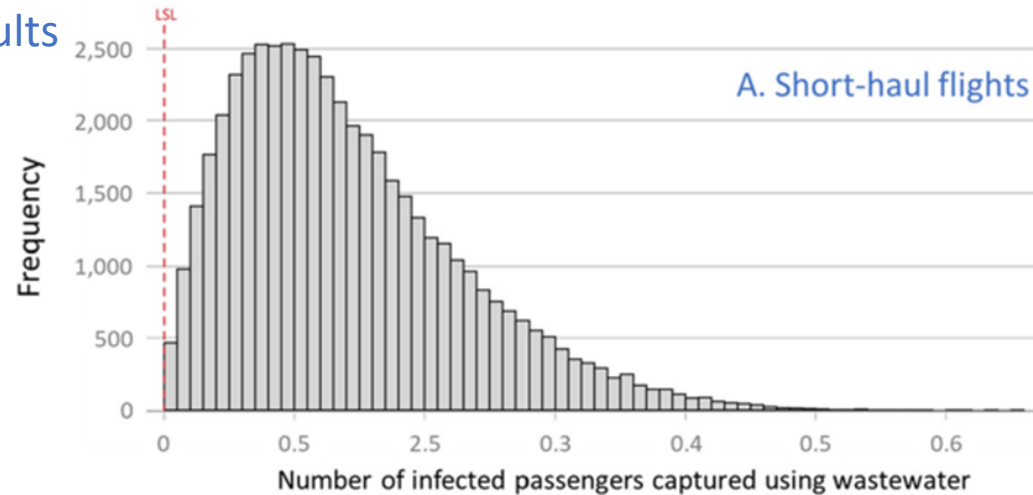


Implications

- More people likely to defecate before leaving.
- Enteric viruses will increase these numbers (increased diarrhoea and vomiting).
- Some individuals prefer to wait until they arrive, rather than use the plane toilets.
- May capture a different cohort than the plane toilets.
- Cannot track to a single destination.

Use of wastewater to capture individuals infected with COVID-19 on airplanes

Key results



Implications

- Short-haul flights carry 1.8 ± 0.2 passengers infected with COVID-19.
- 14% chance of capturing them using wastewater.
- Long-haul flights carry 5.4 ± 1.6 passengers infected with COVID-19.
- 75% chance of capturing them using wastewater.
- Matches experimental data.
- Long-haul flights are suitable for tracing the entry of new variants (or pathogens).

Where next?

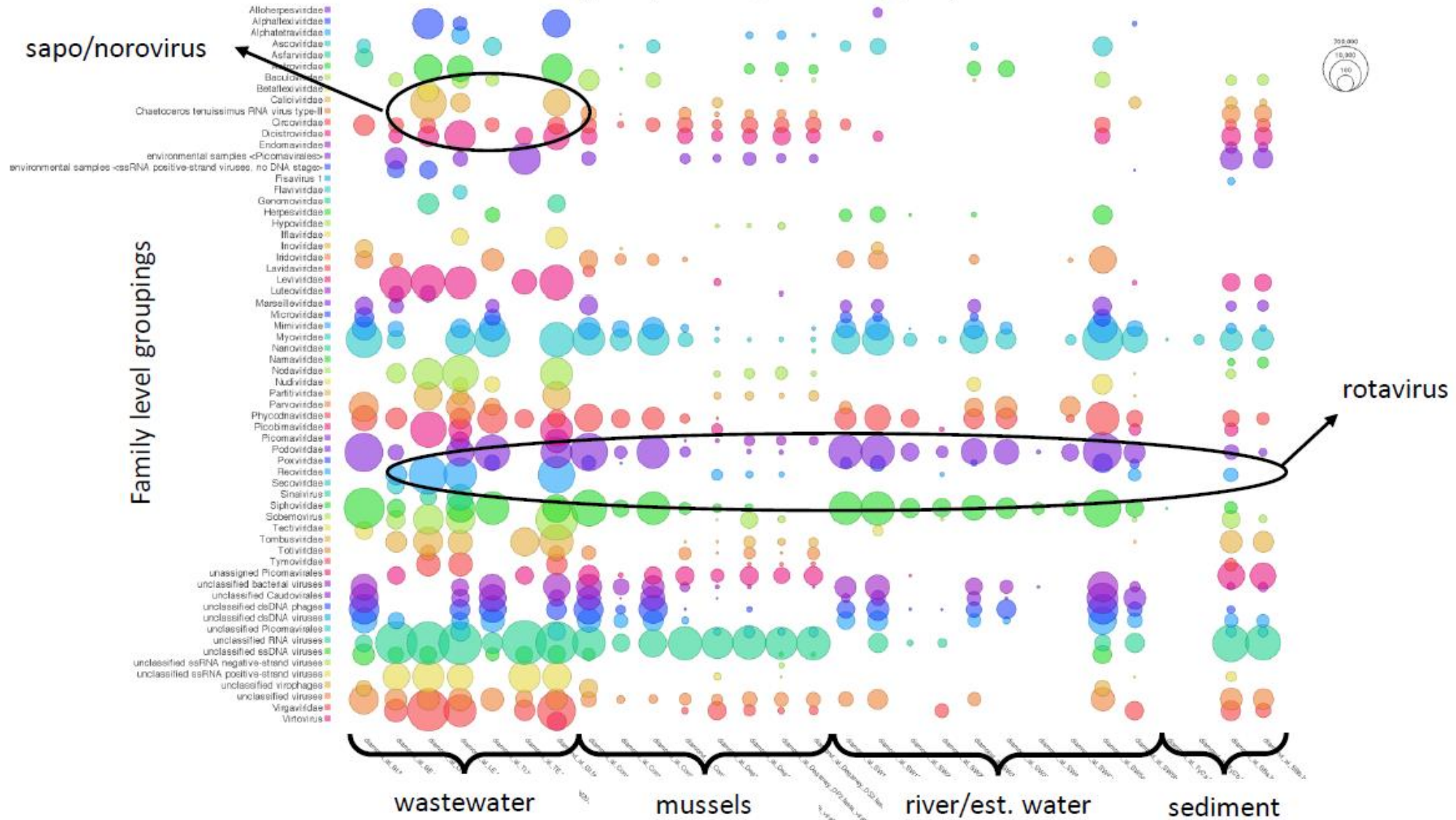
- We can test for many diseases in airport wastewater to provide a holistic view on global pathogen transport
 - Respiratory viruses
 - Enteric viruses
 - Protozoal pathogens
 - Antimicrobial resistant bacteria
 - Antimicrobial resistant fungi



Metaviromics of environmental samples



Taxonomy profile for Comparison_allreads_allsamples_viral2018_absolute_megen (rank=Family)



Conclusions

- Wastewater monitoring of COVID-19 has proven to be very successful
 - Ethics, security, logistics of collection, analysis, bioinformatics and reporting.
 - Rapid and more cost-effective than testing everyone on a plane.
 - Greater public acceptability.
 - Need to combine with other intelligence dataflows.
 - Need to improve data sharing with clinical surveillance programmes.
 - Expand to include a wider range of other targets (e.g. Influenza, AMR, genomics).
 - Still much work needed to build an effective national/global biosecurity system.
- 