LONG COVID KIDS

Awareness Pack
for Schools and Families

January 2022

Next revision due 12th February

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ABOUT LONG COVID KIDS

★ In 2021 Long Covid Kids became the first UK-based, international charity for families, children and young people living with Long Covid. The charity's work is focused on education, prevention, research and support, and is recognised by the NHS and the Centre for Disease Control in the USA.

★ Our small team is based in England and has representatives in Scotland, Ireland, Wales, Canada, Greece & the USA. See more information about our team here.

★ Our peer to peer support group has over 5000 children and continues to grow daily, welcoming members whose children have been infected with COVID-19 & have ongoing symptoms.

★ The team work virtually via longcovidkids.org Facebook, Twitter, Youtube and Instagram

Our short film was published at the start of our campaign in October 2020 and continues to embody the challenges of its members.

Please take a look, it's less than three minutes long.

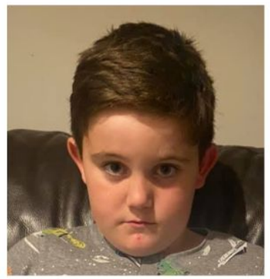
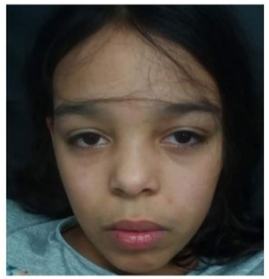
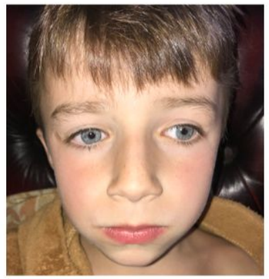
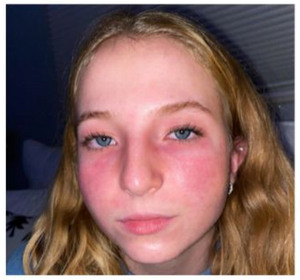
When we created the film, we were facing a narrative that stated children would not become unwell due to Coronavirus. Our founders and their children contracted COVID-19 and became ill at the beginning of the first wave in March 2020. Many remain unwell to this day.

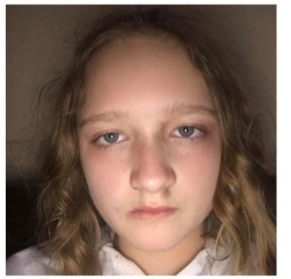
Our film was launched on social media and shortly afterwards, other families began to come forward. This led to us forming a support group.

In addition to our original group we now have groups in Canada and the USA. Each group provides connection, signposting and peer to peer support for families navigating their child's diagnosis and recovery pathway.

Experienced parents support new members alongside our team of volunteers.
Meet the Team, Champions & Partners.

LONG COVID KIDS CHARITY OBJECTIVES



EDUCATION

CHILD FOCUSED
COVID SYMPTOMS
LONG COVID SYMPTOMS
AWARENESS
CLARITY

PREVENTION

GUIDANCE
PREVENTION
MITIGATION
AWARENESS
TRANSPARENCY

SUPPORT

SUPPORT
SIGNPOSTING
COUNSELLING
RELIEF
HONESTY

PROGRESS

CLINICAL DEFINITION
RESEARCH
SUPPORT SERVICES
DIAGNOSIS
HOPE

We are fundraising

Long Covid Kids
Supporting each other.

Education

To raise awareness of Long Covid and related illnesses in children and young people.

Prevention

To promote preventative measures to protect the health and well-being of children and young people.

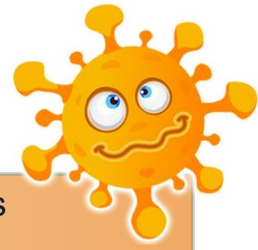
Progress

To support research, establish suitable treatment and support services for children and young people living with Long Covid and related illnesses.

Support

To provide advice, support and connection for schools, families, children and young people living with Long Covid or related illness.

PACK OBJECTIVES. PREVENTION AND MITIGATION IN INDOOR SETTINGS



School staff have been frontline workers throughout the pandemic and we recognise that Head Teacher's responsibilities have increased 10-fold. It is understood that The Department of Education's guidance has been slow and inadequate.

The Long Covid Kids Education and Awareness Pack aims to provide families and teaching staff with evidence and information including:

Awareness of COVID-19's effects specific to children:

- Aid understanding of COVID-19 science and evidence in children to assist decision making
- How COVID-19 can present in a child to aid early identification and reduce transmission
- What we know about Long Covid and how it can present in a child or member of staff
- Referenced information and statistics on teachers and school staff

COVID-19 Aerosol / Airborne Transmission

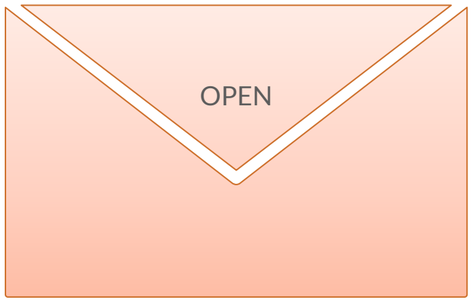
- The scientific evidence of aerosol transmission in crowded and poorly ventilated indoor spaces (e.g. classrooms) to reduce the risk of long-term health implications for teaching staff, children and their carers.

Key Mitigation Measures

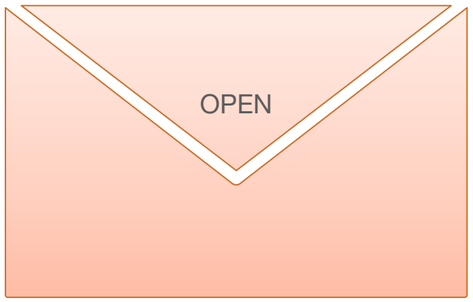
- Reduced time indoors, lower occupancy, hand-washing, social distancing and scientific evidence on mask wearing
- Ventilation and ventilation monitoring (CO_2 monitors) and air cleaning technologies (HEPA, UVC)
- Benefits of improved Indoor Air Quality (IAQ)
- International school comparisons - including technology used in other countries to reduce the risk of COVID-19
- infection
- Health & Safety Executive mitigation measures to reduce the risk for staff & children.

Everything in our pack is referenced by hyperlink or in the appendix for your convenience

LETTER TO HEADTEACHERS FROM OUR FOUNDERS



LETTER FROM A TEACHER WITH LONG COVID



WHAT IS LONG COVID (Post COVID-19 Condition)

"Post COVID-19 condition occurs in individuals with a history of probable or confirmed SARS-CoV-2 infection, usually 3 months from the onset of COVID-19 with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis. Common symptoms include fatigue, shortness of breath, cognitive dysfunction but also others (see Table 3 and Annex 2) which generally have an impact on everyday functioning. Symptoms may be new-onset, following initial recovery from an acute COVI-19 episode, or persist from the initial illness. Symptoms may also fluctuate or relapse over time. A separate definition may be applicable for children" WHO October 2021

Learn more - What is Long Covid

Click on the images below for leaflets and resources to aid your understanding of Long Covid

CDC

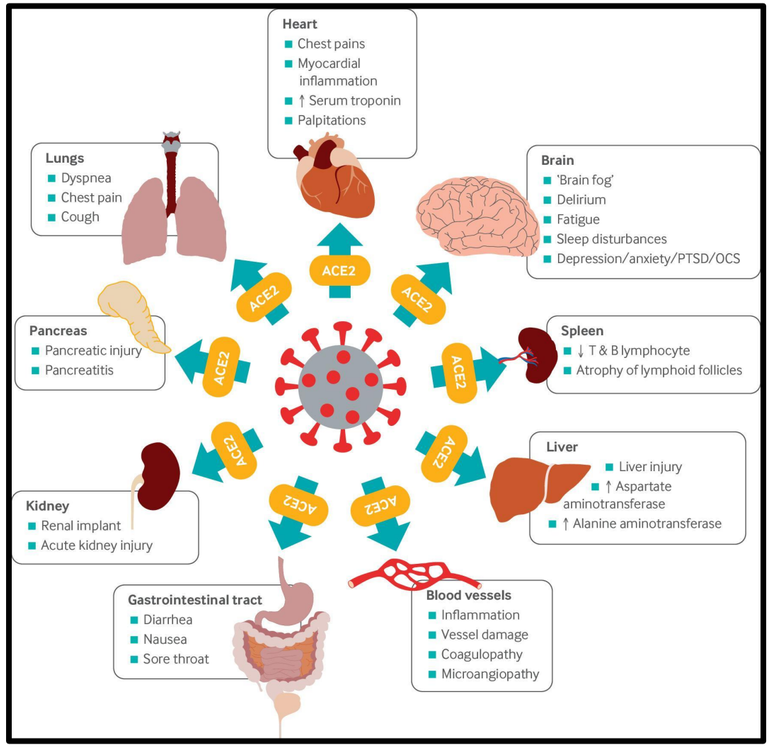
LONG COVID SUPPORT

NHS

LONG COVID PHYSIO

LONG COVID EUROPE

WHAT IS LONG COVID



We know that the virus can cause multi-organ complications of covid-19 and Long Covid.

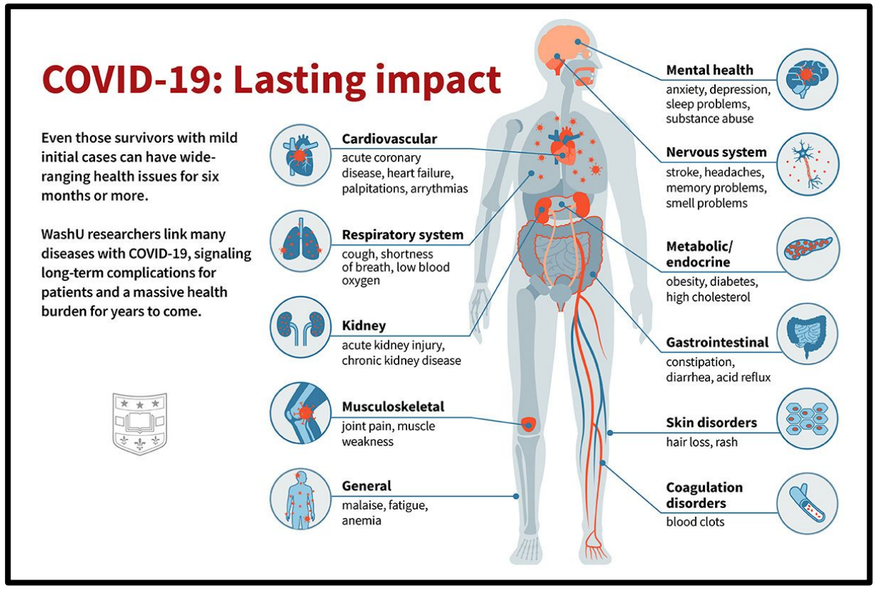
The SARS-CoV-2 virus gains entry into the cells of multiple organs via the ACE2 receptor.

Once these cells have been invaded, the virus can cause a multitude of damage ultimately leading to numerous persistent symptoms

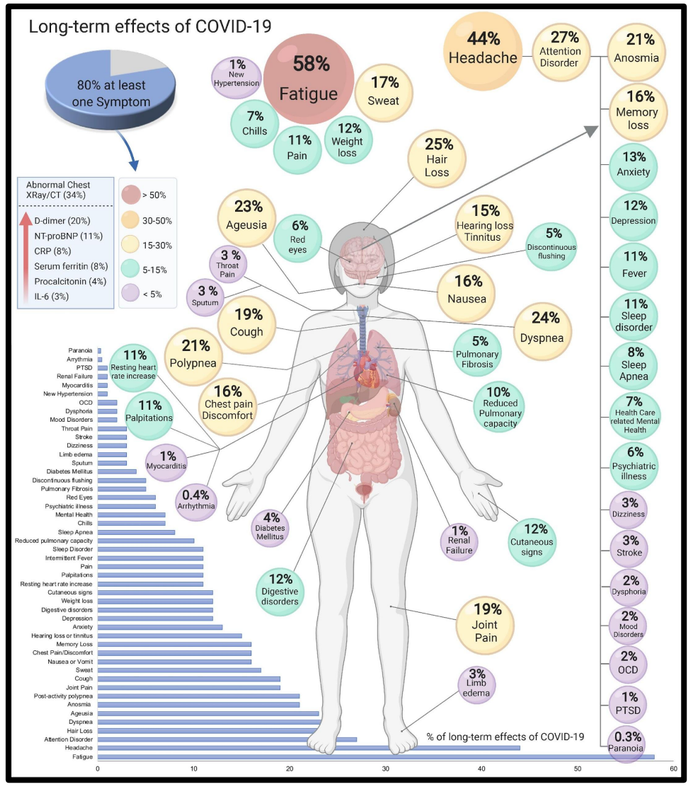
[Long covid—mechanisms, risk factors, and management | The BMJ]

Long Covid "has a wide range of symptoms, but the most common are exhaustion, breathlessness, muscle aches, cognitive dysfunction, including poor memory and difficulty concentrating, headache, palpitations, dizziness and chest tightness or heaviness. The nature of the symptoms is mostly relapsing, resulting in significant dysfunction and limitations in a relatively large proportion of sufferers.

[The Teachings of Long Covid by Nisreen Alwan.]



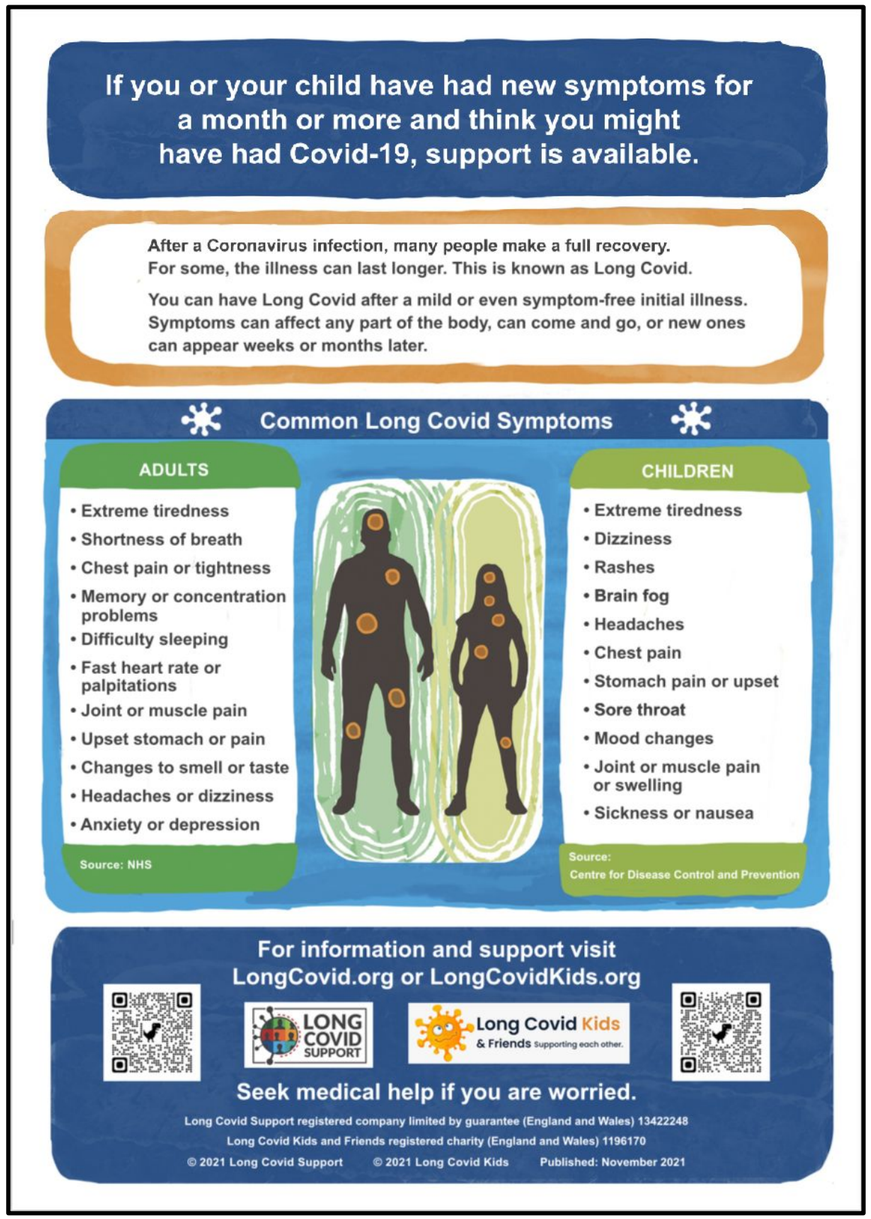
[Washington University School of Medicine in St. Louis (wustl.edu)]



More than 50 long-term effects of COVID-19: a systematic review and meta-analysis.

https://bit.ly/37NyzmE

POSTER - LONG COVID SYMPTOMS IN CHILDREN



Share our leaflet to help others access support.

Long Covid can be difficult to diagnose, and some people might not realise that their symptoms could be linked to a previous COVID-19 infection. Skilled subjective and objective assessment is therefore required alongside evidence based clinical reasoning. This is why:

- There can be more than 200 symptoms
- Symptoms can affect anywhere in the body
- Symptoms can come and go, and new ones can appear weeks or months later. They can also vary in intensity.
- People may not be aware that they had COVID-19: some don't have symptoms at the time of infection, and test results can be unreliable.
- Children may have a period of apparent recovery between COVID-19 infection and the start of Long Covid symptoms.
- The symptoms of Long Covid may present in clusters or constellations. They can also present individually.
- Long Covid affects all ages of children, regardless of the initial severity, or presentation of their COVID-19 infection.
- It is not uncommon within the LCK support group to have gaps of up to 6 months between symptoms, but more often gaps are less than 1 month.
- For most people recovery is not linear. Download the poster.

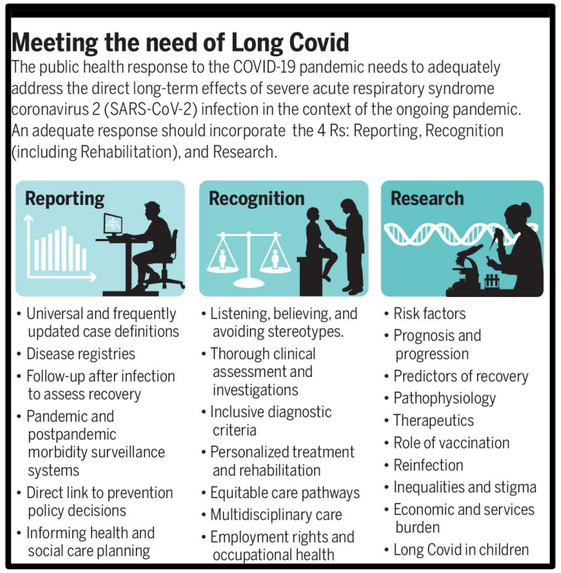
THE STATISTICS - LONG COVID IN CHILDREN

See website for latest graphs and statistics

How Common Is Long Covid?

To answer this question is challenging. It depends how you measure it!

- Varied diagnostic criteria and different ways of counting Long Covid
- Different lengths of follow-up periods
- Some surveys are based on reports of symptoms whilst others are based on investigations e.g. x-rays/scans
- Findings are likely to be conservative due to barriers in testing
- Control groups are notoriously difficult to construct.
- Read more about challenges with control groups in a blog by Long Covid Kids Champion Dr Nisreen Alwan
- Read ONS article "How Common Is Long Covid? That Depends On How You Measure It"



Latest Office For National Statistics Figures

A random household survey with a control group

117 000
children are currently suffering from persistent symptoms since Covid infection
Increase of 40 000 since October 2021

20 000
children are suffering persistent symptoms 12 months following infection

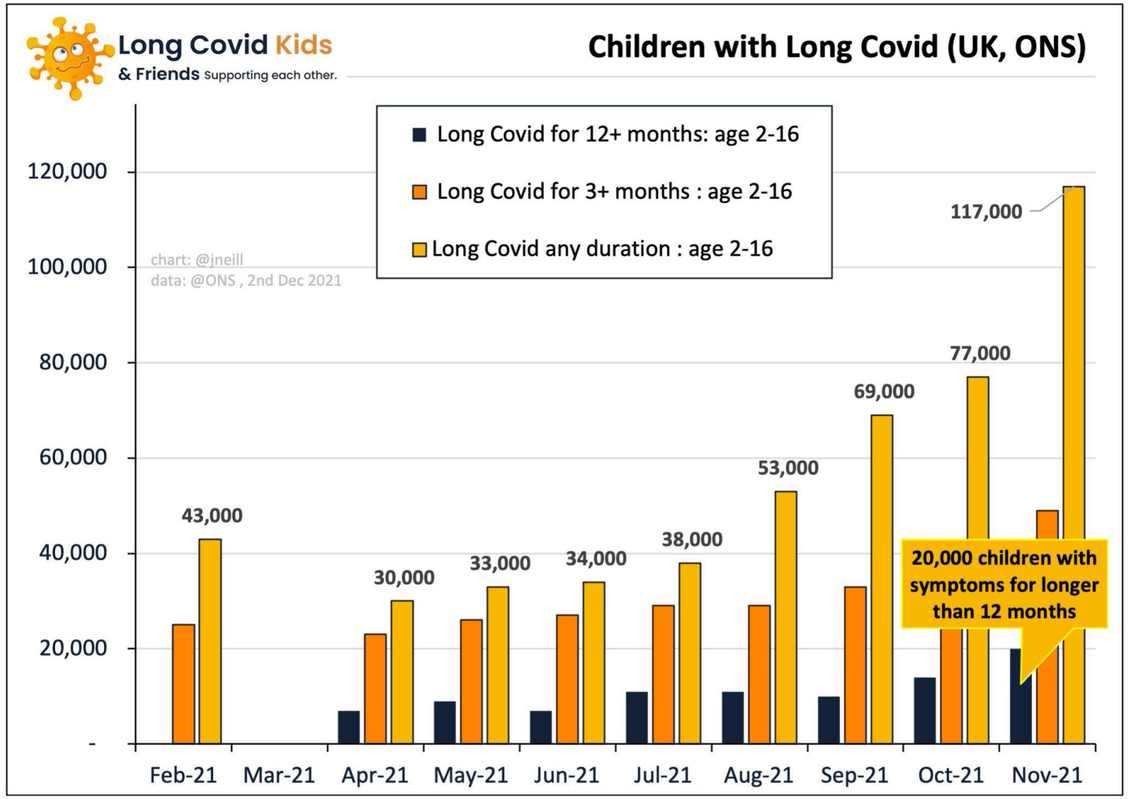
CLOCK STUDY

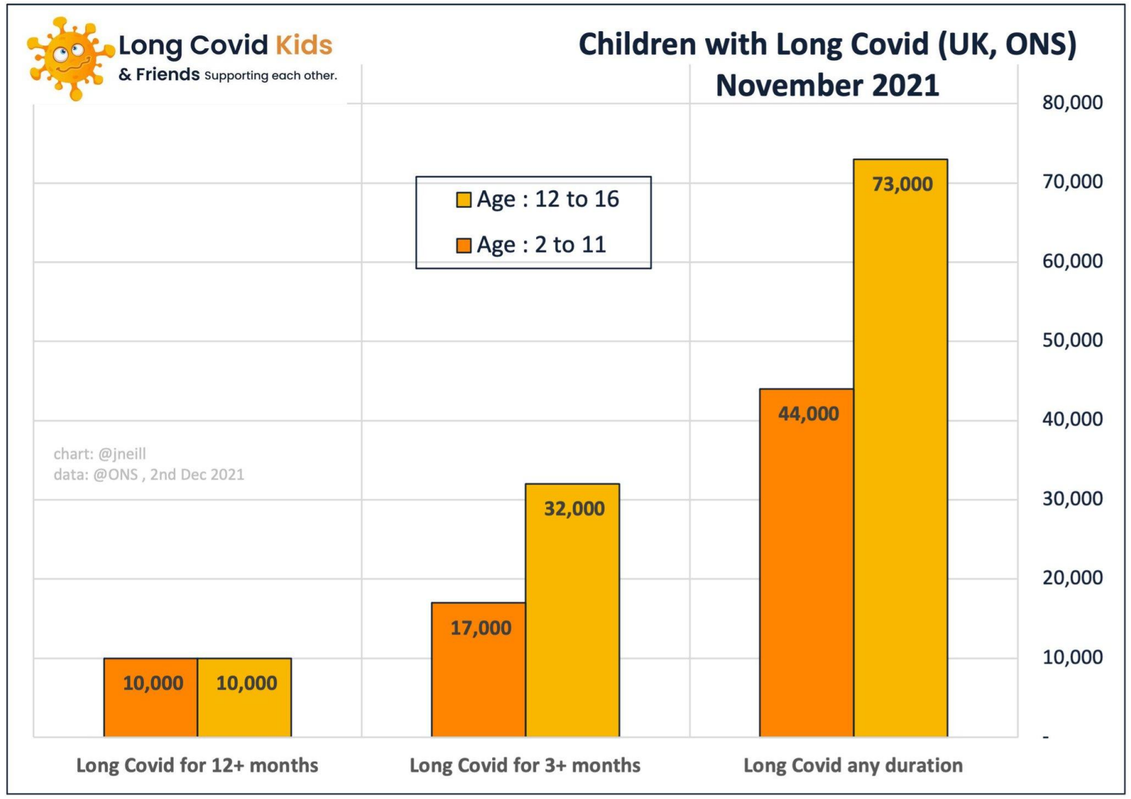
The CLOCK STUDY reports

1 in 7 children who have
COVID-19 will get
Long Covid

~14% of child cases
will get
Long Covid.

THE STATISTICS - LONG COVID IN CHILDREN





"Long Covid will hit young people worse as rules are relaxed. I think we will get a significant amount more Long Covid particularly in the younger ages"

CMO Chris Whitty. June 2021

Regular statistical analysis by James Neill.

BARRIERS & WHY THE DATA MIGHT NOT BY ACCURATE

Barriers to Testing. Assumed prevalence therefore potentially higher.

- Lack of education. There has never been a government awareness campaign to help parents and carers understand or identify COVID-19 in children. Many cases therefore unidentified, untested, and unrecorded.
- Children do not always present with the common symptoms which qualify them to be tested for COVID-19.
- The NHS website does not list all COVID-19 symptoms.
- Children are commonly asymptomatic or atypical and therefore unrecorded in government data.
- Young children are difficult to test - swab size, discomfort, fear.
- Families report only testing one of their children, or swabbing one area, to reduce ‘stress’.

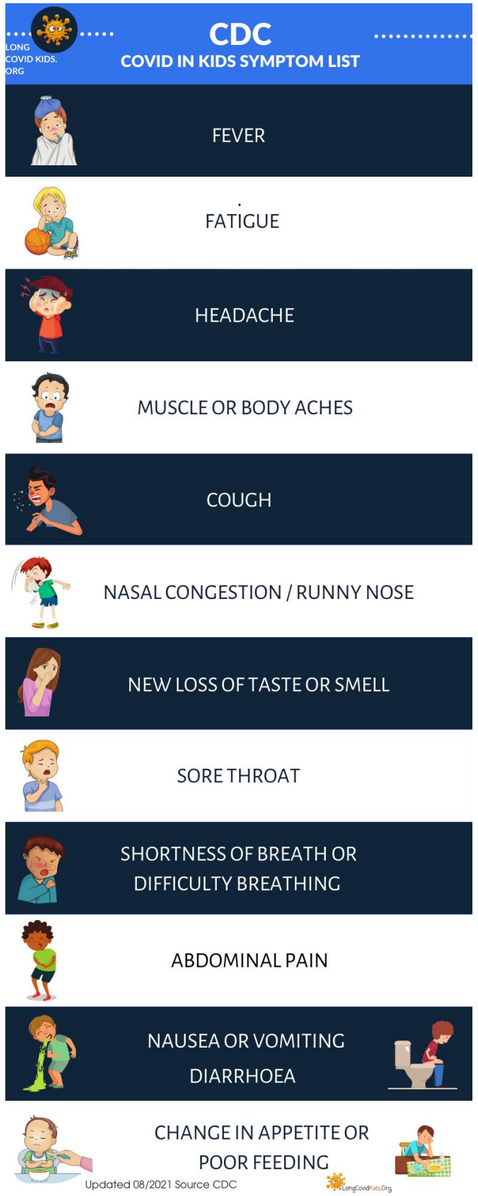
Barriers to Research. Refer to article by [Dr Nisreen Alwan]

- Funding
- Interest in adults with LC vs children with LC
- We do not have an accurate way to establish past infection
- PCR or antibody tests are not enough to establish case status - PCR misses some true infections and timing of test is important
- Antibodies wane
- There is evidence that having LC is in itself associated with weak antibody response to infection.
- Ethical considerations

During the early part of 2020 up to and including September and October, children nor teachers were prioritised for testing.
Thousands of cases were unrecorded then, and continue to be unrecorded now due to lack of public awareness and the barriers to testing.

What are the barriers to getting a COVID-19 test for a child?

COVID SYMPTOMS IN CHILDREN



- 18th August 2020 Zoe COVID researchers announced that the Department of Health had given them a £2 million grant
- 7th September 2020 The Guardian reported that Zoe COVID app stated COVID-19 presents differently in children
- 30th December 2020 The CDC updated it's paediatric symptom list

LCK continue to call for the UK Government & the NHS to update their COVID symptom lists.

Can you help? Here is how.

SPOT THE DIFFERENCE

Families and caregivers must be educated to;

- Recognise the symptoms of COVID-19 in children to ensure early detection, prompt isolation and to reduce transmission in schools
- Know when and how to access a test
- Understand that testing provides data that underpins decision making in Education and Health Care
- Understand that testing can avoid misdiagnosis. Families with untested children report that they are unable to access services and are not believed

The pandemic is GLOBAL. We can look to the USA for clearer public messaging.

WHY ARE SYMPTOMS MISSING?

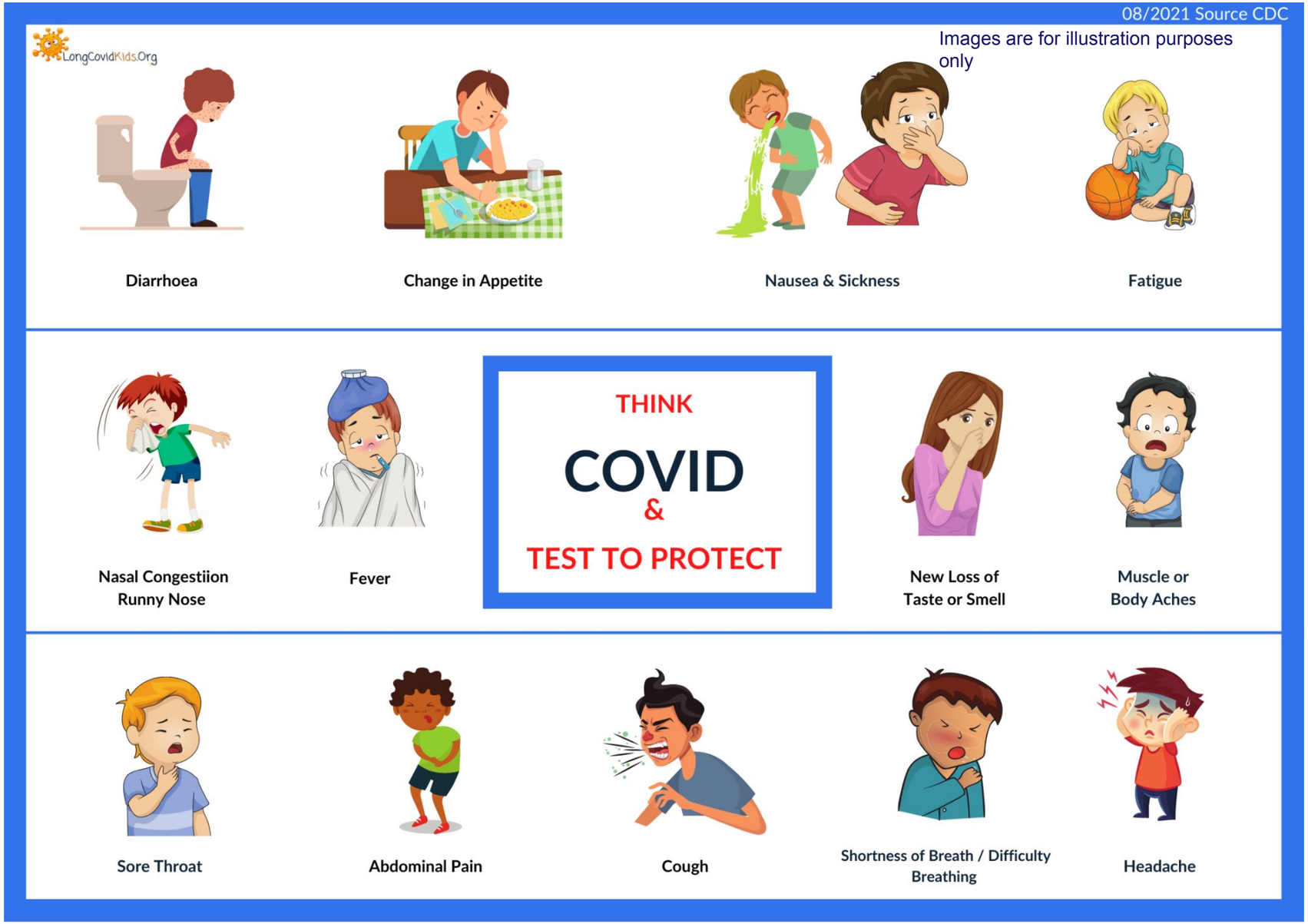
WHERE ARE THE OTHER SYMPTOMS?

WILL CHILD COVID CASES BE MISSED?

HOW CAN FAMILIES AND CAREGIVERS IDENTIFY COVID IN CHILDREN AND REDUCE TRANSMISSION WITHOUT CLEAR INFORMATION?

Updated 08/2021 Source NHS

POSTER - COVID SYMPTOMS IN CHILDREN



Infection in children can be;

- Asymptomatic.
- Atypical
- Symptomatic
- Mild
- Severe

Families often report symptoms disappear after 10-12 days with more concerning symptoms appearing 2-6 weeks after infection.

Any symptom of unwell could be COVID-19, always book a test.

Other Resources

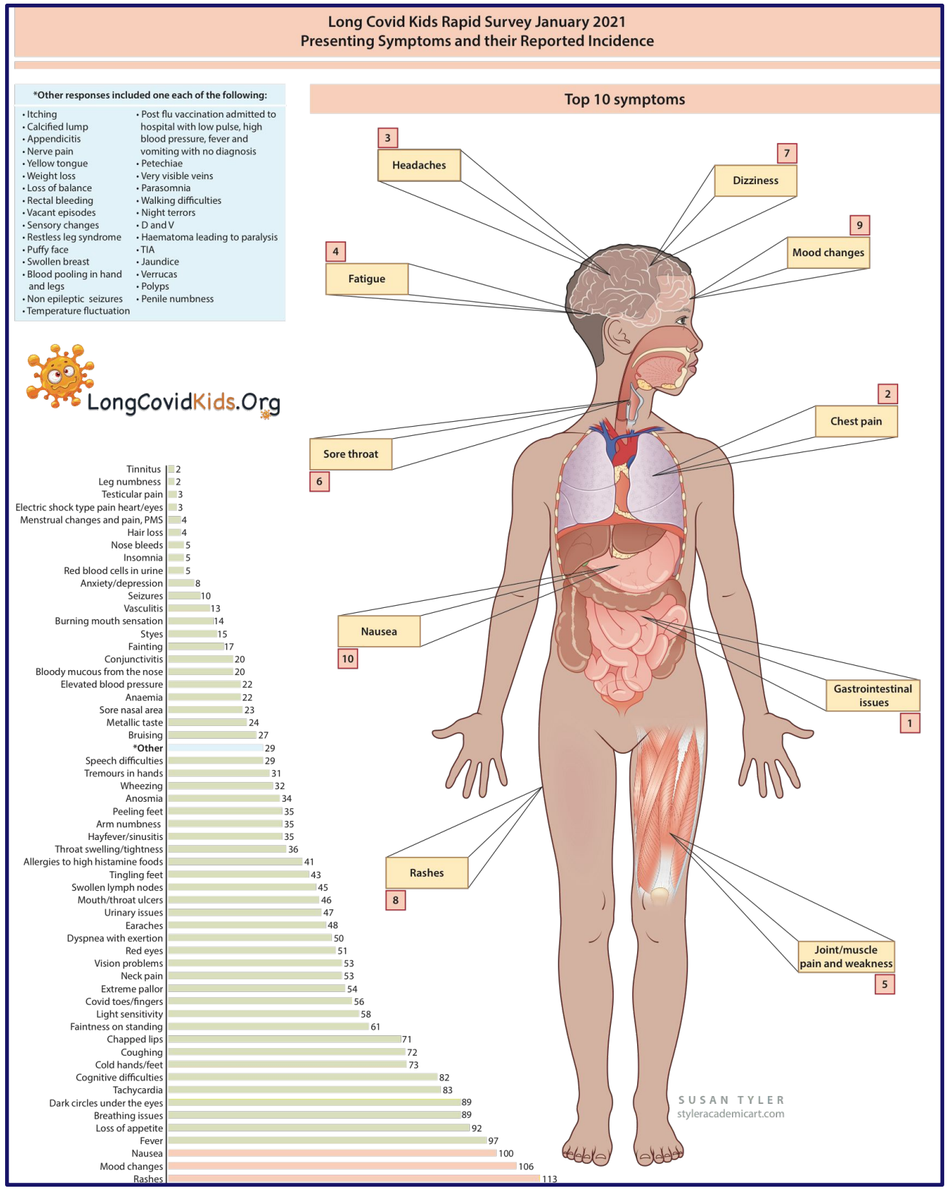
CDC Symptoms List
Manchester City Council
Long Covid Kids
Spot Covid Video

COVID-19 incubation period 1-14 days (WHO)
Quarantine period 10 days (WHO)

In vaccinated people immunity wanes after a few months.

We don't know how long natural immunity lasts yet.
Anywhere from 4 months to 17 months

INSIGHTS FROM CHILDREN'S LIVED INFECTION EXPERIENCES
LONG COVID KIDS RAPID SURVEYS



Research into Long Covid is progressing but full understanding may take years.

Visit our library of paediatric research from around the world on the research page of our website.

From early on in the pandemic we had the unique opportunity to observe the paediatric version of Long Covid. We conducted our first rapid survey in January and a second in February.

Presenting Symptoms & their Reported Incidence

Top Ten Symptoms

1 **Gastrointestinal Issues**
2 **Chest Pain**
3 **Headaches**
4 **Fatigue**
5 **Joint/muscles Pain & Weakness**
6 **Sore Throat**
7 **Dizziness**
8 **Rashes**
9 **Mood Changes**
10 **Nausea**

Anecdotal evidence.

We do not have one recovery story to share. No child in our group has yet returned to their previous state of health. Some children report that they are better and then relapse again. So far the longest period of wellness before relapse has been 6 months.

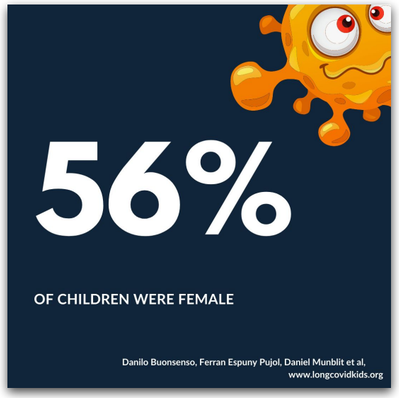
From our full data set: Mean age 10.6 years (SD 4.13) Age range <1-18 years

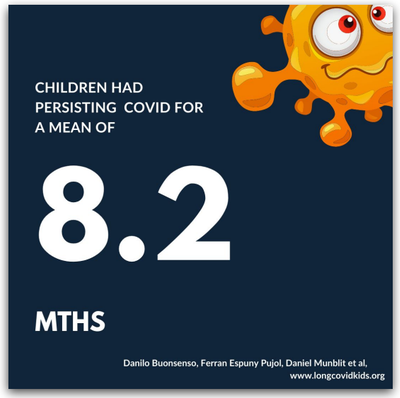
Only 7% of the children and young people were admitted to hospital during their acute COVID-19 illness.

70% of the children and young people had no previous underlying medical condition.

LONG COVID CLINICAL REVIEW BASED ON OUR OWN RAPID SURVEY TWO

Our study provides further evidence on Long COVID in children. It is based on a survey of 510 children. Symptoms such as fatigue, headache, muscle and joint pain, rashes, heart palpitations, and mental health issues like lack of concentration and short memory problems, were particularly frequent. These confirm previous observations, suggesting that they may characterise the condition. A better comprehension of Long COVID in children is urgently needed.





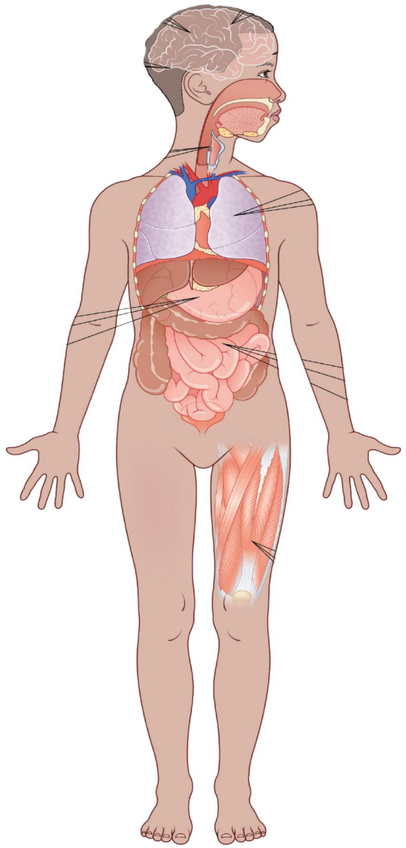
Most Frequent Symptoms — Rapid Survey Two (510 children)

79% Headache

80% Fatigue

54% Post Exertional malaise

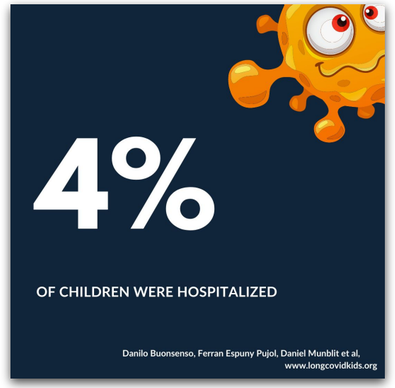
61% Muscle and joint pain

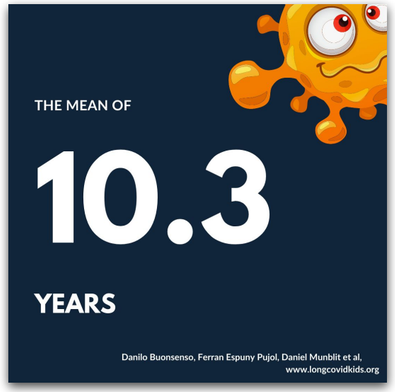


87% Tiredness and weakness

52% Rash

76% Abdominal pain



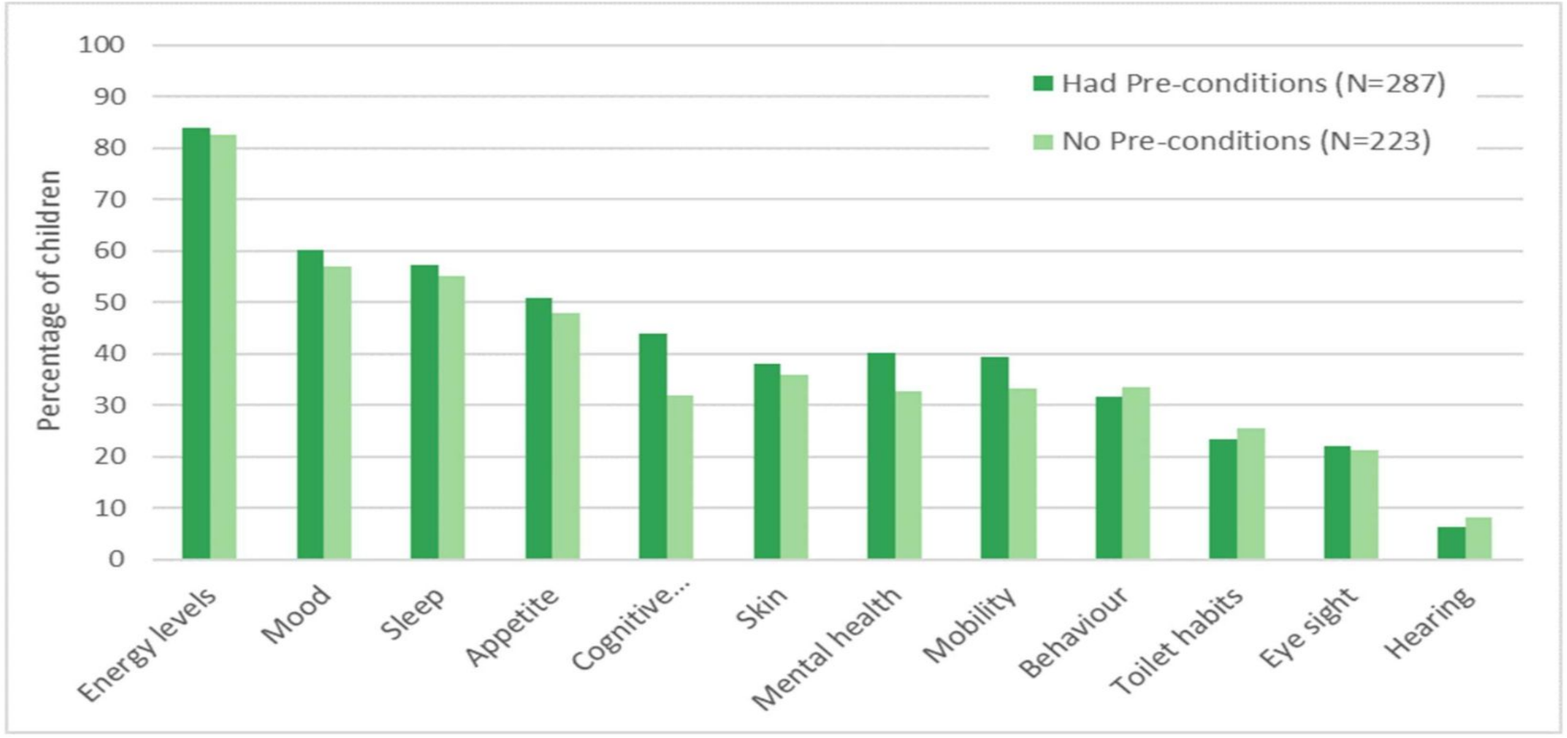


49.4% had periods of apparent recovery. Symptoms have then returned.

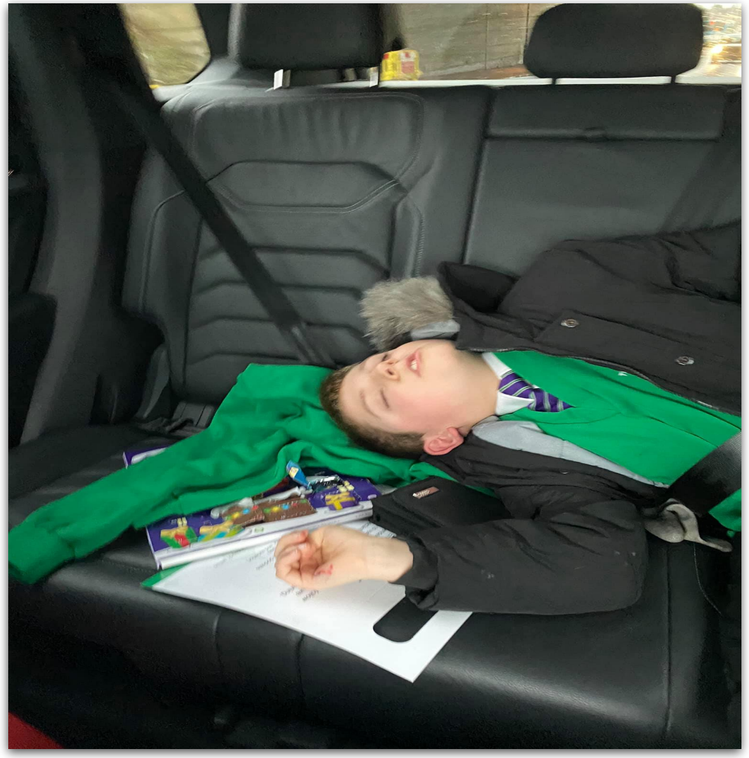
30.2% enjoy occasional activity but usually have an increase in symptoms afterwards.

LONG COVID - RAPID SURVEY TWO

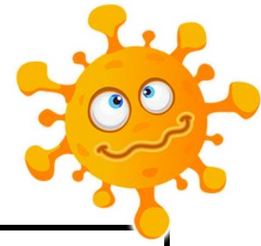
- Most children were physically active before their COVID-19 infection.
- During the first six weeks after infection - 51.4% of children did participate in some level of activity and 42.5% did not.
- Families reported that their children's activity levels were worse than before infection, only 10% of the children have returned to previous levels of activity.
- 21.2% are currently unable to enjoy any activity.
- 30.2% enjoy occasional activity but usually have an increase of symptoms afterwards.



What does this mean for children and young people?
What will the long term effects be?
Will Special Educational Needs provision be provided for these children and young people?
How will teaching be impacted by Long Covid Kids?
Will blended learning be provided?
Will children & young people living with Long Covid achieve their full potential?

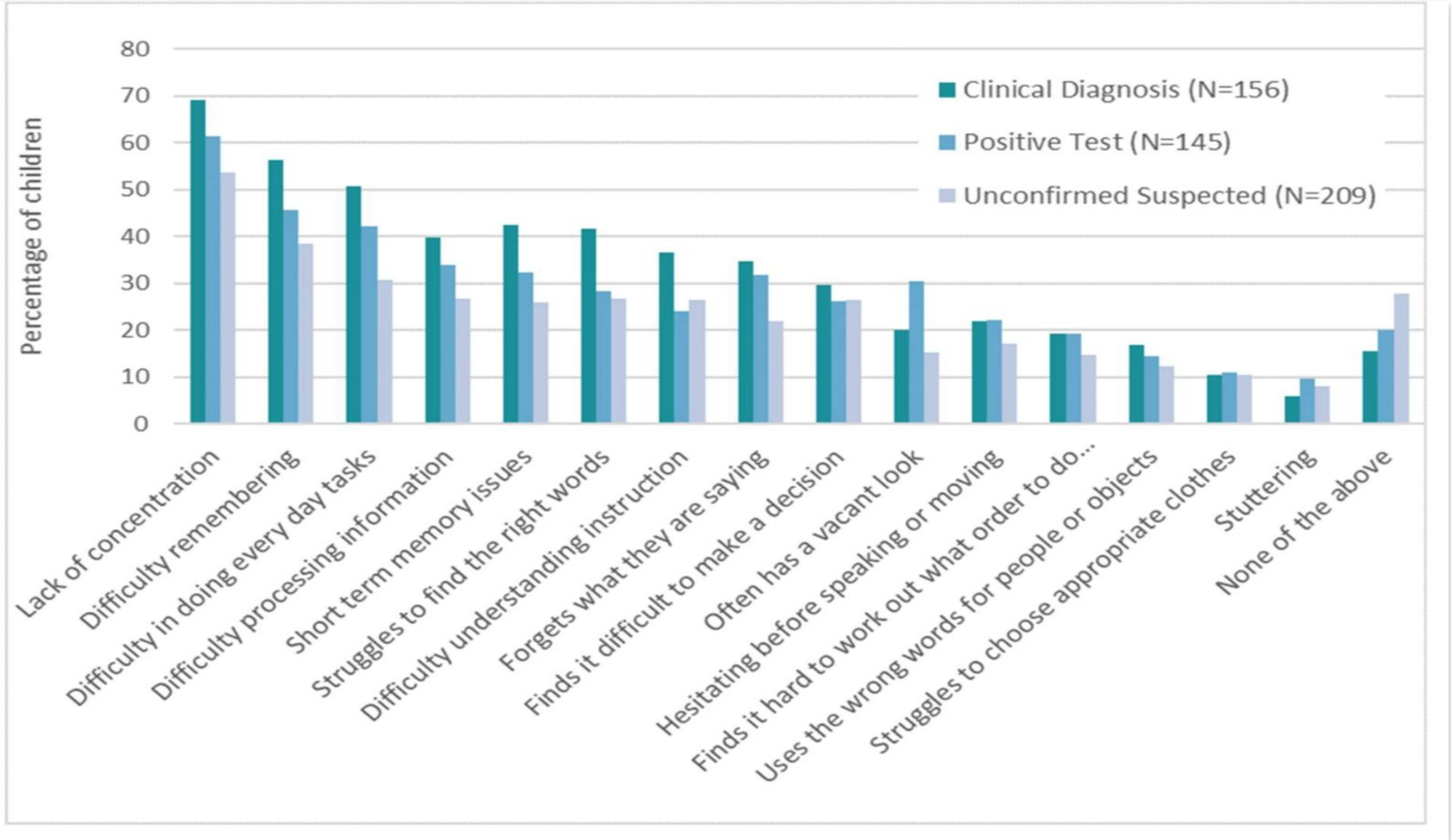


LONG COVID EFFECTS ON CHILDREN BASED ON RAPID SURVEY TWO



Parents reported a significant prevalence of neuropsychiatric symptoms among their children with persisting symptoms:

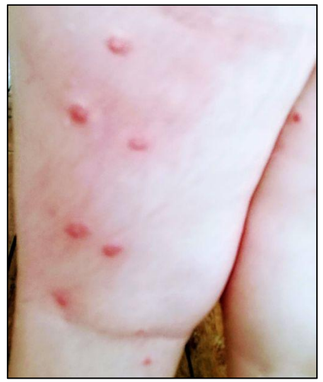
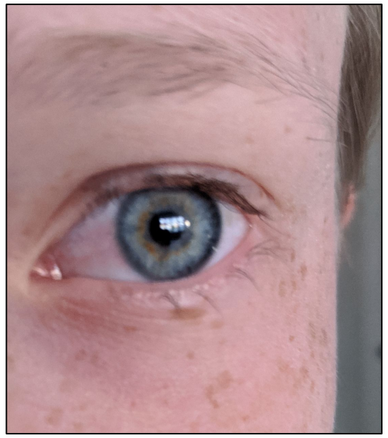
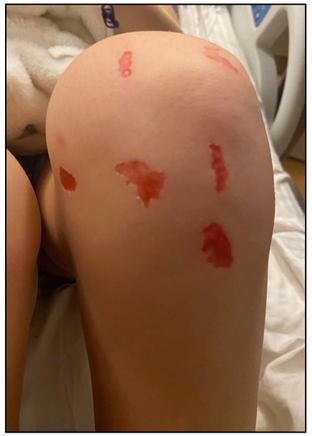
- 60.6% reported lack of concentration
- 45.9% difficulty in remembering information
- 40% difficulty in doing everyday tasks
- 32.7% difficulty processing information
- 32.7% short-term memory issues.

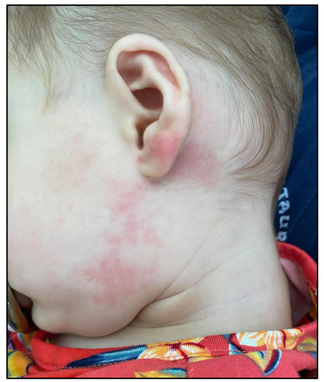
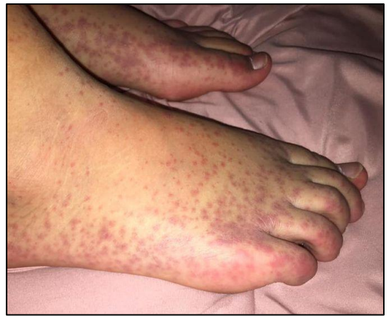
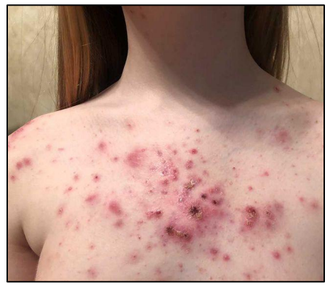


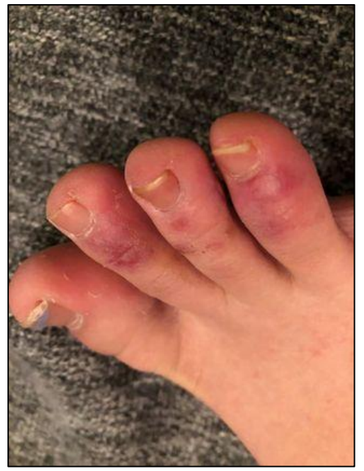
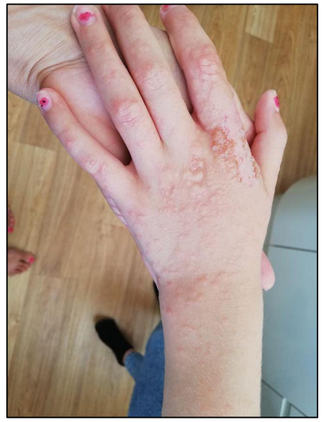
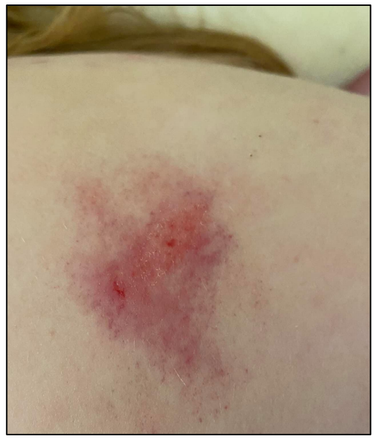
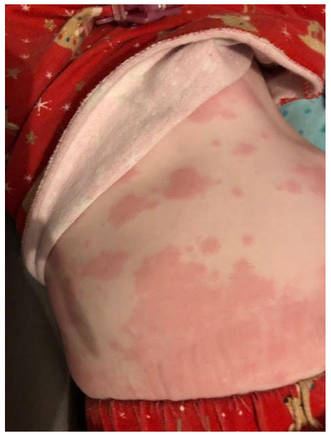
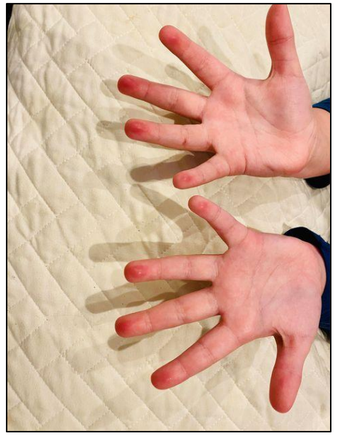
- 54.7% children have had at least three mental health issues
- 8.8% children have had two issues
- 10.6% children have had one issue
- 25.9% children have had no issues
- 28.7% of those with no pre-COVID conditions haven't had any mental health/cognitive issues since their COVID infection.

- **What does this mean for children and young people?**
- **What will the long term effects be?**
- **Will Special Educational Needs provision be provided for these children and young people?**
- **How will teaching be impacted by Long Covid Kids?**
- **Will blended learning be provided?**
- **Will children & young people living with Long Covid achieve their full potential?**

HAVE YOU SEEN THESE SYMPTOMS. THINK LONG COVID? (NON-EXHAUSTIVE LIST)

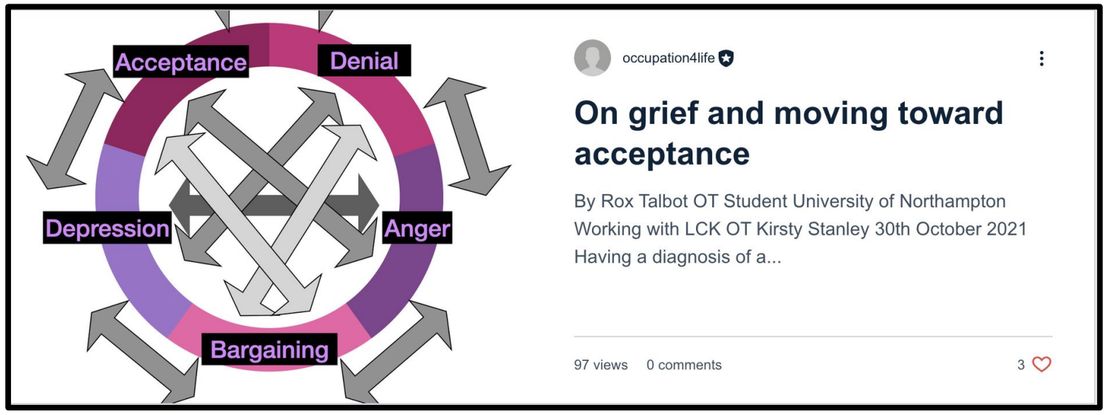





LONG COVID KIDS BLOGS

[Read more here]

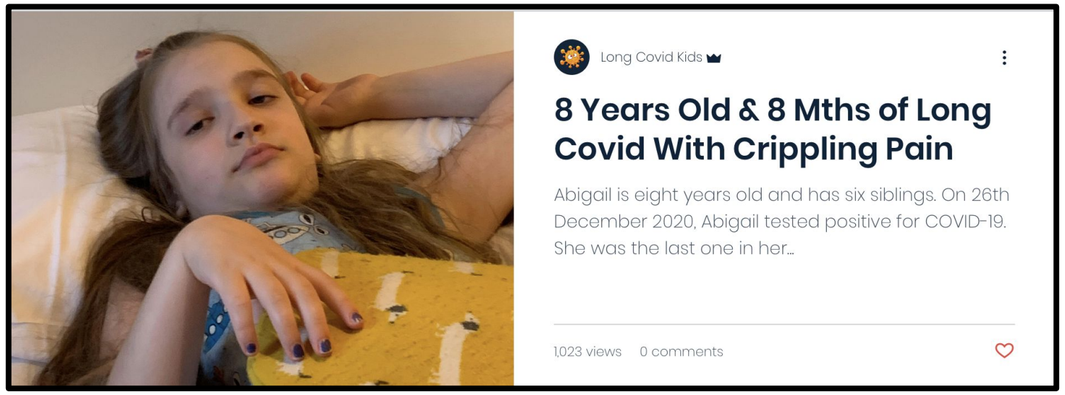


occupation4life

On grief and moving toward acceptance

By Rox Talbot OT Student University of Northampton Working with LCK OT Kirsty Stanley 30th October 2021 Having a diagnosis of a...

97 views 0 comments 3



Long Covid Kids

8 Years Old & 8 Mths of Long Covid With Crippling Pain

Abigail is eight years old and has six siblings. On 26th December 2020, Abigail tested positive for COVID-19. She was the last one in her...

1,023 views 0 comments

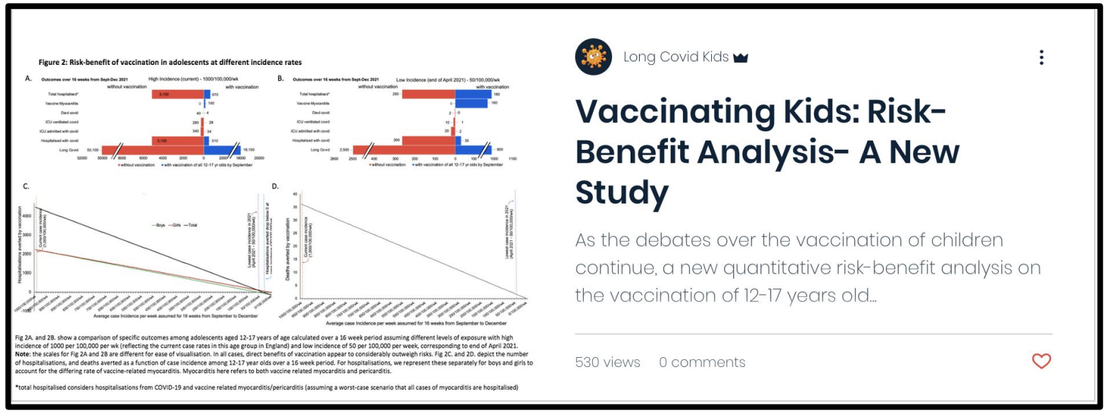


Fig 2A. and 2B. show a comparison of specific outcomes among adolescents aged 12-17 years of age calculated over a 16 week period assuming different levels of exposure with high incidence of 1000 per 100,000 per wk (reflecting the current case rates in this age group in England) and low incidence of 50 per 100,000 per week, corresponding to end of April 2021. **Note:** the scales for Fig 2A and 2B are different for ease of visualisation. In all cases, direct benefits of vaccination appear to considerably outweigh risks. Fig 2C. and 2D. depict the number of hospitalisations, and deaths averted as a function of case incidence among 12-17 year olds over a 16 week period. For hospitalisations, we represent these separately for boys and girls to account for the differing rate of vaccine-related myocarditis. Myocarditis here refers to both vaccine related myocarditis and pericarditis.

*total hospitalised considers hospitalisations from COVID-19 and vaccine related myocarditis/pericarditis (assuming a worst-case scenario that all cases of myocarditis are hospitalised)

Long Covid Kids

Vaccinating Kids: Risk-Benefit Analysis- A New Study

As the debates over the vaccination of children continue, a new quantitative risk-benefit analysis on the vaccination of 12-17 years old...

530 views 0 comments

helenlongcovidkids

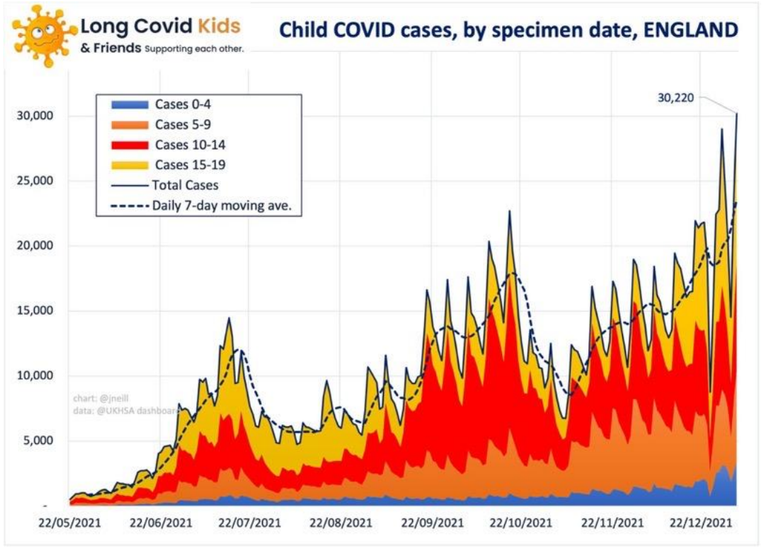
A Silent Tragedy | 108 children have died from Covid

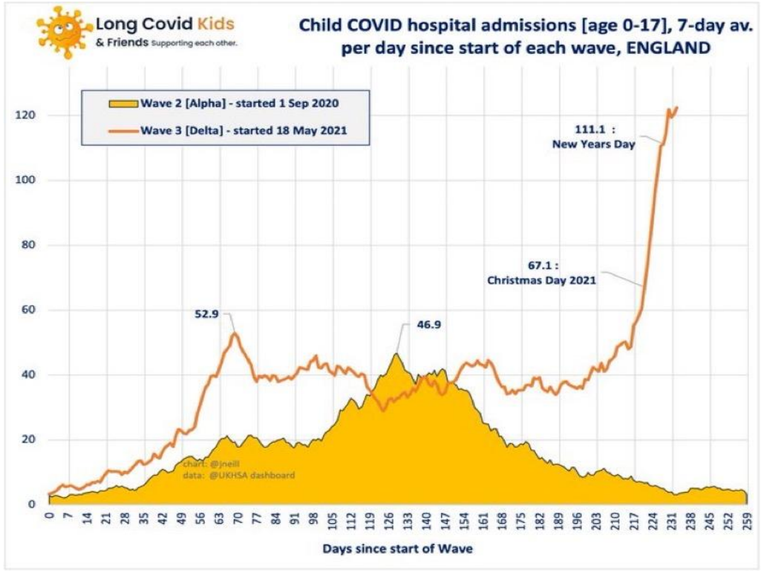
Since the beginning of the COVID19 pandemic, 108 British children have tragically lost their lives, and between 33,000 to 42,000 children...

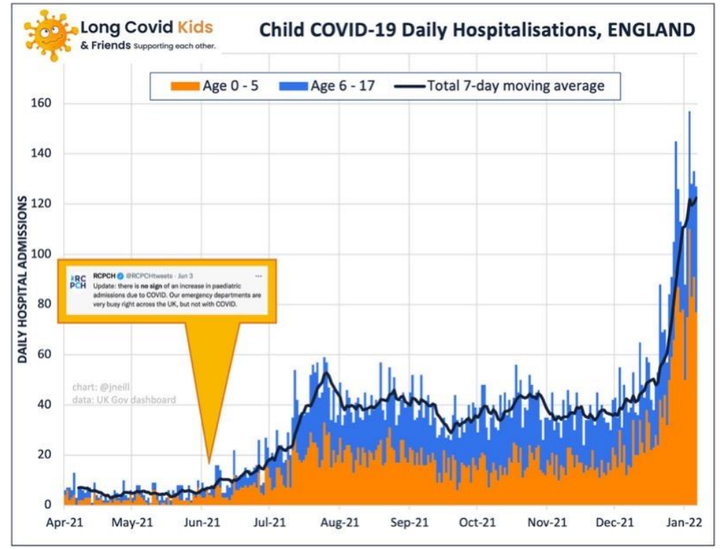
49 views 0 comments

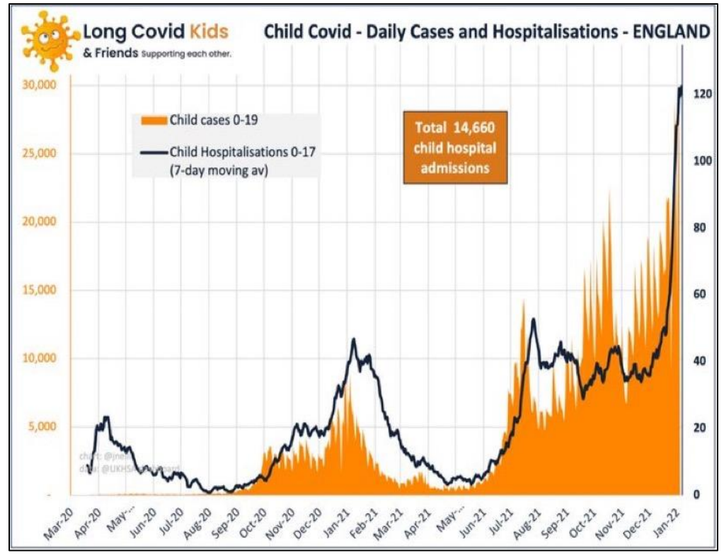
GOVERNMENT DATA. CHILDREN ONLY. ENGLAND

View child only Covid data compiled using child specific ONS and Government data
[in our weekly blog]

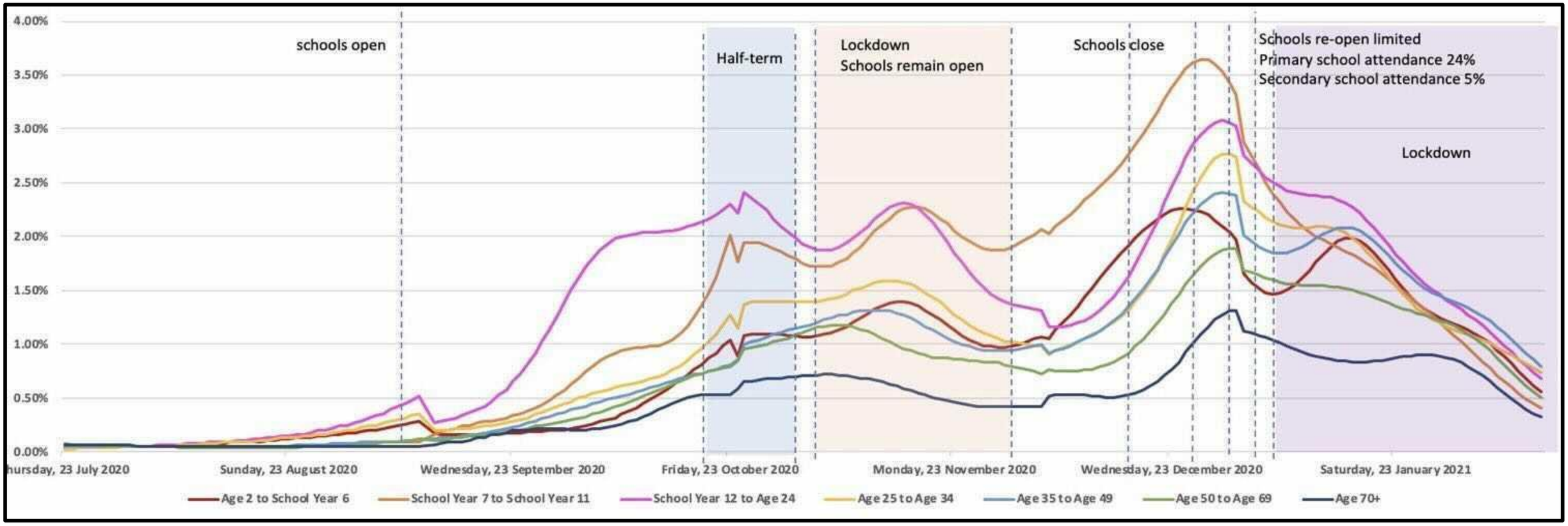








GOVERNMENT DATA: ENGLAND. CHILDREN AND EDUCATIONAL SETTINGS

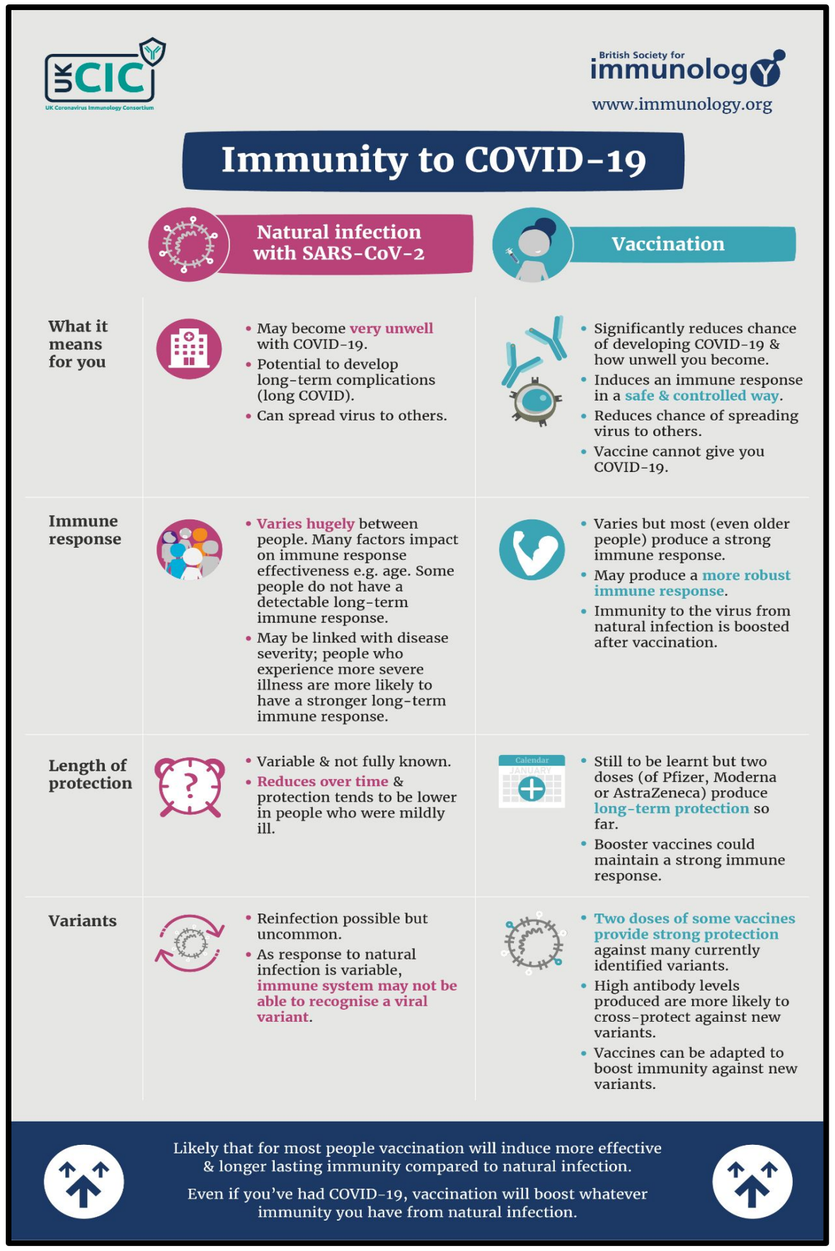


This chart was put together by Dr Deepti Gurdasani and is based on ONS Covid Prevalence Survey data. It shows how closely infections track attendance levels in educational settings. The data necessary to update the chart has been requested from ONS, but is not yet available.

The ONS data states the teaching profession has the second highest at risk from long COVID

114 000 teachers suffering from COVID symptoms beyond 12 weeks

VACCINATIONS & IMMUNITY



Children & Vaccines

- In the USA children 5 years + are offered the vaccine (October 2021)
- In Cuba children from 2 years + are offered the vaccine (September 2021)
- In the UK children from 12 years are offered the vaccine (October 2021)
- Which countries are vaccinating children and why? Click image to view.

When did children in the UK get offered a COVID-19 vaccine?

16-17 August 2021

12-15 October 2021

Primary age not eligible

despite favourable modelling

Researchers question why watchdog passed decision on vaccinating 12-17s to UK's chief medical officers

Coronavirus - latest updates

See all our coronavirus coverage

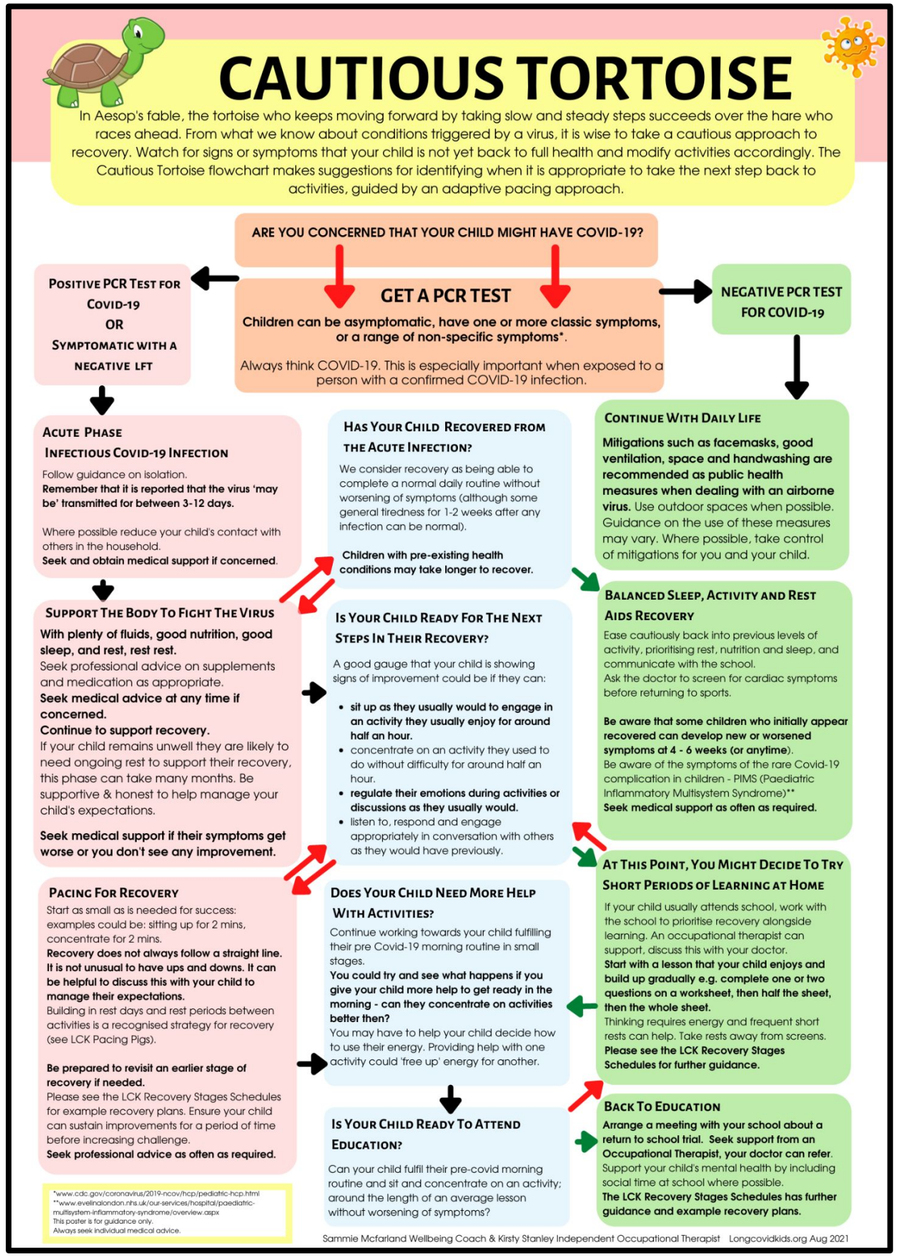
helenlongcovidkids

LONG COVID KIDS RESPONSE TO THE JCVI MINUTES ON CHILD…

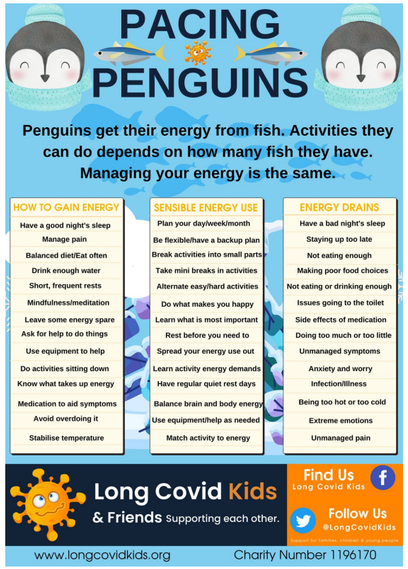
By Helen Goss LCK Representative for Scotland After months of silence, on Friday 29th October the Joint Committee on Vaccination and...

69 views 0 comments 1

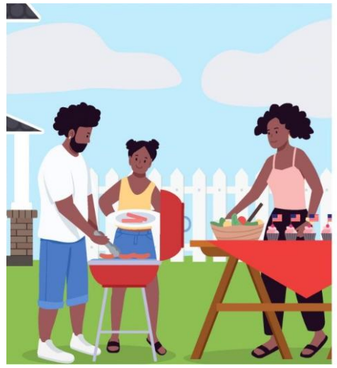
PARENTS PAGE

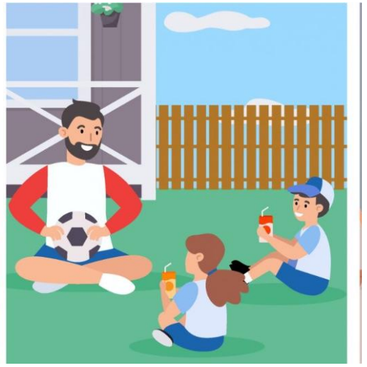


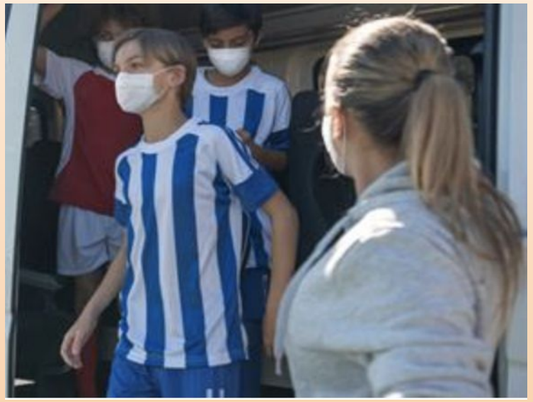
[JOIN OUR SUPPORT GROUP]



The CDC has numerous resources for families that you may find helpful.
We are very proud to be listed as one of them







We welcome recommendations from the The American Academy of Paediatrics.

Returning to physical activity after COVID-19 infection

If your child has a positive COVID-19 test, notify their pediatrician. The doctor can advise how long they need to wait before returning to exercise or sports. This will be based on how severe their COVID-19 symptoms are, and whether they develop signs of multisystem inflammatory syndrome in children (MIS-C), myocarditis, or other post-COVID conditions:

- **Children and teens with no symptoms or mild symptoms of COVID-19, and no symptoms of MIS-C** need to be screened for heart symptoms. The doctor will ask about any chest pain, shortness of breath, fatigue, irregular heartbeat, or fainting , for example. A child with a positive heart screening will need an EKG and referral to a pediatric cardiologist for possible additional cardiac tests.
- **Those with moderate symptoms and no signs of MIS-C** should not exercise until their symptoms are gone and they are seen by their doctor for a cardiac screening, complete physical exam and EKG. Moderate symptoms are considered to be 4 or more days of fever over 100.4 F, a week or more of muscle aches, chills or fatigue, or a non-ICU hospital stay. Next steps depend on cardiac screening or EKG findings.
- **Children who were very sick from COVID-19 or diagnosed with MIS-C** must be treated as though they have an inflamed heart muscle (myocarditis). They should not exercise or compete for 3 to 6 months. A pediatric cardiologist should examine these children before they are allowed to return to exercise or competition. The doctor will recommend a schedule of gradually increasing physical activity based on the child's age and severity of symptoms.

LCK have flagged concerns about symptoms consistent with myocarditis since our group began.

TEACHERS PAGE

Tips for teachers

Covid infection can affect children and young people differently. It can take a long time to recover enough to think about going back to school. Some children will inevitably try to return to education too early to see friends as well as keep up with their studies. Children with, or without a diagnosis of Long Covid may need reassurance that it is okay to prioritise their recovery. It is likely that some will need additional support.

Warning Signs that a Child/ Young Person Is Not Ready To Return To school

- **Reports that they are spending all the time they are not at school sleeping/resting.**
- Unusually heightened emotions at school or home - easily irritable, angry or quick to cry.
- **Looking exhausted - yawning, sleepy eyes.**
- Frequently reports feeling unwell or troublesome symptoms - dizziness, headaches, nausea.
- **Unable to concentrate.**
- Complains of non-specific pain.

School Trial

Children and young people living with Long Covid will most likely need a phased return to school to avoid a worsening of symptoms
Can they be driven to school rather than walk?
Do they need support from an 'access' taxi?
Who will be the key member of staff offering them support on the day?
Will they need special equipment?

After a trial, ask the family to monitor for worsening symptoms over the next few days. If this is successful think about how to build up their attendance gradually.

How Can The School Help

Ask the Special Educational Needs specialist to provide a review of the child/young person.
Put in place a risk assessment that takes account of additional needs.
Discuss a troubleshooting plan with the family. Encourage the child to be involved in the plan.
Provide a quiet room for children and young people living with Long Covid to rest. This should ideally be somewhere they can lie down (in darkness if needed).
Conserving energy for recovery is the priority. Consider equipment/adaptations that might make activities and tasks less energy draining.

As necessary, consider:

- blended learning allowing for a mix of in-person and virtual learning
- **a wheelchair to move around.**
- a backpack instead of an over one shoulder bag.
- **asking friends to carry books between classes.**
- using a laptop/tablet/audio recorder to take notes.
- **having extra support from a teaching assistant to repeat or clarify task instructions.**
- providing instructions in writing.
- **providing or encouraging noise-cancelling headphones for quiet focus activities.**
- allowing children/young people to leave their class earlier to get to the next class when the corridors are less busy.
- **avoiding a purely academic focus. To aid recovery children and young people should be encouraged to balance their studies with the social parts of the school day and to do things they enjoy when out of school.**
- being cautious with encouraging physical education. For some children and young people living with Long Covid who have Post - Exertional Malaise or cardiac symptoms, exercise is not recommended. Request a doctors letter and include it in the risk assessment.
- **planning for days when symptoms are worse, e.g. regular breaks, alternative activities**
- not pushing children and young people to participate in lessons until they are ready, e.g. allow them to volunteer answers rather than call on them unexpectedly.
- **exam or coursework adjustments, e.g. providing extra time, quiet room etc.**

Accessing school-based occupational therapy support can give more individualised tips and strategies. Some children and young people may need an EHCP to access this support.

It is possible that for some children; Long Covid will equate to a disability in terms of duration and impact on everyday life. Consider reasonable adjustments at an early stage to sustain a return to education.
This should be balanced with the child's overall health and wellbeing & leave energy for joy.
Access to home-schooling or may be appropriate and some children will require a lengthy period of recovery without considering school at all. This is obviously something that will need discussing with the health, social and educational teams alongside the parents/guardians and child themselves.

Further Information

www.Longcovidkid.org
Long Covid Kids Support Group
Recovery Stages Schedules
Long Covid Kids Pacing Pigs
Long Covid Kids Cautious Tortoise
Long Covid Physio
CDC
NHS

Sammie Mcfarland Wellbeing Coach & Kirsty Stanley Independent Occupational Therapist. Longcovidkids.org Aug 2021

We are working on a series of support documents for families with children living with Long Covid
In the coming weeks these will be added as downloads to a brand new parents page on our website.

Documents include;

Cautious Tortoise
Teachers Tips
Pacing Pigs
Understanding Long Covid Recovery

This page is under construction, and will be updated in February with brand new resources.

PAEDIATRIC INFLAMMATORY MULTISYSTEM SYNDROME

Paediatric Inflammatory Multisystem Syndrome

Also Known As Multisystem Inflammatory Syndrome In Children

Paediatric Inflammatory Multisystem Syndrome is deemed to be a rare condition thought to be triggered by COVID-19. Although it is a relatively new condition, it can be detected early and treated successfully. It is often referred to as PIMS-TS or PIMS for short.

Learn more

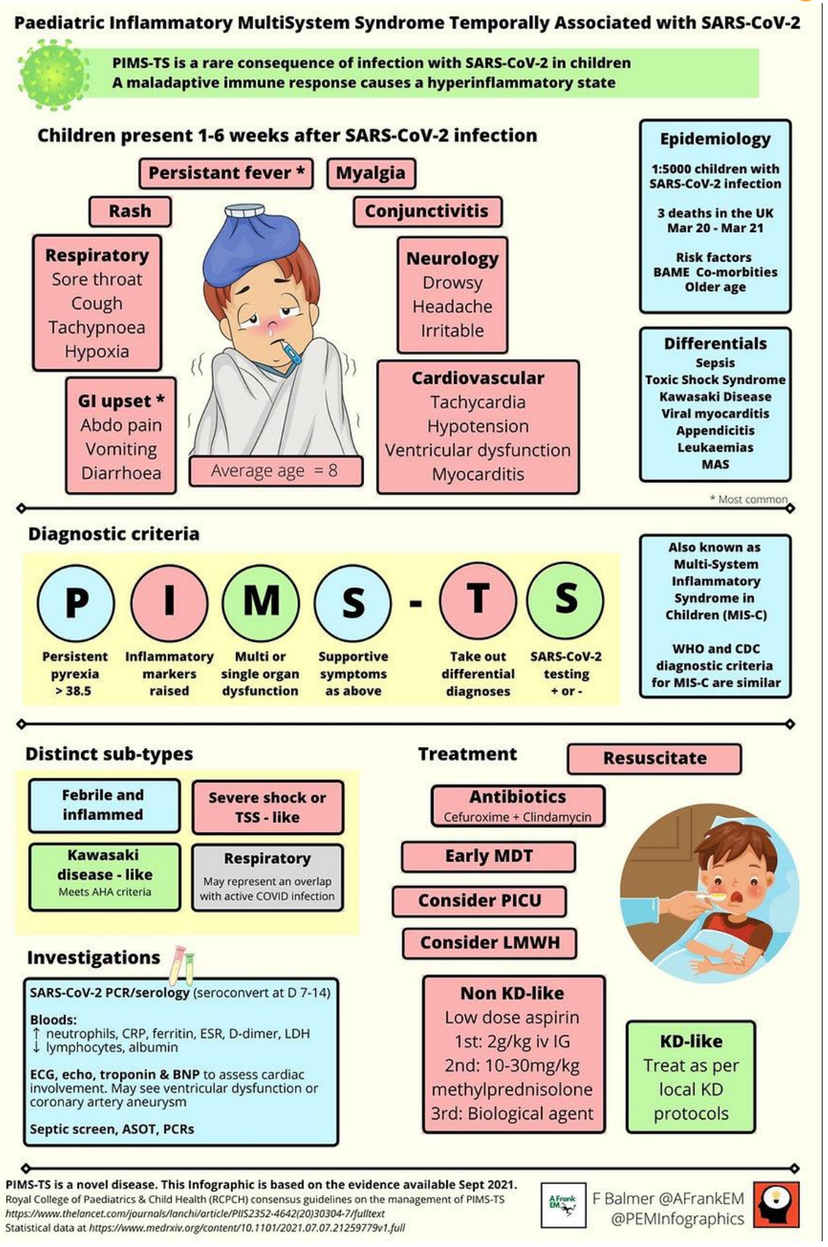
Advice for parents and carers from the Evelina Hospital. http://bit.ly/3uwAaHo

As the condition is a delayed reaction to the body trying to overcome the virus, the symptoms are different to COVID-19, and many children who experience PIMS-TS may not have previously been unwell or had COVID-19 symptoms.

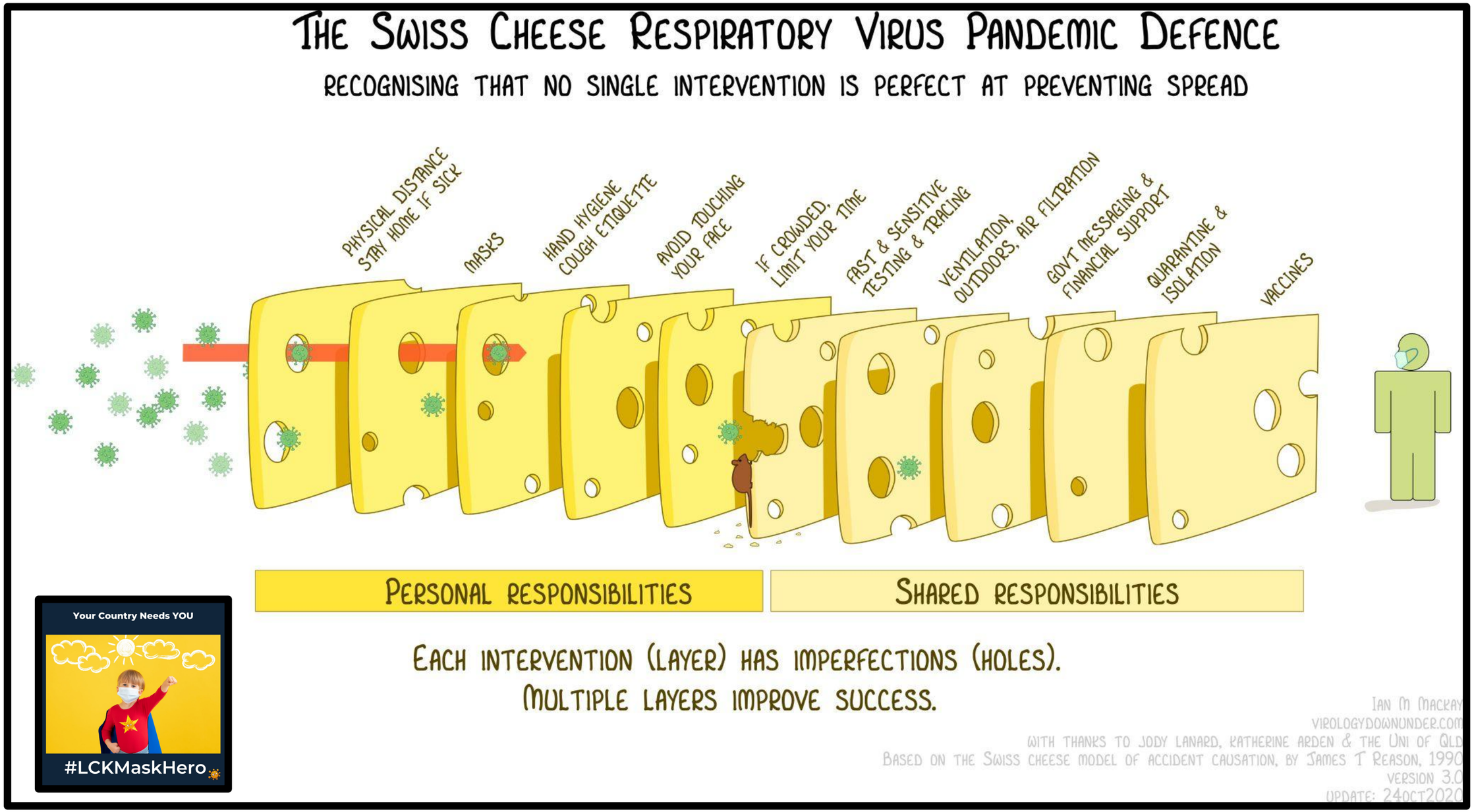
Symptoms of PIMS-TS can include:

- A prolonged fever (higher than 38C)
- Tummy ache
- Diarrhoea and/or vomiting
- Widespread red rash
- Red bloodshot eyes, strawberry red tongue, or red cracked lips
- Swelling of fingers and toes
- Not feeling or acting like themselves.

If your child has any of the following symptoms you should call your GP or call NHS 111 for advice. If your child develops chest pain, please call 999 immediately.



LAYERS OF MITIGATION



CO2 MONITORS IN SCHOOLS - #ProjectSamhe

CoSchools
Tools for healthy schools

We are proud to have partnered with CoSchools which was developed as part of the CO-TRACE project. CO-TRACE is an Engineering and Physical Sciences Research Council funded project involving researchers from the University of Cambridge, the University of Surrey and Imperial College London.

LCK have been campaigning for CO2 monitors throughout 2021.

At the end of the UK school summer holidays the Department of Education announced an 300,000 monitors would be available for schools in England. 300,000 monitors divided by 24,360 = 12 per school approximately.

In January 2022 *Schools Week* revealed the DfE planned to provide 1,000 air cleaning units for alternative provision and specialist or mainstream SEND settings – but was refusing to fund them for other schools.

In January 2022 the DfE announced it will fund 7000 purifiers.

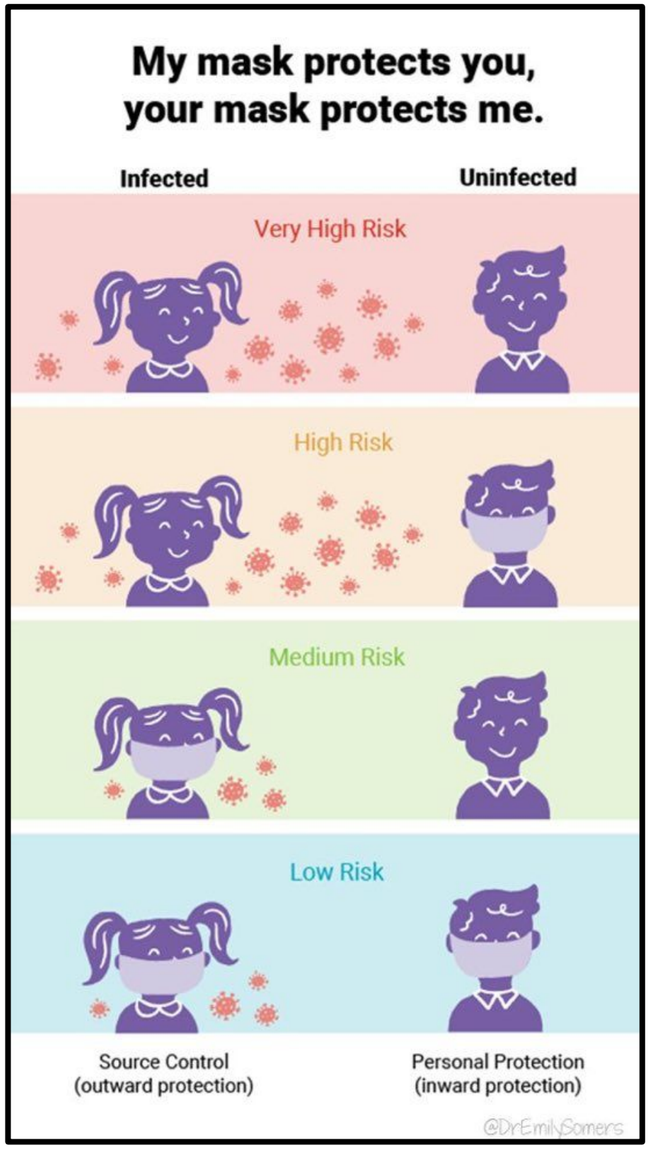
Wes Streeting, Shadow Secretary of health and Social Care, said 7,000 units was insufficient.

MASKS

National Deaf Children's Society

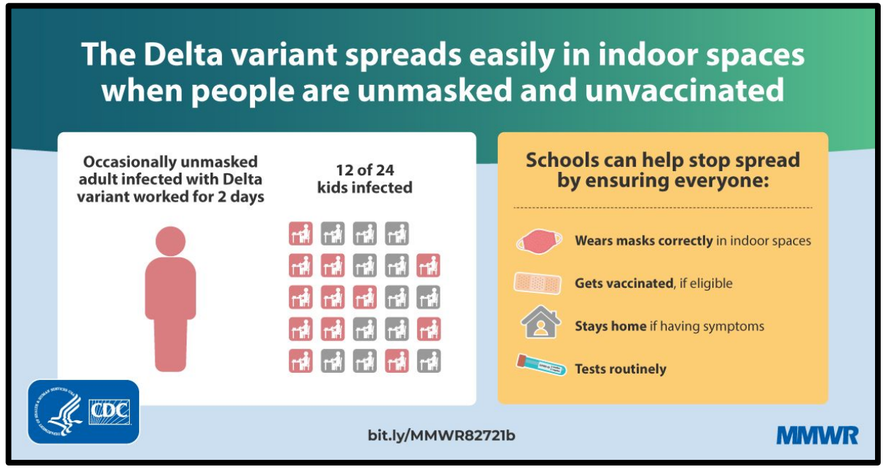
Read about facemasks with clear coverings

Click image to watch animated video helping young children understand how face masks can keep them and loved ones safe against the spread of COVID-19.



Click image to read article by Prof Trish Greenhalgh Professor of Primary Care Health Sciences

Click to read about communicating while wearing a face mask



Click image to read new large scale research on effectiveness of masks

LETTER TO HEADTEACHERS

Dear Headteacher,

Our pack is a heartfelt plea, backed by science and fuelled by personal experiences that we hope others will never have to share.

We recognise the challenges schools have already overcome since the pandemic began, and extend our gratitude through this pack which we hope will assist with the many decisions schools are now facing.

Prior to the third lockdown we started to see the rising spread of COVID-19 mutations such as the B117, with some mutations reported to be 50-70% more infectious.

We know that each school will have taken every precaution the government has suggested through their guidance to ensure pupils are safe.

The question we are asking: is the guidance enough?

The responsibility lies with schools to take appropriate measures to keep pupils and staff safe, as well as to consider the wider local community. We know schools are working harder than ever and that duty of care extends beyond government guidance. We hope this information pack will help inform your decision making.

Our team want to help because we know you have huge demands on your time and Long Covid in children is being overlooked. Since our children became infected with COVID-19, we have learnt a lot, and can offer our support and share what we have learned.

Our recent study found a higher prevalence in girls, and that children suffered symptoms for a mean of eight months. 60% of children reported difficulties with concentration and only 10% have been able to return to previous levels of activity. Read more here.

This pack will provide insight into the complexity of the situation, and evidence that current advice on safety measures are now disproportionate.

Not least because in January child COVID-19 hospital admissions increased by almost 20 fold compared with August.

The objective of our pack is to raise awareness of;

- Aerosol transmission & mitigation
- The scientific evidence
- Statistics from the Government, Office of National Statistics and our rapid surveys
- The challenges families face
- How to spot COVID-19 in a child
- Long Covid and the risk of long-term chronic health

We believe there is an opportunity to minimise further damage from COVID-19. School reopening without robust COVID-19 mitigation risks accelerating the pandemic, read the article here in The Lancet

Long Covid Kids have been calling for the government to place wellbeing into the heart of education and consider the long-term implications of inappropriate action.

Should you have any questions, please do contact us.

Warm wishes to you and your staff,

Yours faithfully,
Sammie McFarland and Frances Simpson
Founders, Long Covid Kids

Back

28 February 2021

Anonymous letter from a secondary school teacher.

The "long covid nightmare" from a teaching perspective

I2 months ago I was living the perfect life! I was skiing during the holidays, taking long weekend walks with my dog and family, cycling with friends whenever possible. I was also doing my couch to 5km running program in the gym several times a week in preparation for the Easter school cross country run that all students and staff participate in. I was six months into a brilliant new teaching job at my dream school, working six sometimes seven days a week and coaching a netball team.

One Monday in March 2020 that all changed. I woke up with diarrhoea – which was a bit odd, as no one else in the family had it and we had all eaten the same food. I started my online teaching classes at 9am, a very new experience for me and the students, but everyone was working hard to use our new suite of remote working tools. As the morning progressed a cough developed, and by the afternoon I could not talk without coughing. I was also consumed by an overwhelming fatigue, so took myself off to bed. Over the ensuing four months the cough and fatigue were joined by a temperature (never a high fever though), sore throat, headache, hoarse voice, burning feeling in my lungs and daily diarrhoea. I was never sick enough to need to be in hospital, but I have never felt so desperately ill in my whole life. During one of my many telephone conversations with the GP she suggested I tried going out for a short walk – I told her I was so fatigued that if I left the house and walked down the road, I genuinely feared I would not have the energy to get back home. She said it sounded like I probably had COVID-19, which agreed with the NHS web site I had put my symptoms in to.

Finally, around mid-July, I started to feel like my old self. I was elated! I was over it at last. I took to my exercise bike with gusto, determined to get fit again and cycle more kilometres in 30 minutes than my teenager. After the third bike session I awoke the next day with stabbing nerve pain down both arms, extreme vertigo, dizziness, neck stiffness, eye pain, fatigue and a scary feeling of being 'spaced out' in my head.

That was the beginning of the "new normal" for me. One which has lasted twelve months and feels like a recurring nightmare from which I cannot escape "yet". I say "yet" in the hope that they will find the cause of Long Covid and that there will be a cure. However, I will confess that on my darkest days I fear that I will never be able to walk, cycle, ski or swim again due to the continuous fatigue and muscle aches, and the dizziness and eye pain that come back when I overdo it.

Fatigue is hard to explain to someone who has never experienced it. I don't mean sleepy or tired. Imagine that incredibly heavy lead weights have been added to your arms and legs so that when you start to use your limbs, they ache immediately with the build-up of lactic acid from the exertion. Then imagine that you will have to spend every day with those weights on your arms and legs and that every task makes your muscles ache with pain and they feel too weak to do anything - that is "fatigue", and it stops you doing lots of things. Brushing my teeth is hard on my bad days. Washing my hair in the shower can almost do me in during a relapse!

My school have been totally brilliant, and I can't praise them enough. When I was ill, they allowed me to be off sick as long as I needed to be and covered my lessons. As I slowly recovered, they put me on a phased return to work allowing me to teach lessons when I could. I was also allowed to step back from the physical demands of sports and co-curricular activities. This has allowed me to slowly recover, but I really miss being with the students outside of lessons.

I wish I could say I was totally recovered, but twelve months on the from the start of this nightmare I am just recovering from a relapse that put me in bed for ten days with extreme fatigue, diarrhoea and severe muscle weakness in my arms and legs again. It is really scary to

discover that lifting a mug of tea to my mouth takes Herculean effort, and to have legs that feel like jelly when I walk! 'When will I get better?'..... I ask myself a hundred times a day. Once again, my school have been fantastic during my latest relapse and have told me to take as much time as I need to recuperate before I come back to teaching again. I hope all employers are as understanding and supportive as mine. I am hopeful that if I take it slowly now and rest properly during my recuperation, I will get back to teaching full time in the future.

My husband has been an absolute rock, cooking all the meals at home, doing all the housework, and walking the dog every day for the last 12 months, leaving me enough energy to do my teaching job. Without him, I do not think I would have been able to get back to teaching so easily, as I don't have the energy for both home and work at the moment. Even more importantly, he hugs me when it all gets too much, and I sob like a baby shouting that "my life is over". He calmly reminds me to keep going, one day at a time.

As the government tells us it is safe for all 10 million children and even more staff to return to school on 8th March, I am filled with a terrible dread. The new UK variant is 70% more transmissible, and most children and staff in schools will not have been vaccinated. More people will end up like me, with debilitating Long Covid, that will change their lives, possibly forever. At least 10% of adults and children get long Covid. Based on the current estimates of daily cases, 1000 adults and children a day will get Long Covid.

I would not wish Long Covid on my worst enemy! Currently there is no cure, or any kind of treatment for this horrible disease that has completely taken way my active lifestyle and left me almost housebound on bad days. I don't want another teacher, another child or another family member to catch COVID-19 and end up like me.

So please, if you work in a school, or if you are a student, wear a mask at all times. Keep your space from others and keep all the doors and windows open. Get yourself tested at every opportunity, and remember that a negative test does not mean you don't have it. Don't think that just because you are young and fit, it won't happen to you. It happened to me!

Back

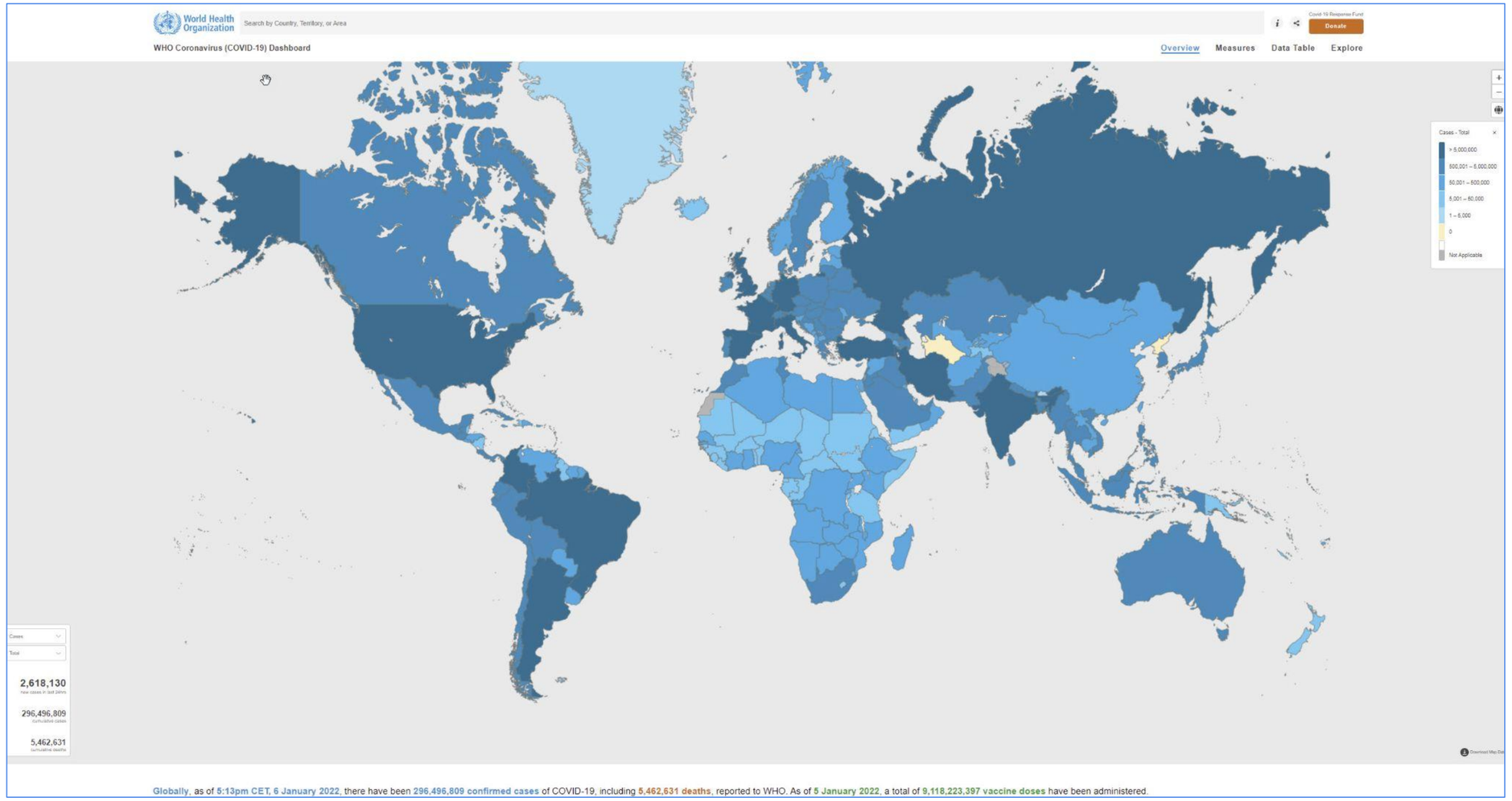
DISCLAIMER

This pack is to provide awareness of how COVID-19 can affect children and young people,

By viewing the enclosed material or using the information provided you agree that it is for educational purposes only and that you will not hold anybody responsible for loss of damages resulting from the content.

Long Covid Kids recommends seeking appropriate professional services before implementing any changes.

Ventilation and Other Strategies to Reduce the Risk of COVID-19 Aerosol Transmission



Educational materials only
(not endorsements).
Refer to disclaimer - slide #4.

Ventilation and other Strategies slides have succinct one-page summaries of detailed/linked expert resources.

The majority of images have hyperlinks to these resources which include:

government, agencies, teaching unions, technical docs, quality research, videos, websites etc

History Lesson – Spanish Flu - 1918

"Fresh Air is the bomb Washington is firing at the flu. "Get the air!" is the health department's slogan. Get all the fresh air you can. Stay outdoors more than ever. Let outdoors into homes, offices, classrooms and workshops. Fresh air will prevent the flu and will cure it"

DATE: 06 Jan 2022

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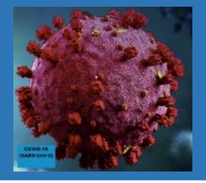

Slide	ITEM	Pages
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2	Ventilation (UK Schools) – key mitigation measure to reduce the risk of aerosol transmission	38 – 39
3	CoSchools - Tools for Healthy Schools	40 – 41
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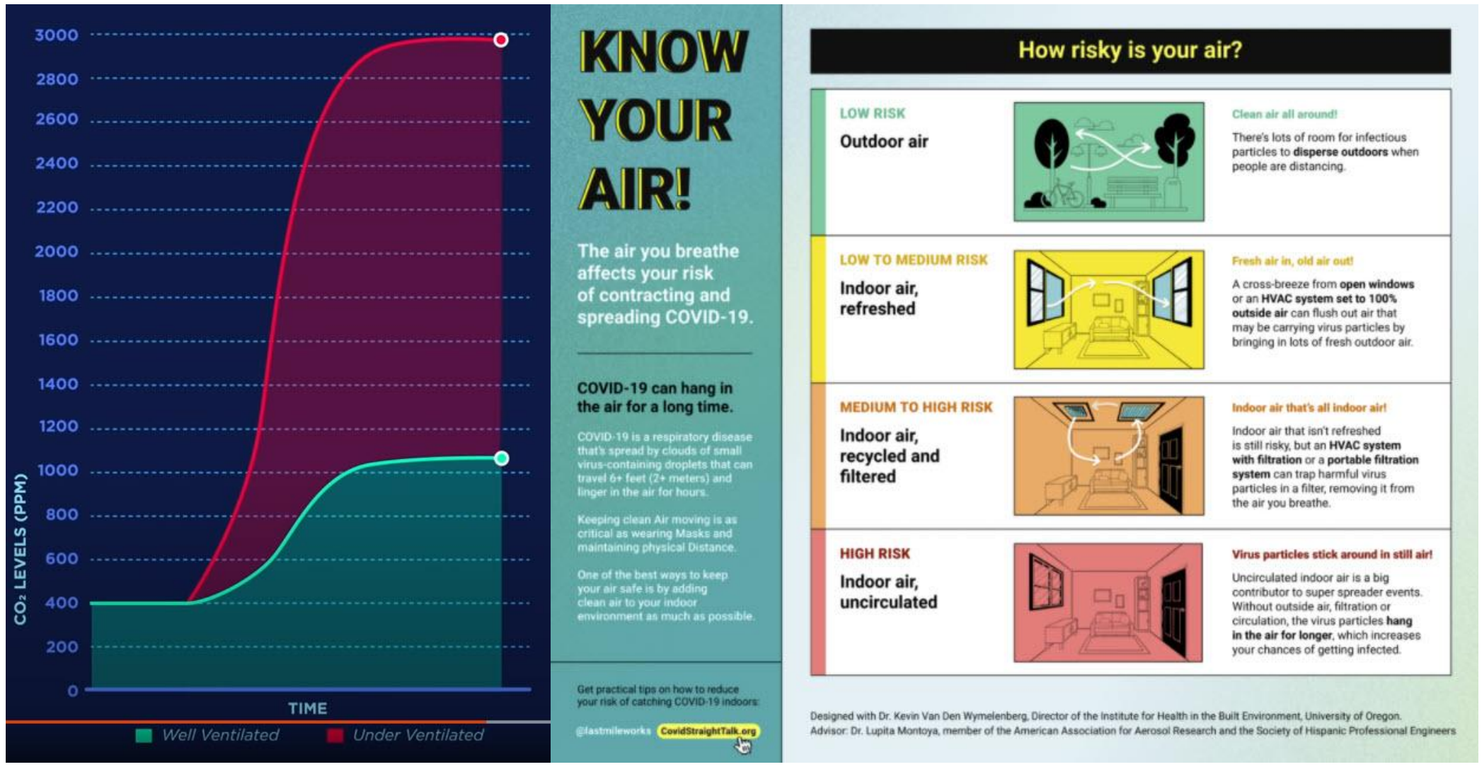
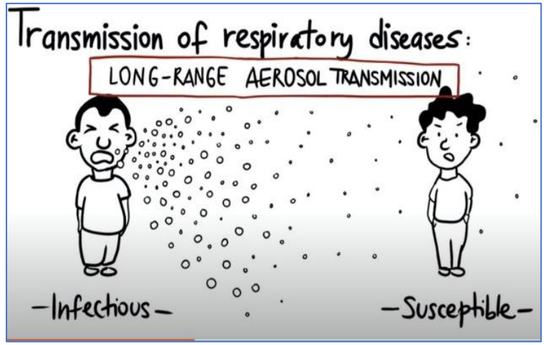
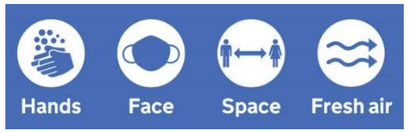
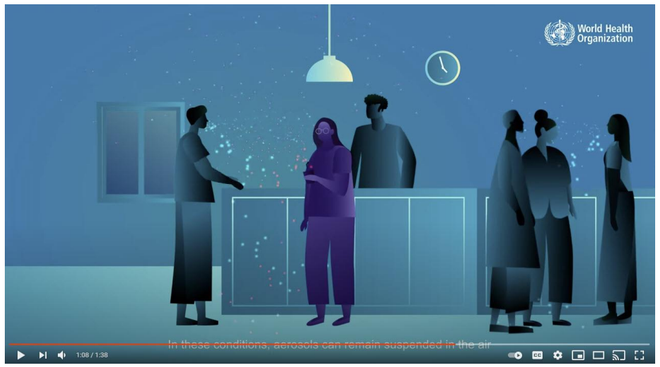
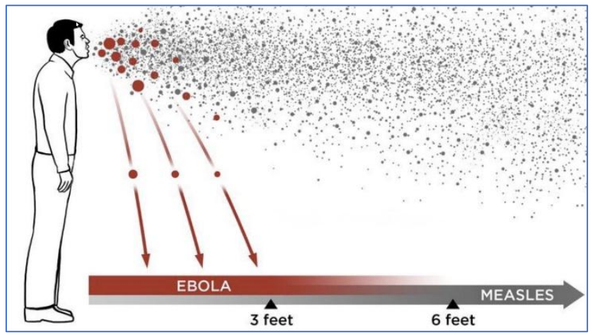


CLEAN AIR is a HUMAN RIGHT

"Every child has the right to breathe clean air, whether at home, at school or at play"

1. COVID-19 – Aerosol / Airborne Transmission

Transmission of Respiratory Diseases

Transmission Routes	Educational Videos	WHO - How COVID-19 Virus is Transmitted	SARS-CoV-2 travels by aerosols and droplets
Transmission of respiratory diseases, occurs between two people, where one person is infectious (asymptomatic, pre-symptomatic or symptomatic) and the other person who is susceptible to infection. SARS-CoV-2 is most often spread by normal **breathing, coughing or talking,** as well as shouting, sneezing, singing and playing specific musical instruments (e.g. wind & brass) and from contact through contaminated surfaces. Risk of aerosol transmission is greater in poorly ventilated indoor spaces where people spend a prolonged period of time (e.g. classrooms).	 	 COVID-19 spreads most easily in crowded settings, closed spaces with poor ventilation or through prolonged contact with an infected person(s). Aerosols can travel more than 1 metre.	 1. Ebola transmits via DROPlets (drop to the floor) 2. Measles transmitted via AERosols (travel in the AIR) 3. SARS-CoV-2 does both Transmission of Respiratory Viruses - Nature article HERE

Transmission Route	Description	Infection route	Mitigation Strategies
1. Aerosol / Airborne	Respirable microscopic aerosols < 5µm from breathing, talking, shouting or singing and playing specific music instruments (e.g. wind and brass) Short-range aerosol transmission (< 2m) and Long-range aerosol transmission (>2m) *Aerosols can float in the air from a few minutes up to 4 hours in poorly ventilated indoor spaces (e.g. classrooms)*	Inhalation	• Good Ventilation (10+ litres/second/person) and air-cleaning • Quality Multi-Layer / snug fit masks (SAGE-EMG advice for UK Alpha variant) • Reduce time spent indoors, shorter class-times, breaks (10 mins / hour) • Smaller class sizes where possible
2. Droplets	Spray of large particles from coughing, sneezing. Droplet transmission < 2 metres	Impact on mucosa surfaces (mouth, nostril or eyes)	• Quality Multi-Layer / snug fit masks (SAGE-EMG advice for UK Alpha variant) • Social Distancing > 2 metres • Cough etiquette - catch it, bin it, kill it
3. Contact	Direct Contact (physical) and Indirect Contact (fomites – contaminated surfaces) *Virus can remain on contaminated surfaces for periods from hours to days, depending on the ambient environment (inc temperature and humidity) and type of surface*	Touch surface or person then touch mouth, nostril or eyes	• Good personal hand hygiene • Good surface cleaning hygiene
4. Other	Long-range transmission through faecal aerosols from toilet flushing. Article (Figure 2) in Appendix #4.1 and also HERE	Inhalation	• Good toilet cleaning hygiene • Flush toilet with closed lid

1. COVID-19 – Aerosol / Airborne Transmission

Overwhelming Global Evidence, SARS-CoV-2 is airborne – PHE, SAGE, WHO, CDC, BMJ, Schools Guidance (ScotGov & DfE) etc* – *refer to Appendix #3.1

Risk of SARS-CoV-2 Transmission

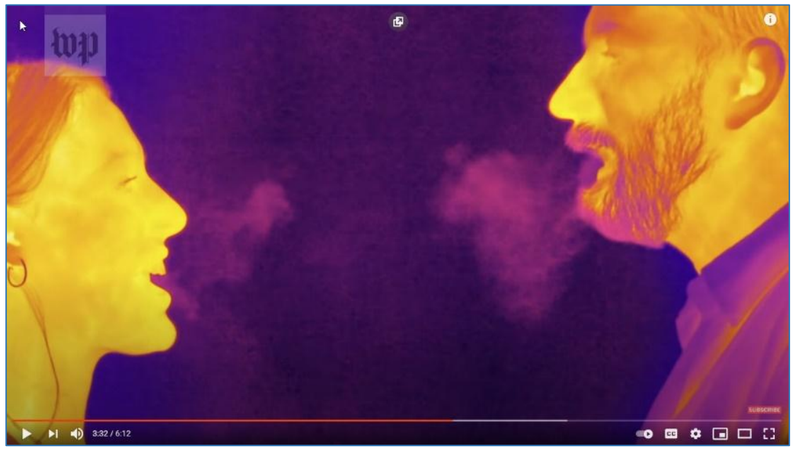
Indoor conditions for increased risk of CV-19 (potential super-spreading events):

1. Crowded, poorly ventilated indoor spaces, no social distancing, no face masks
2. Prolonged period of time (e.g. classrooms and offices)
3. Talking, shouting, singing, playing musical instruments (e.g. wind and bass), high breathing rates (exercise / gyms)
4. High Concentration of Carbon Dioxide ($CO2$)[1] > 1,500ppm – high % of exhaled air can transmit virus particles
5. Mechanical HVAC systems where recirculation of air is **NOT** from a fresh air supply. Recirculation of infected air can spread the virus (e.g. cruise ships, slaughterhouses)

It is known that an infected person spreads more viral particles as the respiratory rate increases (e.g. from silent to talking to shouting or singing), while $CO2$ production also increases at the same time.
How $CO2$ sensors might help us return to "normal"-Indoor Dining/Bars, Shops HERE

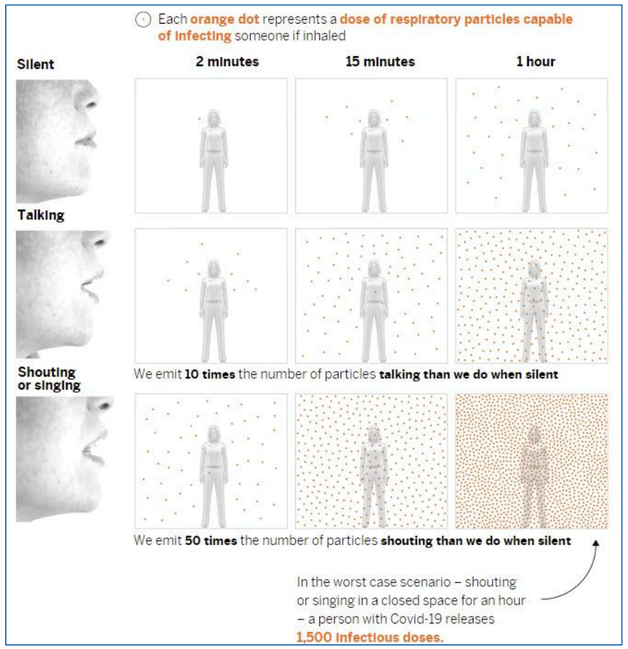
Typical indoor spaces where risk of infection can be high:
workplaces, classrooms, care homes, hospital wards, offices, bars, restaurants, family homes, gyms, public/school transport, taxis, private cars, etc.

Military-grade camera (video) shows risks of airborne CV-19 spread

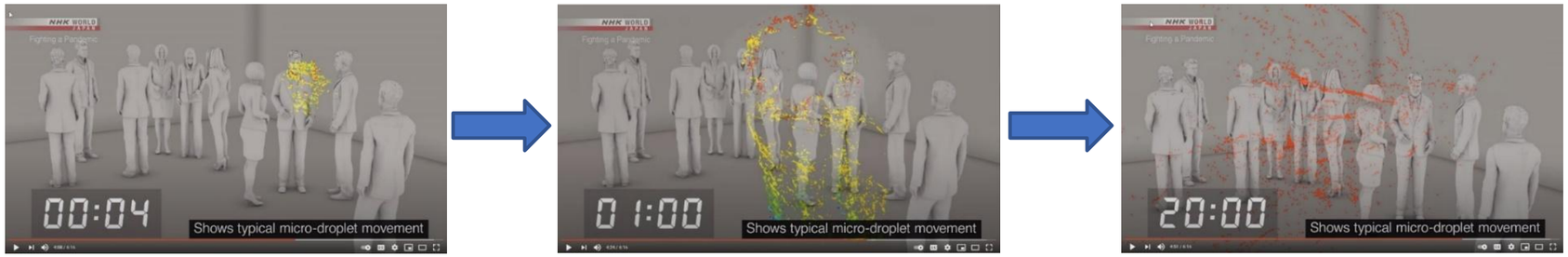


Note 1: Every time you exhale, you release Carbon Dioxide ($CO2$) into the air. Since CV-19 is most often spread by breathing, coughing or talking, you can use $CO2$ levels to see if the room is filling up with potentially infectious exhalations. The $CO2$ level lets you estimate if enough fresh outside air is getting in.

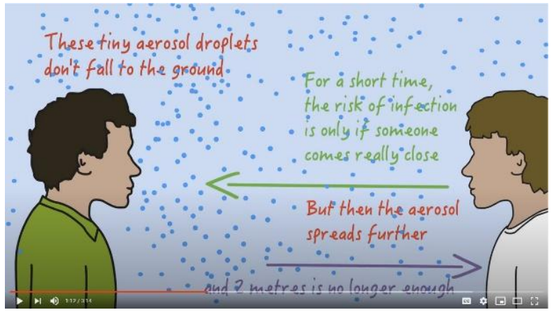
Visualisation of Respiratory Particles – click on image/scroll



Visualisation of Aerosols (Time 3:50): Droplets (yellow/green) drop to floor ~ 1 minute. Aerosols (red) can remain in the air from a few minutes up to 4 hours



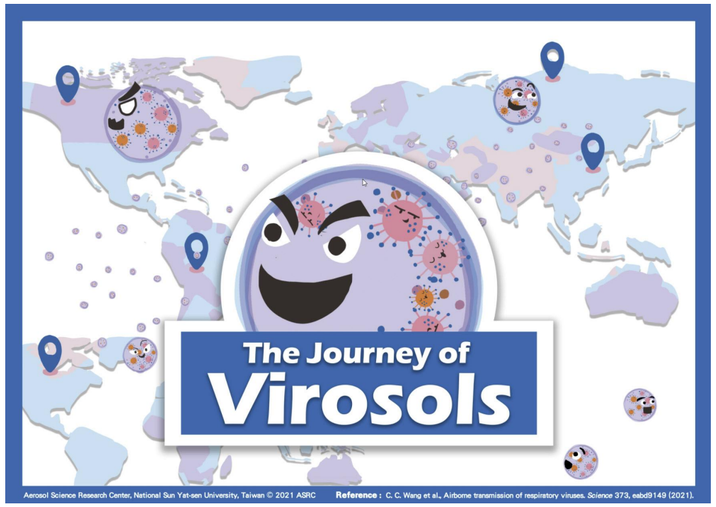
Aerosols and Making Spaces Safe

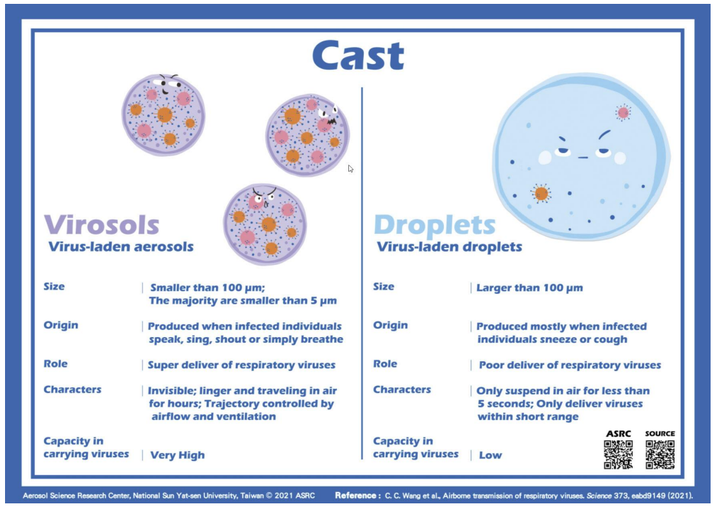


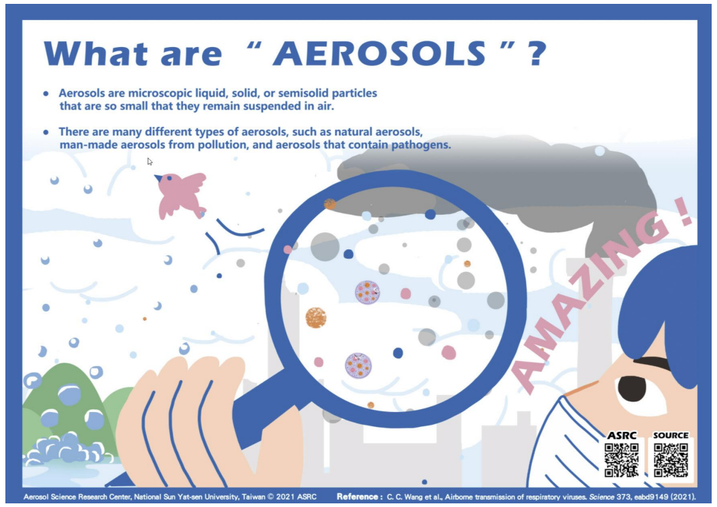
1. COVID-19 – Aerosol / Airborne Transmission

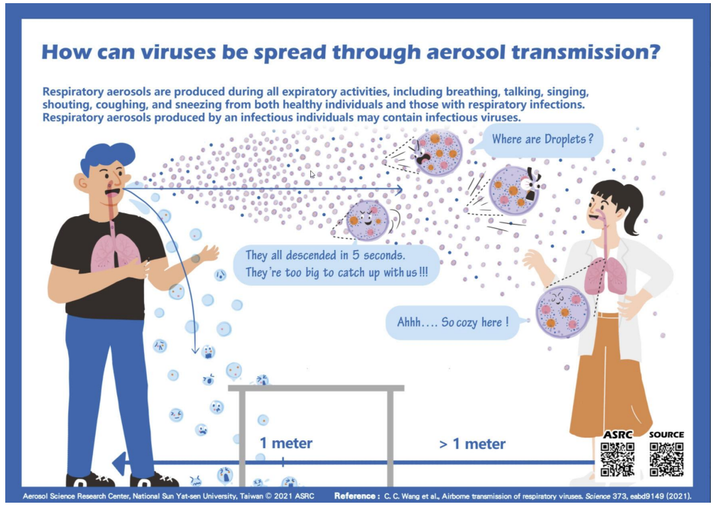
Airborne Transmission of Respiratory Viruses - review published HERE

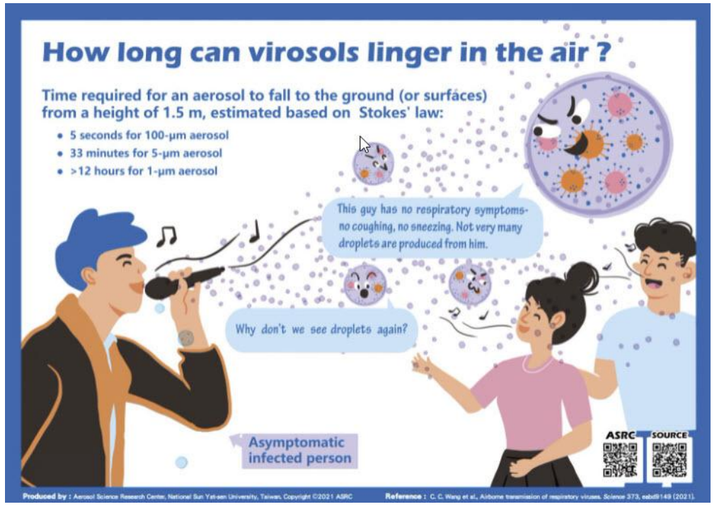
Infographics (#17 in total) available at Aerosol Science Research Centre HERE and Chia Wang's Twitter feed HERE

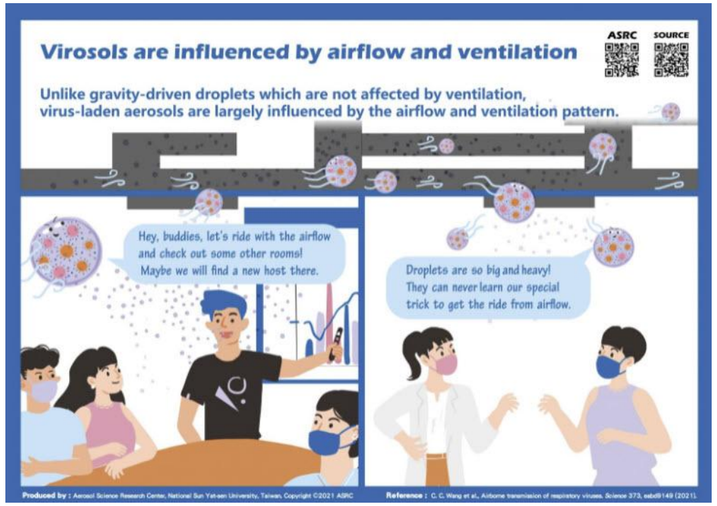










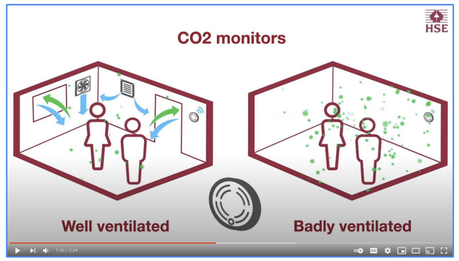


2. Ventilation (UK Schools) – key mitigation measure to reduce the risk of aerosol transmission

Ventilation is a key mitigation measure to control far-field (>2m) transmission of SARS-CoV-2 by aerosols, between people who share the same indoor space

UK School Ventilation (#LongCovidKids)

Health & Safety Executive - Ventilation



Importance of Ventilation in Schools

Risk of SARS-CoV-2 Transmission

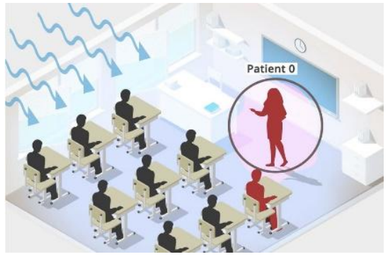
Type and level of group activity	Low occupancy: Outdoors and well ventilated	Low occupancy: Indoors and well ventilated	Low occupancy: Poorly ventilated	High occupancy: Outdoors and well ventilated	High occupancy: Indoors and well ventilated	High occupancy: Poorly ventilated
Wearing face coverings, contact for short time						
Silent	Low	Low	Low	Low	Low	Medium
Speaking	Low	Low	Low	Low	Low	Medium
Shouting, singing	Low	Low	Medium	Medium	Medium	High
Wearing face coverings, contact for prolonged time						
Silent	Low	Low	Medium	Low	Medium	High
Speaking	Low	Low *	Medium	*	Medium	High
Shouting, singing	Low	Medium	High	Medium	High	High
No face coverings, contact for short time						
Silent	Low	Low	Medium	Medium	Medium	High
Speaking	Low	Medium	Medium	Medium	High	High
Shouting, singing	Medium	Medium	High	High	High	High
No face coverings, contact for prolonged time						
Silent	Low	Medium	High	Medium	High	High
Speaking	Medium	Medium	High	High	High	High
Shouting, singing	Medium	High	High	High	High	High

Risk of transmission Low Medium High

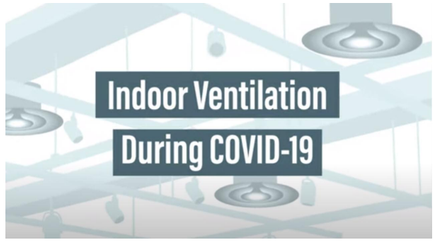
* Borderline case that is highly dependent on quantitative definitions of distancing, number of individuals, and time of exposure

Classroom/Dining-hall/Staffroom

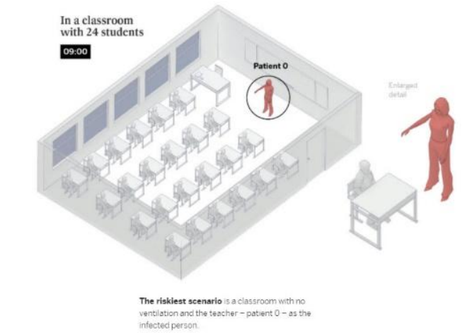
Ventilation in Classroom



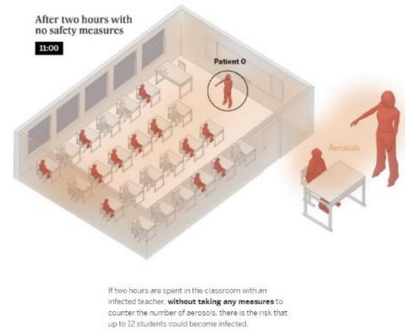
Ventilation as part of a Layered Approach



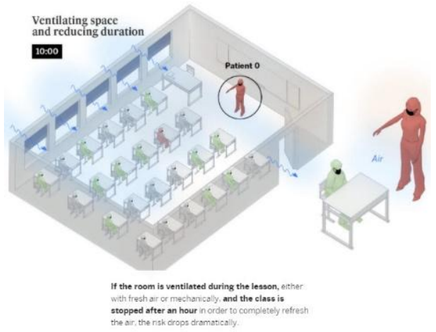
9am: Windows closed - Index case (Red)



11am: Windows closed – Infected (Red)



10am: Windows open – Infected (Red)



- Risk of SARS-CoV-2 transmission from asymptomatic people in different settings and for different occupation times, ventilation, and crowded levels (ignoring variation in susceptibility and viral shedding rates). Source British Medical Journal
- BBC News article (5 Mar 2021) COVID: Fresh air 'key to safer classrooms'
- Return to school is welcome, but we must minimise shared air – BMJ article HERE

2. Ventilation (UK Schools[1]) – key mitigation measure to reduce the risk of aerosol transmission

Leverage 4 Key Pillars:*	SAGE-EMG/RAMP	BB101 Ventilation / BESA	HSE/CIBSE/ PHE	REHVA etc	*Appendices #4.3 onwards

Summary Guidance ****** ONE PAGE CHEAT-SHEET ******

1. SAGE-EMG "In most settings the risk of aerosol transmission is likely to be low if the ventilation rate achieves current design standards. For most workplaces and public environments this equates to flow rate of **8-10 litres/second/person** based on design occupancy". WHO recommend: non-residential settings pg11 - 10l/s/p
2. Options for improvement: Natural vent'ln windows/doors (not fire-doors unless fitted with auto-close device), mechanical systems (HVAC), air-cleaning (HEPA)
3. Consider air-cleaning units to remove bacteria and particulates from the indoor air where indoor spaces are difficult to ventilate (e.g. no windows, unable to open windows / open slightly) OR where outside air is polluted (e.g. in cities and heavy traffic)). Refer to Air-cleaning guidance in the Appendices
4. Implement Ventilation monitoring strategies – leverage CO2 monitors as effective method of identifying poor ventilation in multi-occupant spaces
5. CO2 levels for well-ventilated rooms < 1,000ppm, target < 800ppm. If > 1,000ppm then additional ventilation required. SAGE-EMG CO2 analysis Appendix #4.5

COVID-19 Carbon Dioxide (CO2) RAG Settings - REHVA

It's LAW in Taiwan, Norway and Portugal to limit indoor CO2 levels to 1,000ppm – link HERE. In Belgium, the law is 900ppm

UK Variant SARS-CoV-2 (UK Alpha) - SAGE EMG et al (22 Dec 2020) mitigation measures. "step change in rigour of application due to increased transmission risk"

< 800ppm	800 to 1,000ppm	>1,000ppm

1. Enhance ventilation rates by a factor of 1.5 to 1.7 and to wear a multi-layer / snug fit mask. Relative Humidity 40% to 60%. Take rooms out of use if ventilation cannot be improved to acceptable 'safe' levels.
2. Interpretation: Good ventilation 10+ l/s/p. Ventilation of poorly ventilated areas (< 5 l/s/p, CO2 levels > 1,500ppm) to be improved to 10+ l/s/p (CO2 levels < 1,000ppm, target < 800ppm). Outdoor Air CO2 level is approx. 415ppm.

General Tips At CO2 levels of 1,000ppm, a person is breathing in 1.5% of exhaled air from other occupants. At CO2 levels of 800ppm, it's 1.0% of exhaled air

1. Ventilate premises 2 hours before/after use, purge rooms at lunchtime/breaks can be as effective as constant open windows. Do not block ventilation grilles.
2. Small window openings effective in cold weather (big temp difference = more air-flow). In winter, open windows at top, in summer open at top and bottom
3. CO2 sensors should be located away from windows, doors and ventilation grilles. Located at breathing height of main occupants at a distance > 50cm from folks
4. Any actions to improve ventilation should not compromise other aspects of safety & security (e.g. do not open fire doors unless fitted with auto-close device)
5. Clear the air effectively using 2-point cross-diagonal openings to allow air-flow through the classroom (video clip HERE) OR Indoor Wind Tunnel
6. Switch off HVAC systems and fans (ceiling & desk) if recirculation of air is NOT from a fresh air supply
7. Upgrade HVAC systems to recirculate air from a fresh air supply (qualified registered HVAC professional required)
8. Mechanical ventilation systems – at nights and weekends, do not switch ventilation off, but keep systems running at lower speed
9. Consider smaller class sizes and shorter class times where possible. Take regular breaks from classroom (e.g. 10 mins/hour)
10. Encourage mask wearing (exemptions apply) throughout indoor spaces, inc classrooms. Involve children and teaching staff with CO2 monitoring/education
11. Toilets – instruct occupants to flush toilets with closed lid. Avoid opening internal toilet windows as this may cause a contaminated airflow to other rooms

Temperature - Classrooms*	Min	Max
• BB101: Table 7.2 classrooms • Legalised Min – Scotland Table X • H&S Workplace Regs England	20°C 17°C 16°C	25°C
Relative Humidity*	**Min**	**Max**
• Relative Humidity for classrooms	40%	60%
Ventilation Rates*	**l/s/p**	**ACH**
• Guidance (4 Pillars, WHO / ASHRAE)	10+	4-6

Operational Health and Safety Guidance and COVID-19 Risk Assessment (Legal Requirement)

1. Health and Safety Executive – employers must make sure there's adequate supply of fresh air (ventilation) in enclosed areas of the workplace. HSE FAQ General Ventilation is risk assessed by an appointed competent person
2. Ensure school risk assessment (RA) explicitly includes ventilation requirements for COVID-19 aerosol transmission and a qualified registered HVAC professional and a school safety representative have been consulted
3. **NEU Step-by-step guide for Reps COVID-19 Risk Assessment** – video, guidance and safety checklist HERE . **NASUWT Ventilation & COVID-19 advice** HERE . **Joint union** guide to improving ventilation in schools HERE
4. 'COVID-Ready' operational signage for classrooms / indoor spaces: e.g. maximum # of people, normal CO2 levels, how to operate windows/doors and mechanical ventilation, instructions as CO2 levels reach Amber/Red
5. Workplace (Health, Safety and Welfare) Regulations 1992 states "Temperature in indoor workplaces "7. – (1) During working hours, the temperature in all workplaces inside buildings shall be reasonable". However, for classrooms, in Scotland, the legalised minimum temperature is 17°C, and 2 Air Exchange per Hour (ACH). WHO recommend 6 Air Changes per Hour (ACH). In England the minimum temperature in classrooms is 16°C

Note 1 : For non-UK Schools, above can be used as a guide. For detail refer to country specific guidance (e.g. USA Schools – refer to CDC + Healthy Buildings guidance in appendix #4.3 and air-filtration in #4.17)

3. CoSchools - Tools for Healthy Schools

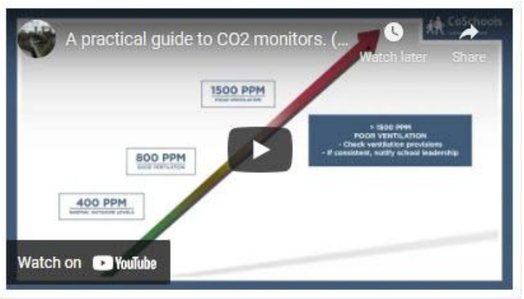
CoSchools has also received support and input from the following:

Long Covid Kids & Friends Supporting each other.

CoSchools was developed as part of the CO-TRACE project - EPSRC funded project involving Uni of Cambridge, Uni of Surrey and Imperial College London

To Assist with UK Government's rollout of CO2 monitors to Schools - CoSchools have created four videos, and other materials, that aim to explain how CO2 monitors can help teachers manage their classroom ventilation to provide a more comfortable and healthier learning environment - All materials available on CoSchools website HERE

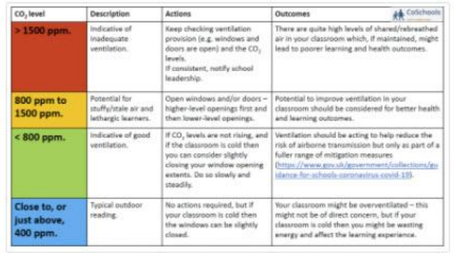
Watch these videos to learn how to use your CO2 monitor and why it might help in your classroom



LongCovidKids Feedback to CoSchools includes a greater emphasis on:

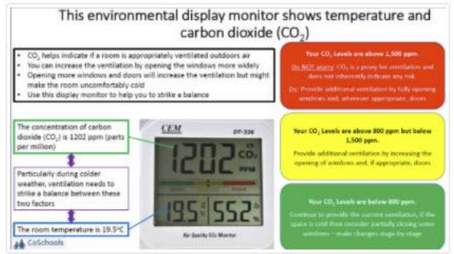
1. Improving ventilation when CO2 levels are between 800ppm to 1,500ppm to maintain a level of below 800ppm
2. Clear ventilation education/communication aimed at all levels of the school community - including a simple one-page laminated infographic to be wall mounted in all indoor spaces
3. Consider repurposing indoor spaces (or reduce headcount numbers) if CO2 levels are consistently over 1,500ppm
4. Clear guidance on the use of air-cleaning solutions (e.g. air-filtration units) for indoor spaces that are difficult to ventilate (e.g. no windows and/or outside air is polluted - cities/heavy traffic)

We have also created a simple table which some schools have found helpful. The table contains: the relevant CO2 levels, their descriptions, some recommended actions, and potential outcomes – click the image below to download your printable copy.



CO_2 level	Description	Actions	Outcomes
> 1500 ppm.	Indicative of inadequate ventilation.	Keep checking ventilation provision (e.g. windows and doors are open) and the CO_2 levels. If consistent, notify school leadership.	There are quite high levels of shared/rebreathed air in your classroom which, if maintained, might lead to poorer learning and health outcomes.
800 ppm to 1500 ppm.	Potential for stuffy/stale air and lethargic learners.	Open windows and/or doors – higher-level openings first and then lower-level openings.	Potential to improve ventilation in your classroom should be considered for better health and learning outcomes.
< 800 ppm.	Indicative of good ventilation.	If CO_2 levels are not rising, and if the classroom is cold then you can consider slightly closing your window opening extents. Do so slowly and steadily.	Ventilation should be acting to help reduce the risk of airborne transmission but only as part of a fuller range of mitigation measures (https://www.gov.uk/government/collections/guidance-for-schools-coronavirus-covid-19).
Close to, or just above, 400 ppm.	Typical outdoor reading.	No actions required, but if your classroom is cold then the windows can be slightly closed.	Your classroom might be overventilated – this might not be of direct concern, but if your classroom is cold then you might be wasting energy and affect the learning experience.

In addition, the following A4 poster can be edited, printed, and laminated to sit alongside the monitors in classrooms – click the image below to start editing your poster in Powerpoint format, or click here for an OpenDocument version, or if you're happy with the image of the Rexel DT326 then click here for a pdf.



If you are looking to motivate and train your classroom staff in using their CO2 monitors then there is also this a template of a presentation intended to help you – click the image below to start editing your presentation in Powerpoint format (or click here for an OpenDocument version).

If you have tried your best with your Department for Education CO2 monitor and you are still struggling to maintain adequate ventilation then please visit our Resources page to find useful links to guidance to help remedy your circumstances.

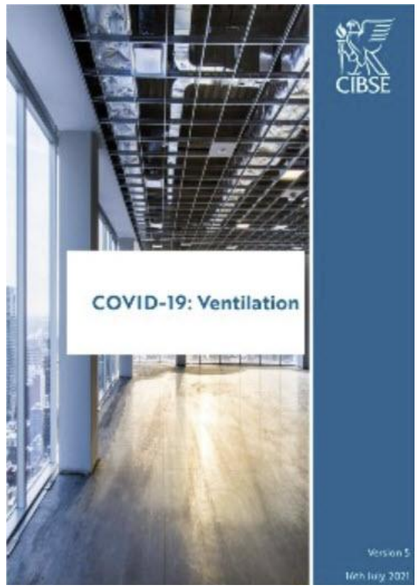
3. CoSchools - Tools for Healthy Schools

CoSchools has also received support and input from the following:

Long Covid Kids & Friends Supporting each other.

Additional Resources on Ventilation, CO2 monitoring and Air-Cleaning units available on CoSchools website - resource page HERE

Ventilation and CO2 monitoring - DfE, CIBSE, SAGE-EMG HERE



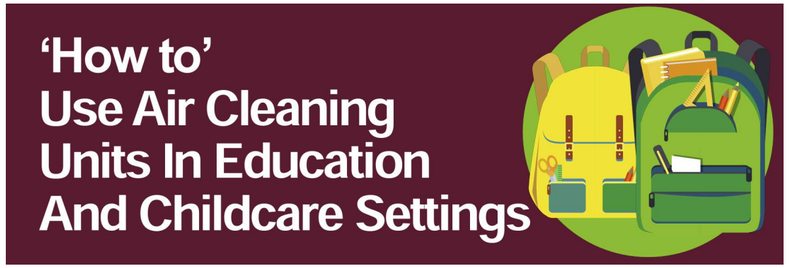
Research and analysis

EMG: Role of ventilation in controlling SARS-CoV-2 transmission, 30 September 2020

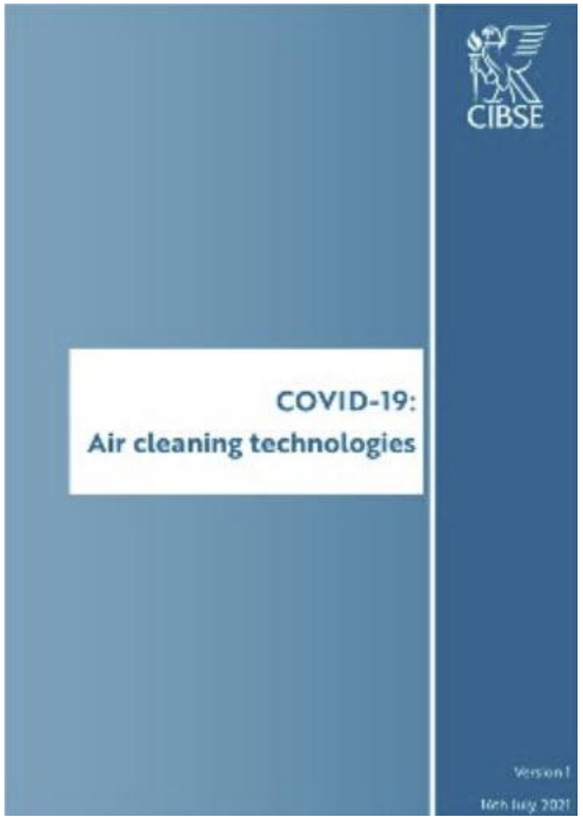
Research and analysis

EMG and SPI-B: Application of CO2 monitoring as an approach to managing ventilation to mitigate SARS-CoV-2 transmission, 27 May 2021

Air-Cleaning Units - DfE, CIBSE, SAGE-EMG HERE



EMG: Potential application of air cleaning devices and personal decontamination to manage transmission of COVID-19, 4 November 2020



4. Appendices

Slide	Item	Pages	Slide	Item	Pages
4.1	COVID-19 Aerosol / Airborne Transmission - Evidence	43	4.12	Air for Kids (#AirforKids) - Airthings	55
4.2	COVID-19 Superspreading Conditions and Examples	44	4.13	Indoor Air Quality - Airthings	56 - 57
4.3	Ventilation (UK Schools) – Ventilation Guidance: 4 Key Pillars and Additional Resources	45	4.14	Indoor Air Quality - uHoo	58
4.4	Quality Ventilation Report - commissioned by Chief Scientific Advisor to UK Government	46	4.15	PP-L-Biosafety	59 - 61
4.5	Ventilation (UK Schools) – Carbon Dioxide (CO2): Leverage SAGE-EMG advice	47	4.16	Relative Humidity and Temperature	62
4.6	Ventilation (UK Schools) – Carbon Dioxide (CO2) Levels, Exhaled Air, Cognitive Effects	48	4.17	Air-Filtration – Guidance from USA and Canada	63
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4.8	Carbon Dioxide (CO2) – Aranet4	50	4.19	Air-Cleaning Trials - Bradford Primary Schools	65
4.9	Carbon Dioxide (CO2) – CO2 Panel	51	4.20	Portable Air filtration/UV Sterilisation devices reduces SARS-CoV-2 in COVID-19 Wards	66
4.10	Carbon Dioxide (CO2) – Other CO2 Companies	52	4.21	U.S. Environmental Protection Agency (EPA) - Takes Aim at Purification Devices	67
4.11	Air Pollution and Indoor Air Quality	53 - 54	4.22	The Swiss Cheese Respiratory Pandemic Defence Model and Japan's 3Cs	68

"If you can not measure it, you can not improve it."

- Lord Kelvin

4.1 COVID-19 – Aerosol / Airborne Transmission - Evidence

Overwhelming Global Evidence, SARS-CoV-2 is airborne – PHE, SAGE, WHO, CDC, BMJ, Schools Guidance (ScotGov & DfE), Science articles

Slow motion sneeze

16 mins

Aerosol Scientists

2 mins

12 mins

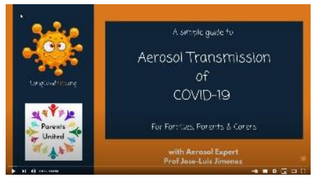
Airborne Exposure

32 mins

Slides link - HERE

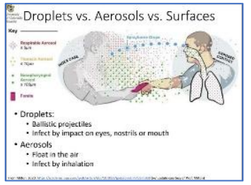
Simple Guide

70 mins



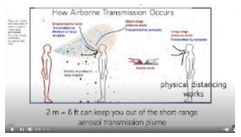
Infectious Aerosols

45 mins



Minimise Aerosol Transmission

27 mins

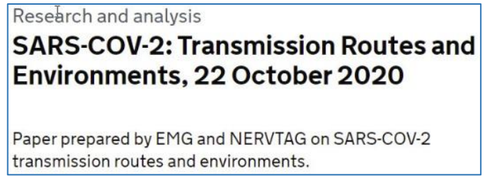


COVID "Myths" (podcast)

24 mins

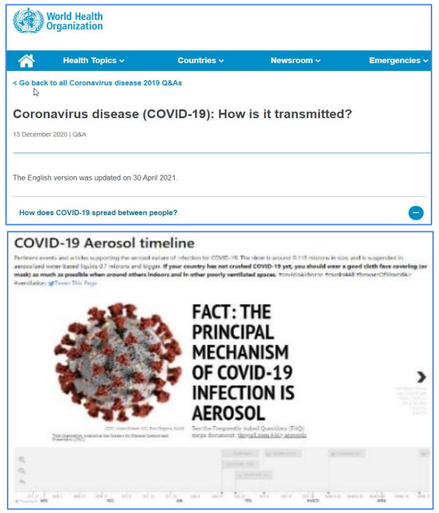
Document HERE

PHE / SAGE-NERVTAG-EMG / RAMP



Schools (ScotGov, DFE, DFE-HE)

WHO / Aerosol Timeline / Lancet

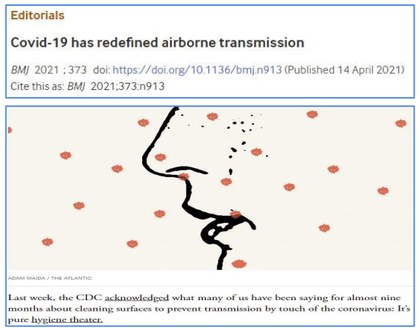


Lancet - 10 Scientific reasons in support of airborne transmission

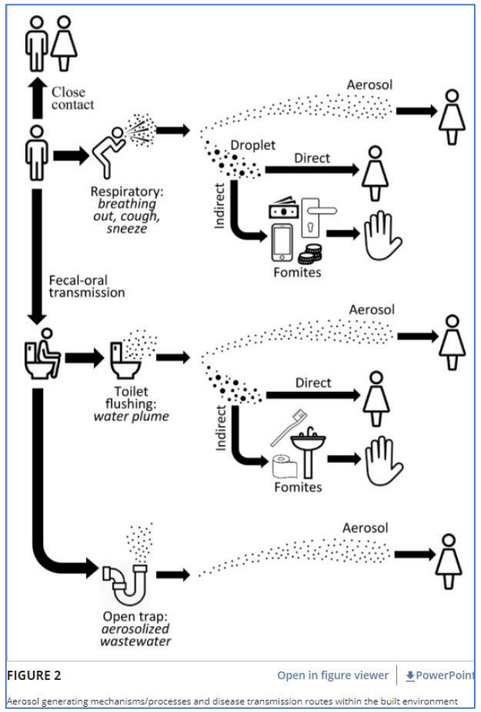
ASHRAE Epidemic Task Force declares COVID is airborne

CDC / BMJ / Science articles

COVID-19 and Your Health
Symptoms, testing, what to do if sick, daily activities, and more.
cdc.gov



Aerosols from defective sanitary plumbing



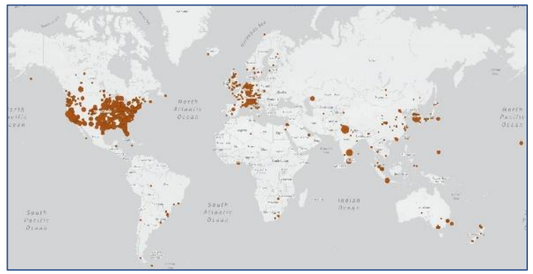
4.2 COVID-19 Superspreading Conditions and Examples

COVID-19 Superspreading events continue to increase as people spend more time indoors (classrooms/workplaces/homes)

COVID-19 Superspreading Conditions

Global evidence has grown in strength on superspreading events where the virus spreads quickly given the ideal conditions. The majority of these events are indoors. Transmission route favours aerosol transmission, although droplets and contaminated surfaces will also be present. Superspreading conditions as follows:

1. Crowded, poorly ventilated indoor spaces, no social distancing, no face masks
2. Prolonged period of time (e.g. classrooms and offices)
3. Talking, shouting, singing, playing musical instruments (e.g. wind and bass) high breathing rates (e.g. exercise / gyms)
4. High concentration of Carbon Dioxide (CO_2)[1] > 1,500ppm – high % of exhaled air can transmit virus particles
5. Mechanical HVAC systems where recirculation of air is **NOT** from a fresh air supply. Recirculation of infected air can spread the virus (e.g. cruise ships)



Super-spreading Database events link HERE

Typical indoor spaces where risk of infection can be high – *e.g. workplaces, classrooms, care homes, hospital wards, offices, bars, restaurants, family homes, gyms, public/school transport, taxis, private cars, etc*.

Note 1: Every time you exhale, you release Carbon Dioxide (CO_2) into the air. Since CV-19 is most often spread by breathing, coughing or talking, you can use CO_2 levels to see if the room is filling up with potentially infectious exhalations. The CO_2 level lets you estimate if enough fresh outside air is getting in.

Risk of SARS-CoV-2 Transmission

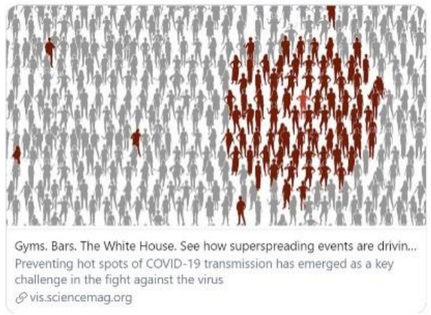
Type and level of group activity	Low occupancy: Outdoors and well ventilated	Low occupancy: Indoors and well ventilated	Low occupancy: Poorly ventilated	High occupancy: Outdoors and well ventilated	High occupancy: Indoors and well ventilated	High occupancy: Poorly ventilated
Wearing face coverings, contact for short time						
Silent	Low	Low	Low	Low	Low	Medium
Speaking	Low	Low	Low	Low	Low	Medium
Shouting, singing	Low	Low	Medium	Medium	Medium	High
Wearing face coverings, contact for prolonged time						
Silent	Low	Low	Medium	Low	Medium	High
Speaking	Low	Low*	Medium	Medium*	Medium	High
Shouting, singing	Low	Medium	High	Medium	High	High
No face coverings, contact for short time						
Silent	Low	Low	Medium	Medium	Medium	High
Speaking	Low	Medium	Medium	Medium	High	High
Shouting, singing	Medium	Medium	High	High	High	High
No face coverings, contact for prolonged time						
Silent	Low	Medium	High	Medium	High	High
Speaking	Medium	Medium	High	High	High	High
Shouting, singing	Medium	High	High	High	High	High

Risk of transmission: Low, Medium, High

* Borderline case that is highly dependent on quantitative definitions of distancing, number of individuals, and time of exposure

- Risk of SARS-CoV-2 transmission from asymptomatic people in different settings and for different occupation times, ventilation, and crowded levels (ignoring variation in susceptibility and viral shedding rates). Source British Medical Journal
- Why some people are superspreaders and how the body emits CV-19 - article HERE
- Superspreading through aerosols and importance of ventilation – article HERE
- Super-spreading events – drive most of spread - article HERE
- Outdoor seating often reduces CV19 exposure but not all structures are equal HERE

Science of Super-spreading



Superspreading drives CV-19 pandemic

Visualisation of CV-19 Spread

4.3 Ventilation (UK Schools) – Ventilation Guidance: 4 Key Pillars + Additional Resources

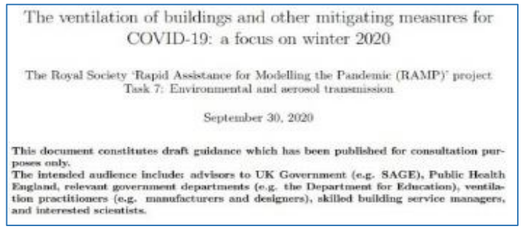
Ventilation Guidance from the following 4 Key Pillars and additional resources

SAGE-EMG et al and Royal Society (RAMP)

Research and analysis
EMG: Role of ventilation in controlling SARS-CoV-2 transmission, 30 September 2020

Research and analysis
EMG: Simple summary of ventilation actions to mitigate the risk of COVID-19, 1 October 2020

Research and analysis
EMG/SPI-B/TWEG: Mitigations to reduce transmission of the new variant SARS-CoV-2 virus, 22 December 2020


The ventilation of buildings and other mitigating measures for COVID-19: a focus on winter 2020

The Royal Society 'Rapid Assistance for Modelling the Pandemic (RAMP)' project
Task 7: Environmental and aerosol transmission

September 30, 2020

This document constitutes draft guidance which has been published for consultation purposes only.
The intended audience includes advisors to UK Government (e.g. SAGE), Public Health England, relevant government departments (e.g. the Department for Education), ventilation practitioners (e.g. manufacturers and designers), skilled building service managers, and interested scientists.

BB101: Ventilation/ Estate Management / BESA

Guidance
BB 101: Ventilation, thermal comfort and indoor air quality 2018

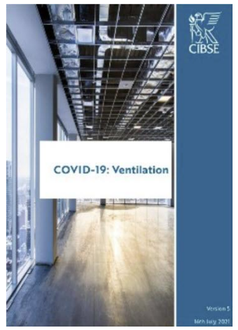
Building Bulletin 101: calculation tools

Good estate management for schools
From: Department for Education

BESA – Building Engineering Services Association

HSE / CIBSE / PHE

The role of school leaders - who does what



REHVA/Ireland/Wales/Europe etc

1. REHVA - COVID-19 Ventilation Guidance - inc Schools and Infographic etc HERE
2. Ireland - Role of Ventilation in reducing CV-19 Transmission HERE
3. Ireland - Employer checklist ventilation
4. Wales - CO2 monitors in education HERE
5. Europe: Guide for Ventilation towards Healthy Classrooms HERE
6. Singapore: Ventilation and Indoor Air Quality (IAQ) Guidance and Infographic
7. ASHRAE Ventilation rates HERE

UK Teaching Unions Ventilation Guidance

1. NEU Step-by-step guide for Reps COVID-19 Risk Assessment – video, guidance and safety checklist HERE
2. NASUWT Ventilation and COVID-19 advice HERE
3. Joint union guide to improving ventilation in schools HERE
4. EIS Union - ventilation actions HERE

Additional Ventilation Resources

WHO

England + Northern Ireland

England School Guidance

Northern Ireland School Guidance

Scotland School Guidance

Scottish Government
Riaghaltas na h-Alba
gov.scot

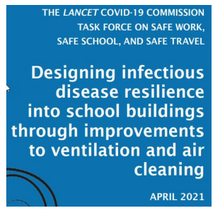
Scottish Schools Premises Regulations

Ireland and Wales

Ireland Ventilation Guidance for Schools

Wales School Guidance

Lancet

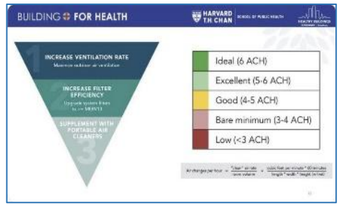


L.Morawska et al

Ventilation procedures to minimise airborne viruses at schools

US - CDC

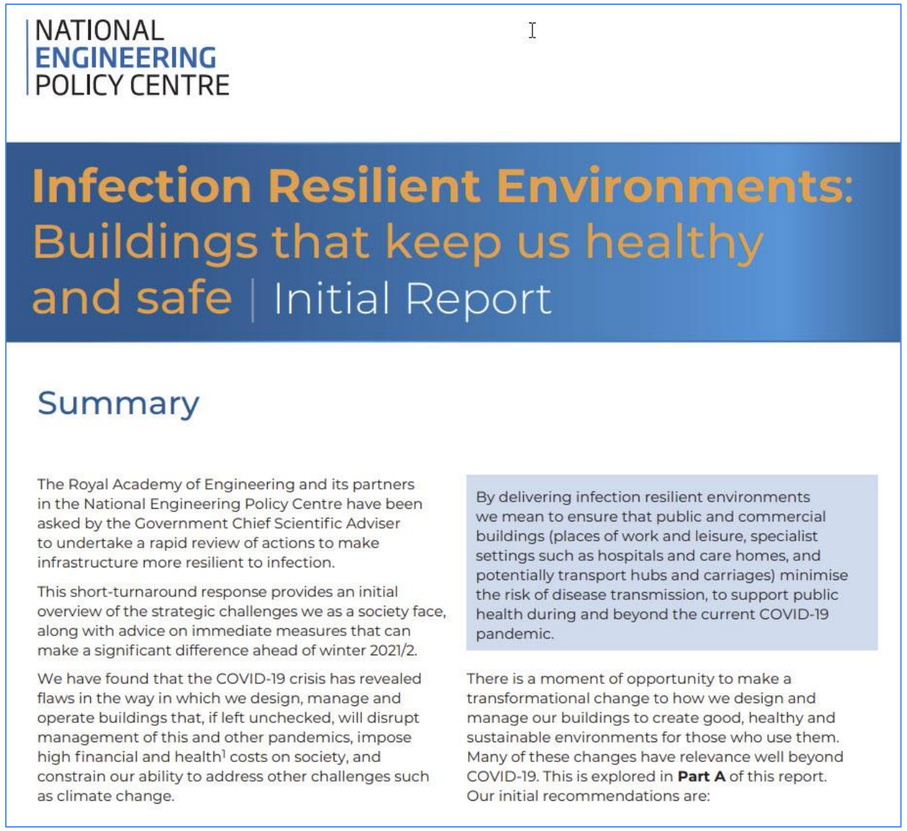
Healthy Buildings for Health – US Schools



4.4 Quality Ventilation Report - commissioned by Chief Scientific Advisor to UK Government

Improved ventilation essential to safe use of buildings & public spaces

Royal Academy of Engineering Article HERE and Initial Report HERE



NATIONAL ENGINEERING POLICY CENTRE

Infection Resilient Environments: Buildings that keep us healthy and safe | Initial Report

Summary

The Royal Academy of Engineering and its partners in the National Engineering Policy Centre have been asked by the Government Chief Scientific Adviser to undertake a rapid review of actions to make infrastructure more resilient to infection.

This short-turnaround response provides an initial overview of the strategic challenges we as a society face, along with advice on immediate measures that can make a significant difference ahead of winter 2021/2.

We have found that the COVID-19 crisis has revealed flaws in the way in which we design, manage and operate buildings that, if left unchecked, will disrupt management of this and other pandemics, impose high financial and health[1] costs on society, and constrain our ability to address other challenges such as climate change.

By delivering infection resilient environments we mean to ensure that public and commercial buildings (places of work and leisure, specialist settings such as hospitals and care homes, and potentially transport hubs and carriages) minimise the risk of disease transmission, to support public health during and beyond the current COVID-19 pandemic.

There is a moment of opportunity to make a transformational change to how we design and manage our buildings to create good, healthy and sustainable environments for those who use them. Many of these changes have relevance well beyond COVID-19. This is explored in **Part A** of this report. Our initial recommendations are:

"There will be different information needs for those with responsibility but no technical background, such as a **HEADTEACHER** or office manager, and an engineer or facilities manager who does have a technical background but who lacks specific expertise in ventilation."

LongCovidKids comment - without immediate Government investment, many of the recommendations will not be actioned. The IMMEDIATE actions ahead of winter 2021/2 may be deferred to 2022.

Initial Recommendations

PART A: Strategic Change Required

1. Government should provide support to map the knowledge and skills requirements across the building industry, general businesses, and the engineering professions to manage buildings in a way which minimises infection risks. It should then work with professional bodies, sector skills organisations and training boards to put in place plans to address the skills gaps identified.
2. Working with the National Core Studies Programme, UKRI and the National Academies, government should put in place an action plan to address key research gaps on an accelerated basis.
3. Government should undertake a rapid review of the capacity and capability requirements among regulators (including local authorities) to support and enforce standards in maintaining buildings for public health.
4. Demonstration projects should be commissioned to fill specific knowledge gaps to underwrite regulation and enforcement such as the acceptable minimum standards for ventilation to manage infection risk.
5. Government policy on net zero must be developed in a way that is consistent with priorities around indoor air quality and making buildings resilient to infection.

PART B: IMMEDIATE Actions ahead of Winter 2021/2

6. Government and its agencies should collaborate to rapidly develop and deliver clear communications aimed at building owners and operators with the lowest capability, emphasising the importance of improving ventilation whilst maintaining wider good practice on infection control.
7. Communications should be accompanied by guidance, available via trusted and widely accessible sources, to support owners and operators to establish an appropriate balance of measures to manage infection risks, alongside thermal comfort, air quality and energy efficiency.
8. Government and professional engineering bodies should provide rapid and specific technical guidance to enable owners and operators to select and effectively implement appropriate technology (e.g. conventional ventilation systems, CO_2 monitoring).
9. Government should provide incentives to encourage private and public sector organisations to improve the poorest performing spaces in buildings.

4.5 Ventilation (UK Schools) – Carbon Dioxide (CO2): Leverage SAGE-EMG advice

Context of SARS-CoV-2 transmission, measurements of CO2 levels in indoor air are effective method of identifying poor ventilation in multi-occupant spaces

Traffic Light (RAG) CO2 sensors measure: CO2 levels, Temperature and Relative Humidity. Quality CO2 sensors must have a sensing method of Non-Dispersive Infrared (NDIR) and accuracy of 50 parts per million (ppm)

1. In single-zone space > 20 people, a CO2 level that is regularly > 1,500 ppm is likely to indicate ventilation conditions that pose a higher risk of aerosol transmission.
2. Measurement of CO2 should be carried out in the occupied area of a room with the sensors located away from windows, doors and ventilation grilles. CO2 sensors should be located at breathing height of occupants.
3. Measurement should normally be made over a period of at least 1 hour to ensure a representative reading. Sensor placement and accuracy must be taken into account when analysing measured data.
4. Preliminary research suggests that in spaces where the same group of people regularly attend (e.g. offices, schools), continuous monitoring may be possible to use as a transmission risk indicator.
5. Indoor CO2 concentration level depends on the number in a given area, their activity level, and the outdoor air ventilation rate per person. Both CIBSE and ASHRAE recommendations for ventilation rates of 8-10 l/s per person in an office type setting correspond to a CO2 concentration around 1,000ppm.
6. Use **Traffic Light RAG CO2 monitors** where ventilation depends on opening windows as this visualises the need for additional ventilation levels. **GREEN CO2 < 800 ppm, RED CO2 > 1,000 ppm.**
7. In low occupancy or large volume spaces - much greater uncertainty in CO2 measurements, therefore low level of CO2 cannot necessarily be used as an indicator that ventilation is sufficient to mitigate transmission risks.
8. CO2 is not a good proxy for transmission risk in spaces where there is additional air cleaning (filtration or UVC) as these strategies remove virus but not exhaled CO2.
9. CO2 cannot be used as a proxy for ventilation in spaces where there are other CO2 sources present (e.g. combustion devices).
10. Leverage CO2 guidance from the following 4 Pillars: SAGE-EMG / RAMP, BB101 Ventilation & Thermal comfort / BESA, CIBSE / HSE / PHE, REHVA.
11. NEW*** EMG and SPI-B: Application of CO2 monitoring as an approach to managing ventilation to mitigate SARS-CoV-2 transmission (27 May 2021) - published 11 June 2021 - Document HERE

SAGE-EMG – Role of ventilation in controlling SARS-CoV-2 transmission (30 Sep 2020). Document HERE

Table 3: Averaged likely number of new cases in a worst-case occupancy scenario with ventilation rate/ CO_2, quanta generation rate and time (30 people, 150 m3 room, continuous occupancy, 8 l/min breathing, 0.005 l/s/person CO_2 generation).

		1 hour			2 hours			4 hours			6 hours		
l/s/person	steady CO2	1	10	100	1	10	100	1	10	100	1	10	100
1	5373	0.04	0.38	3.59	0.13	1.23	10.25	0.36	3.38	20.92	0.61	5.58	26.17
3	2058	0.03	0.26	2.51	0.07	0.68	6.13	0.16	1.53	12.24	0.25	2.36	16.79
5	1395	0.02	0.19	1.88	0.05	0.46	4.26	0.10	0.98	8.45	0.15	1.49	11.96
10	897	0.01	0.11	1.13	0.02	0.25	2.38	0.05	0.51	4.73	0.08	0.77	6.88
20	649	0.01	0.06	0.61	0.01	0.13	1.26	0.03	0.26	2.51	0.04	0.39	3.70

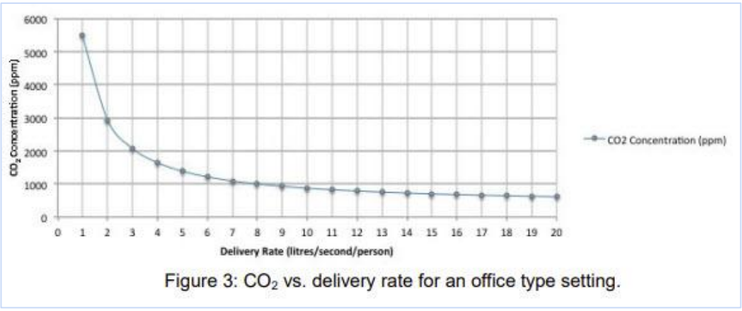


Figure 3: CO_2 vs. delivery rate for an office type setting.

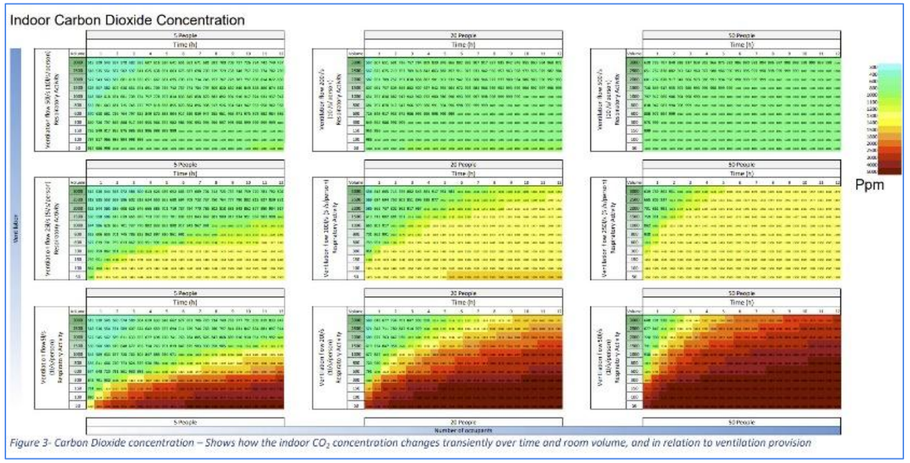


Figure 3- Carbon Dioxide concentration – Shows how the indoor CO_2 concentration changes transiently over time and room volume, and in relation to ventilation provision

Case Study: Ventilation + CO2

Tuberculosis Outbreak at Taipei University

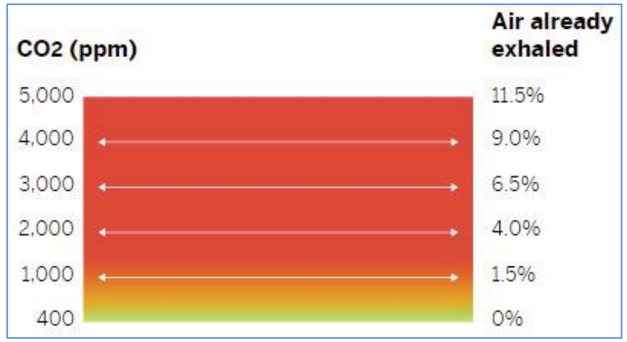
1. Classrooms under-ventilated with CO2 > 3,000ppm
2. Engineers improved air-circulation CO2< 600ppm
3. Increase in ventilation was responsible for 97% decrease on transmission. Outbreak completely stopped.

CO2 Videos

4.6 Ventilation (UK Schools) – Carbon Dioxide (CO2) Levels, Exhaled Air, Cognitive Effects

Carbon Dioxide (CO2) Levels, Exhaled Air, Cognitive Effects

Avoid Coronavirus infection in indoor spaces: don't breathe other people's air – link HERE



If car is shared and there is no ventilation, within the space of 10 mins, 8% of the air we breathe in will have already been exhaled by the other passenger. That means we are sharing the air with another person and the risk of transmission is high. 5,000ppm = 11.5% of exhaled air

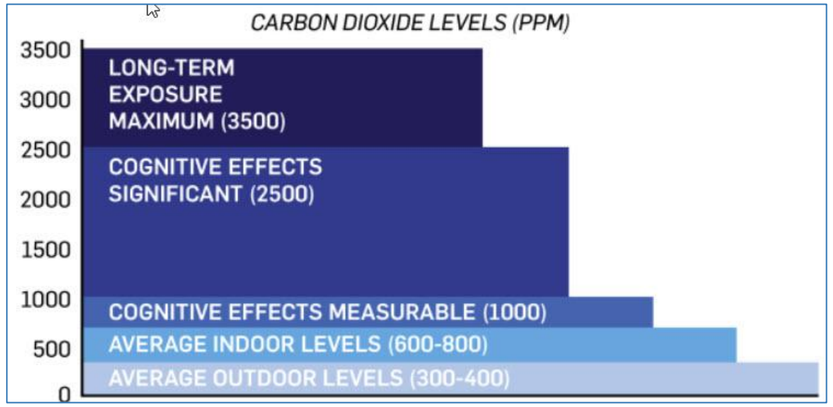
School Classrooms - REHVA CO2 Levels
1,000ppm (Red) = 1.5% of exhaled air
800ppm (Green) = 1.0% of exhaled air
415ppm (outside air) = 0% of exhaled air

Additional Benefits of Higher Ventilation and Improved Air Quality in Schools beyond airborne infectious disease transmission - HERE

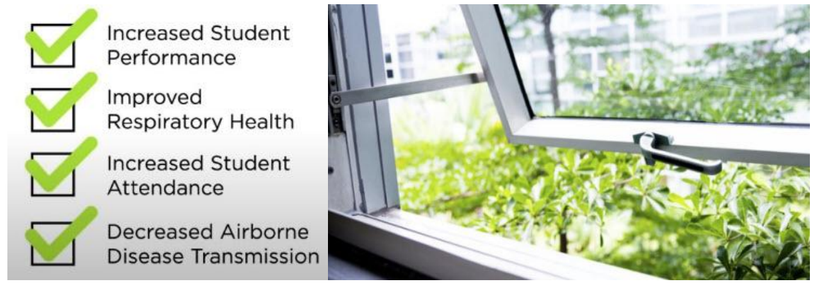
Table 1. Additional benefits of higher ventilation and improved air quality in schools beyond airborne infectious disease transmission.

Impact of Ventilation	Context	Findings	Reference
↑ Test scores	Ventilation renovations were completed to improve IAQ in all school buildings within a single Texas school district.	Math and reading test scores significantly improved, with an increased probability of passing by 2% and 3%, respectively.	42
↑ Cognitive function	CO_2 concentrations were measured as a proxy for ventilation rates in classrooms.	Cognitive testing of students shows a 5% decrease in 'power of attention' in poorly ventilated classrooms. Researchers equate this to the effect of a student skipping breakfast.	38
↑ Math, reading, and science scores	Classroom ventilation rates were measured in 140 fifth grade US classrooms.	Mean mathematics scores increased by up to 0.5% per each liter per second per person increase in ventilation rate, with similar effects on reading and science scores.	43
↓ Asthma symptoms	Exposure factors were measured in 100 primary and secondary school classrooms with and without new ventilation systems.	Pupils who attended schools with new ventilation systems reported fewer asthmatic symptoms.	44
↓Respiratory symptoms ↓ Missed school days	Over 4,000 sixth graders from 297 schools participated in a survey of indoor environmental quality in schools.	Lower ventilation rates, moisture, and dampness were all independently associated with a higher incidence of respiratory symptoms. Inadequate ventilation was also associated with more missed school days.	45
↓Child absenteeism	Increased ventilation rates and child sick days were studied for 635 children attending 20 day-care centers in Denmark.	A 12% decrease in sick days was found per hour increase in the air exchange rates.	46
↓ Missed school days	CO_2 as a proxy for ventilation was studied in 60 naturally ventilated primary school classrooms in Scotland.	For each 100 ppm increase in time average CO_2 concentration, student attendance decreased by about 0.4 days per year.	47
↓Illness absence	CO_2 concentration was measured continuously over two years in 162 US primary school classrooms with a mixture of mechanical and natural ventilation.	For each 1 L/s (2.2 cfm) per occupant increase in ventilation rate, illness absence decreased 1.6%.	26

Cognitive Effects - link HERE



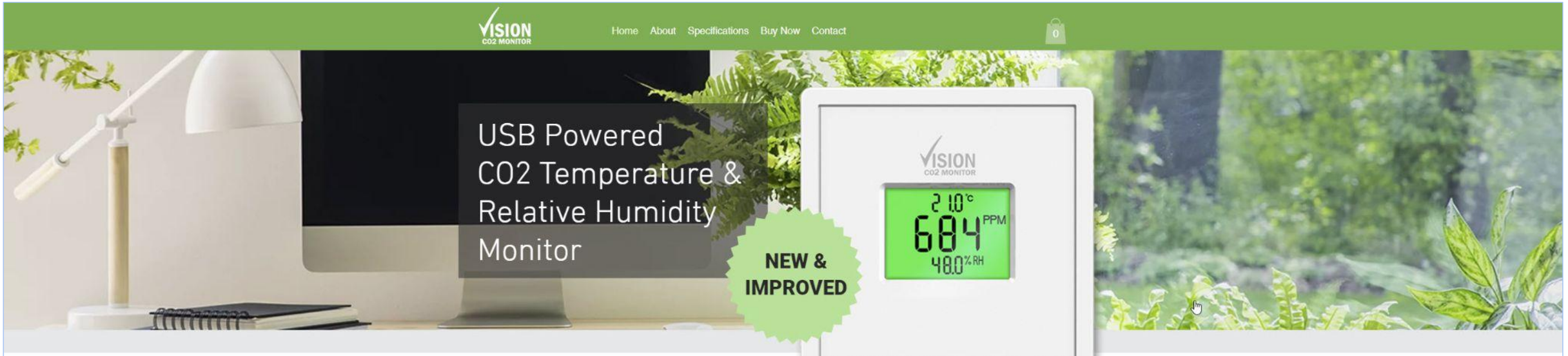
Good ventilation and lower CO2 levels help with student exam performance (27 May 2019) – link HERE



4.7 Carbon Dioxide (CO2) – Flamefast UK CO2 Specialists

Leading UK manufacturer and global supplier: Local Authorities, Schools, Universities, Offices, Public Buildings, Workplaces and Homes

Portable or Wall Mounted HERE



What's included:

- Vision CO2 Monitor
- Anti-tamper Wall Bracket
- USB Mains Adapter (White)
- 2m USB Cable (White)

Free Windows app:

- Multicoloured setting configuration
- 30-day historical data can be viewed
- Temp & RH Readings can be disabled
- Manual Calibration

VISION CO2 MONITOR

Vision is a high-quality **UK Manufactured** CO2 Monitor that advises when further ventilation is required. This 'plug and play' solution does not require hard wiring yet has the added benefit of continuous monitoring (updated every 5 seconds) and provides a bold visual indication that is not achievable with battery operated units.

An anti-tamper wall bracket (with cable securing channel) is supplied as standard, so Vision can be used as both a portable or fixed solution. When you connect Vision to a Laptop or PC, the free PC app allows your Vision settings to be fully customised, and readings for the previous 30 days to be viewed

LongCovidKids.Org

Proudly supporting Long Covid Kids!
www.longcovidkids.org

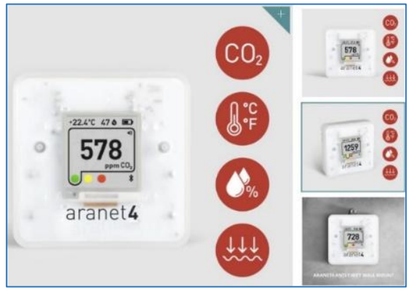
KEY FEATURES

- USB Powered - PC/Mains Adapter
- Non-dispersive Infra-red (NDIR) CO2 Sensor
- Bold Multicoloured Indication
- Desktop or Wall Mountable
- Anti-tamper Wall Bracket supplied as standard
- Typical 10 year life expectancy
- Configurable through free PC App
- **UK MANUFACTURED**

4.8 Carbon Dioxide (CO2) – Aranet4

Aranet4 - based in Europe and USA – Global Distribution

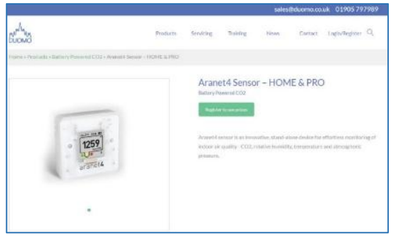
Aranet4 – Portable or Wall Mounted



- Case Study – Milan School HERE

Base Station video & Air Quality video

UK Supplier - Duomo



Australia – CO2 Radical

Webinars (60 mins) – Science and Risks of Indoor Aerosol Transmission

Aranet4: Home, Pro (Ideal for classrooms) and Base Station – link HERE

ARANET4 PRO + ARANET PRO

FOR EDUCATIONAL FACILITIES

- The Centers for Disease Control and Prevention guidelines assert that COVID-19 can be spread via small droplets and aerosols
- These virus containing aerosols can linger in the air for several hours
- Proper air exchange and ventilation can shorten this time interval 10 times
- Aranet4 is the perfect device for monitoring the air exchange rate. It warns when the air quality has become unhealthy and you should take care of the airflow in the classroom

Schools and universities often are hotbeds for COVID-19 spread. This is no surprise since there are many people in closed environments like classrooms, so it can be a nightmare to ensure all safety precautions are met. **The Centers for Disease Control and Prevention has warned that COVID-19 can spread via aerosols.** These are small droplet particles containing the SARS-CoV-2 virus - a serious risk factor that has to be considered indoors. The best way to combat it is to ensure proper air exchange. How can you know if the air quality is good? This is where Aranet comes in!
Aranet4 PRO sensors + Aranet PRO base station is the perfect solution for educational facilities to ensure safety from COVID-19 spreading via aerosols.

ARANET4 PRO SENSOR
A COVID-19 aerosol transmission risk monitoring device

- A wireless plug-and-play device with on-screen display
- Monitors CO_2 (an air quality indicator), temperature, relative humidity and atmospheric pressure
- Warns via color indicator and sound signal when action must be taken to increase airflow

ARANET PRO BASE STATION
for centralized data monitoring

- Wirelessly gathers readings from up to 100 Aranet4 devices
- Centralized reporting, graphing and alarms – understand the situation in the whole building and find out which classrooms are more dangerous
- Integrate into existing systems/databases

Aranet4 is an easy to use CO_2 monitoring device that lets you know right away if the ventilation is sufficient and whether you are at an elevated risk of SARS-CoV-2 infection via aerosols. Visual color indicators as well as a sound alarm will notify you when action (opening windows, turning up the ventilation or leaving the room all together) must be taken.

For a complete school solution you can have an Aranet4 device in each classroom and then wirelessly network them to an Aranet PRO base station. It's **plug-and-play** easy to set up and comes with **free software** that allows you to see graphs, download reports and receive centralized alarms. With it you get a complete overview of what is happening in the educational facility building, you see which classrooms are more dangerous so you can plan accordingly. Aranet allows you to see the invisible.

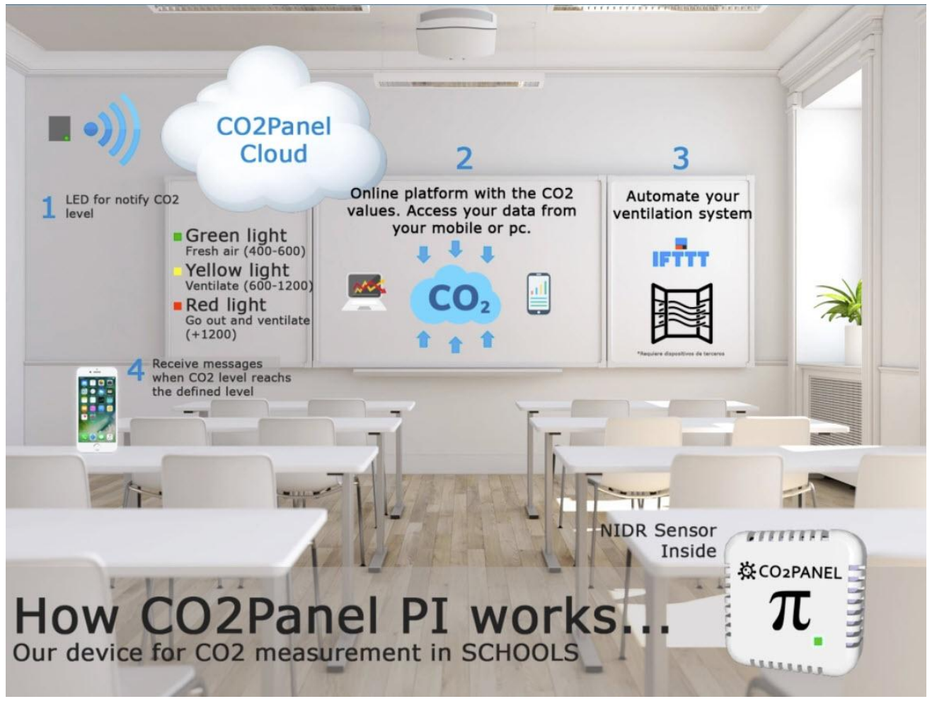
You can only improve what you can measure.
Let Aranet4 make your facilities safer!

WWW.ARANET.COM

4.9 Carbon Dioxide (CO2) – CO2 Panel

CO2 Manufacturer and distribution within UK, Spain, Sweden and across Europe

CO2 Panel PI www.co2panel.co.uk and www.co2panel.com

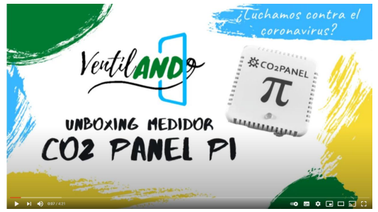


Monitoring CO2 Levels to control spread of Covid-19

At co2panel we have developed 2 different covid-19 specific co2 monitors in line with the latest research studies[*] to provide industry specific support to the UK community (Schools, Surgeries, Hospitals, Offices, Restaurants, Pubs and Cinemas).

LongCovidKids.Org

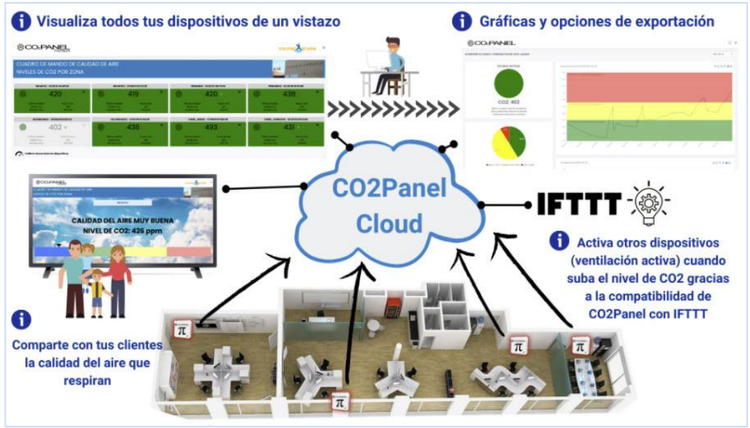
PROUDLY SUPPORTING LONG COVID KIDS



- Monitors CO2 discreetly
- Schools, offices and cinemas
- 3 colour LED display
- Internet connection

- Certified to be used to monitor CO2 for Covid-19
- NDIR Sensors as advised by CIBSE
- Permanent installation (Continuous use 24/7)
- Wi-Fi connectivity (view readings online multi-device)
- Industrial Grade
- Easy/simple to read (traffic light system)
- Automatic calibration
- Alarm set available (SMS, email)
- Full data capture (download co2 histories)
- Remote monitoring and integration for number of classrooms (online access mobile and desktop)
- Discrete and well integrated

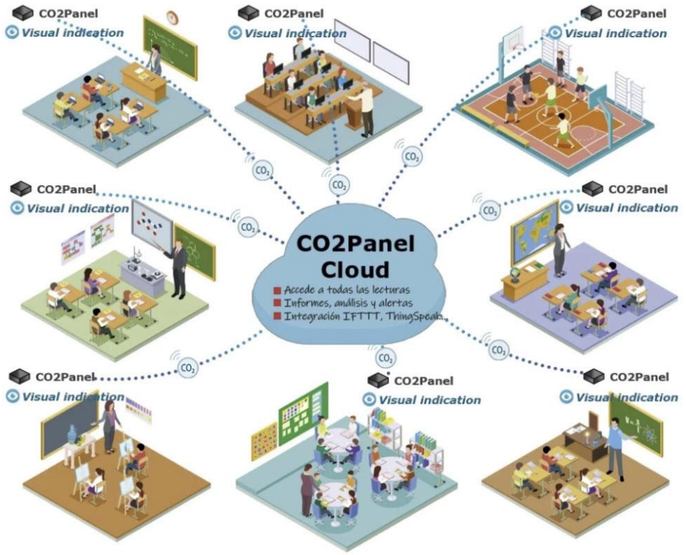
CO2 Panel Premium



CO2 Panel Matrix

- Monitors CO2 and displays information
- Schools, surgeries, offices, restaurants
- 14 Inch colour LED display
- Internet connection

CO2 Panel CLOUD



CO2PANEL products are accurate, long lasting and DONT require calibration. They are all maintenance-free and have been design for continuous monitoring (industrial grade)

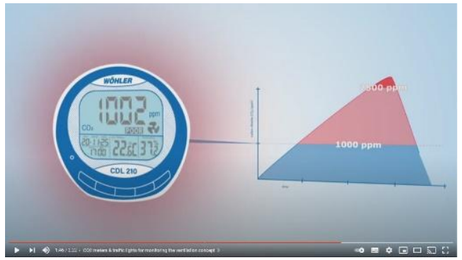
4.10 Carbon Dioxide (CO2) – Other CO2 Companies

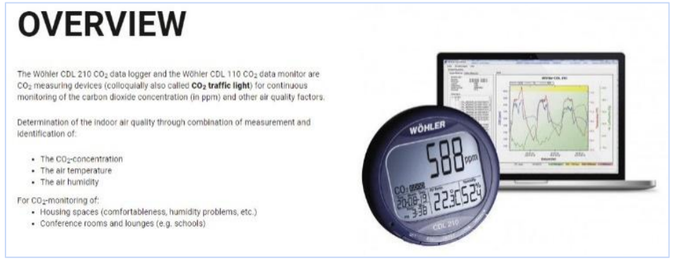
Selection of Global Companies that supply CO2 monitors that are suitable for school classrooms and other workplaces

Rotronic (Switzerland) – Portable CO2 data display and data logger

- Ideal for classrooms, meeting rooms open-plan offices, shopping centres and fitness studios
- Worldwide distribution hubs: Switzerland, Germany, France, Italy, UK, USA, Canada, Singapore, China, Japan

Wohler (Germany) – Portable data monitor and data logger





- Ideal for classrooms, care homes, offices, conference rooms, homes
- Worldwide distribution hubs: Germany, Austria, France, Italy, Netherlands, USA, UK

Senseair (Sweden) Portable and Fixed Units and Duomo (UK) Fixed Unit

It is recommended by REHVA that the levels are temporarily changed to green-yellow 800ppm and red at 1000ppm, in order to promote as much ventilation as possible. Duomo offer compatible devices such as the Senseair tSense, CO2MC and TLD1. ...

- Variety of products for most workplaces (inc Schools)

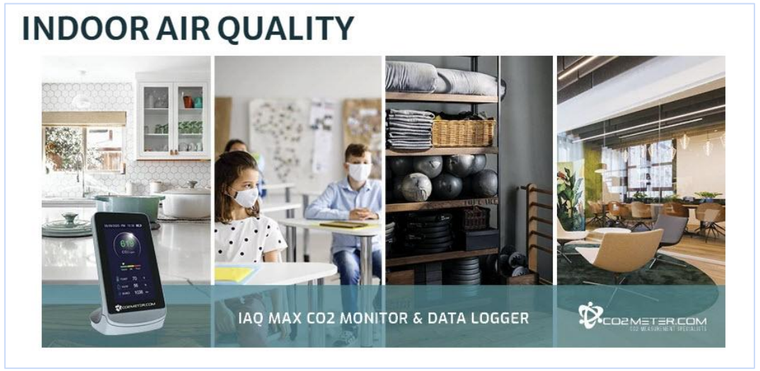
CO2MC – Carbon Dioxide, Temp & RH Monitor

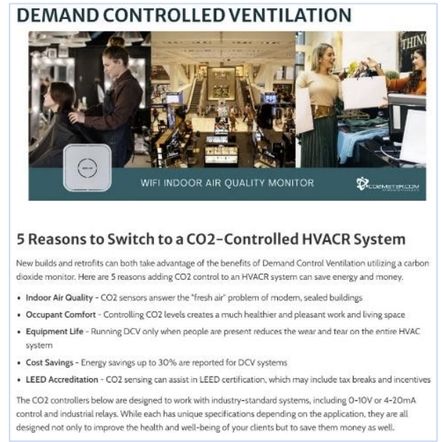
Aercast – Senseair Customisable CO2, Temp and RH

ExploraCO2 – Senseair CO2, Temp and RH sensor

- UK Supplier www.Duomo.co.uk for Senseair and Duomo products
- Senseair products directly available from https://senseairsafestart.com/en/

CO2Meter (USA) - Portable/Desktop AND Fixed/Wall Mounted Units





- Variety of products for most workplaces (inc Schools)
- Global distribution

4.11 Air Pollution and Indoor Air Quality

Air Pollution and Indoor Air Quality

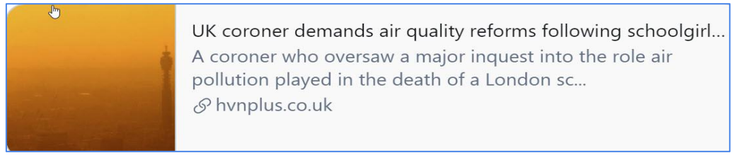
Air Quality Scientists are demanding a “Paradigm shift” in Ventilation Standards – HERE

1. The pandemic has brought air quality to the fore, but it isn’t just Coronavirus that’s a concern if air safety isn’t monitored in schools - HERE
2. Total overhaul of indoor air quality needed post-pandemic, experts warn - HERE
3. Urgent Need for Indoor Air Quality Regulation - HERE
4. To prevent next pandemic, scientists say we must regulate air like food and water - HERE
5. Calls for post-Covid ‘revolution’ in building air quality – proposal for public places to have ventilation certificates - HERE
6. BESA Backs Scientists’ call for overhaul of ventilation standards – HERE
7. Ask more questions about building’ indoor air quality – say leading scientists - HERE
8. Why opening windows is as important as Hands, Face, Space – HERE
9. Boost air quality in buildings to reduce respiratory infections – HERE
10. A paradigm shift to combat indoor respiratory infection. Science article HERE + next slide

Effects of Indoor air quality (IAQ) on children and young people – Dated 28 Jan 2020 (pre-COVID) – link HERE

- UK children spend more of their lives indoors, and health impact of the air within homes + schools must be taken seriously
- Report based on systematic review of science of indoor pollution, + conversations with children, young people and families
- Recommendations for Government and local authorities, and provide guidance for families

Air Pollution and Indoor Air Quality (IAQ) Articles



1. UK coroner demands air quality reforms following schoolgirl’s death – HERE
2. Study links childhood air pollution exposure to poorer mental health - HERE
3. Why is Indoor Air Quality important in schools - Video Link HERE
4. Indoor Air Quality Matters more than ever - plants aren’t the solution HERE
5. Researchers explore connection between air pollution + mental health HERE
6. Systemic Inequalities in Indoor Air Pollution exposure in London – HERE
7. Majority of Londoners want cleaner air – article HERE
8. Heterogeneous medium benefits of CV19 lockdowns on air pollution - HERE
9. Trends in indoor air quality and their effects on human health – HERE
10. Volatile Organic Compounds (VOCs) in Commonly used products HERE
11. Ventilation Guide argues UK in urgent need of IAQ Standards HERE

N.Wood + 10 year-old son highlight:

- Air Pollution is the BIGGEST environmental threat to health in the UK
- Governments need to do more to improve IAQ and protect children and families in schools and businesses

4.11 Air Pollution and Indoor Air Quality

Air Pollution and Indoor Air Quality

A paradigm shift to combat indoor respiratory infection. Science article HERE

POLICY FORUM

INFECTIOUS DISEASE

A paradigm shift to combat indoor respiratory infection

Building ventilation systems must get much better

By Lidia Morawska, Joseph Allen, William Bahnfleth, Philomena M. Bluyssen, Atze Boerstra, Giorgio Buonanno, Junji Cao, Stephanie J. Dancer, Andres Floto, Francesco Franchimon, Trisha Greenhalgh, Charles Haworth, Jaap Hogeling, Christina Isaxon, Jose L. Jimenez, Jarek Kurnitski, Yuguo Li, Marcel Loomans, Guy Marks, Linsey C. Marr, Livio Mazzarella, Arsen Krikor Melikov, Shelly Miller, Donald K. Milton, William Nazaroff, Peter V. Nielsen, Catherine Noakes, Jordan Peccia, Kim Prather, Xavier Querol, Chandra Sekhar, Olli Seppänen, Shin-ichi Tanabe, Julian W. Tang, Raymond Tellier, Kwok Wai Tham, Pawel Wargocki, Aneta Wierzbicka, Maosheng Yao

There is great disparity in the way we think about and address different sources of environmental infection. Governments have for decades promulgated a large amount of legislation and invested heavily in food safety, sanitation, and drinking water for public health purposes. By contrast, airborne pathogens and respiratory infections, whether seasonal influenza or COVID-19, are addressed fairly weakly, if at all, in terms of regulations, standards, and building design and operation, pertaining to the air we breathe. We suggest that the rapid growth in our understanding of the mechanisms behind respiratory infection transmission should drive a paradigm shift in how we view and address the transmission of respiratory infections to protect against unnecessary suffering and economic losses. It starts with a recognition that preventing respiratory infection, like reducing waterborne or foodborne disease, is a tractable problem.

Two factors in particular may contribute to our relatively weak approach to fighting airborne transmission of infectious diseases compared to waterborne and foodborne transmission. First, it is much harder to trace airborne infections. Food and water contamination nearly always come from an easily identifiable point source with a discrete reservoir, such as a pipe, well, or package of food. Its impact on human health is early if not immediate in terms of characteristic signs and symptoms, so that diligent epidemiology can track and identify the source relatively easily. Over the years, this has led to the current public health structures in well-resourced countries. Standards have been enacted for all aspects of food and water processing, as well as wastewater and sewage. Public health officials, environmental health officers, and local councils are trained in surveillance, sampling, and investigation of clusters of potential food and waterborne outbreaks, often alerted by local microbiology laboratories. There are published infection rates for a large range of pathogens, with morbidity and mortality risks now well established. By contrast, airborne studies are much more difficult to conduct because air as a contagion medium is nebulous, widespread, not owned by anybody, and uncontained. Buildings and their airflows are complicated, and measurement methods for such studies are complex and not generally standardized.

> "...healthy indoor environments with a substantially reduced pathogen count are essential for public health."

Second, a long-standing misunderstanding and lack of research into airborne transmission of pathogens has negatively affected recognition of the importance of this route (*1*). Most modern building construction has occurred subsequent to a decline in the belief that airborne pathogens are important. Therefore, the design and construction of modern buildings make few if any modifications for this airborne risk (other than for specialized medical, research, or manufacturing facilities, for example). Respiratory outbreaks have been repeatedly "explained away" by invoking droplet transmission or inadequate hand hygiene. For decades, the focus of architects and building engineers was on thermal comfort, odor control, perceived air quality, initial investment cost, energy use, and other performance issues, whereas infection control was neglected. This could in part be based on the lack of perceived risk or on the assumption that there are more important ways to control infectious disease, despite ample evidence that healthy indoor environments with a substantially reduced pathogen count are essential for public health.

It is now known that respiratory infections are caused by pathogens emitted through the nose or mouth of an infected person and transported to a susceptible host. The pathogens are enclosed in fluid-based particles aerosolized from sites in the respiratory tract during respiratory activities such as breathing, speaking, sneezing, and coughing. The particles encompass a wide size range, with most in the range of submicrometers to a few micrometers (*1*).

Although the highest exposure for an individual is when they are in close proximity, community outbreaks for COVID-19 infection in particular most frequently occur at larger distances through inhalation of airborne virus-laden particles in indoor spaces shared with infected individuals (*2*). Such airborne transmission is potentially the dominant mode of transmission of numerous respiratory infections. There is also strong evidence on disease transmission—for example, in restaurants, ships, and schools—suggesting that the way buildings are designed, operated, and maintained influences transmission.

Yet, before COVID-19, to the best of our knowledge, almost no engineering-based measures to limit community respiratory infection transmission had been employed in public buildings (excluding health care facilities) or transport infrastructure anywhere in the world, despite the frequency of such infections and the large health burden and economic losses they cause (*3*). The key engineering measure is ventilation, supported by air filtration and air disinfection (*4*). In this context, ventilation includes a minimum amount of outdoor air combined with recirculated air that is cleaned using effective filtration and disinfection.

VENTILATION OF THE FUTURE

There are ventilation guidelines, standards, and regulations to which architects and building engineers must adhere. Their objectives are to address the issues of odor, and occupant-generated bioeffluents [indicated by the concentrations of occupant-generated carbon dioxide (CO_2)], by specifying minimum ventilation rates and other measures to provide an acceptable indoor air quality (IAQ) for most occupants. Similarly, there are other guidelines and regulations to ensure thermal comfort. To achieve this, the amount of outdoor air delivered to indoor spaces is recommended or mandated in terms of set values of air change rate per hour, or liters of air per person per second. Threshold values of CO_2 and a range of indoor air temperatures and relative humidity have also been prescribed.

There are also some health-based indoor air quality guidelines. The most important are the World Health Organization (WHO) IAQ guidelines, providing values for benzene, carbon monoxide, formaldehyde, and other chemicals, based on the duration of exposure (*5*). There are, however, no ventilation guidelines or standards to specifically control the concentration of these pollutants indoors. None of the documents provide recommendations or standards for mitigating bacteria or viruses in indoor air, originating from human respiratory activities. Therefore, it is necessary to reconsider the objective of ventilation to also address air pollutants linked to health effects and airborne pathogens.

One challenge is that ventilation rates required to protect against infection transmission cannot be derived in the same way as rates for other pollutants. First, infection-focused ventilation rates must be risk-based rather than absolute, considering pathogen emission rates and the infectious dose [for which there exist data for a number of diseases, including influenza (*6*), severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome, tuberculosis, SARS-CoV-2, and measles]. There is often limited knowledge of viral emission rates, and rates differ depending on the physiology of the respiratory tract (which varies with age, for example), the stage of the disease, and the type of respiratory activity (e.g., speaking, singing, or heavy breathing during exercise). The infectious dose may differ depending on the mode of transmission. This is well established for influenza A, for which the infectious dose is smaller with an aerosol inoculum than with nasal instillation (*7*). Some infectious agents display "anisotropy," in which the severity of disease varies according to the mode of transmission (*7*).

Second, future ventilation systems with higher airflow rates and that distribute clean, disinfected air so that it reaches the breathing zone of occupants must be demand controlled and thus flexible (see the figure). The ventilation rate will differ for different venues according to the activities conducted there (e.g., higher ventilation rates for exercising in gyms than for resting in movie theaters). There are already models enabling assessments of ventilation rates and their effective distribution in the occupant microenvironments (*8*), and in general this is a rapidly expanding field.

Demand control and flexibility are necessary not only to control risk but also to address other requirements, including the control of indoor air pollution originating from inside and outside sources and, especially, to control energy use: Ventilation should be made adequate on demand but not unreasonably high. Buildings consume over one-third of energy globally, much of it expended on heating or cooling outdoor air as it is brought indoors. Therefore, although building designs should optimize indoor environment quality in terms of health and comfort, they should do so in an energy-efficient way in the context of local climate and outdoor air pollution.

Third, in some settings, it will not be possible to increase ventilation to the point of reducing the risk to an acceptable level, regardless of the quality of the ventilation system. This refers to individual risk of infection for each susceptible occupant, to the event reproduction number (the expected number of new infections arising from a single infectious occupant at an event), and to the reality that ventilation has less of an impact for near-field exposure. Management of the event reproduction number is important for the control of an epidemic, especially for indoor spaces with a high density of people, high emission rate (vocalization or exercising), and long periods of shared time. Spaces like this will require air-cleaning measures, including air filtration and disinfection. Air filtration can be achieved by incorporating filters into the building heating, ventilation, and air conditioning system or by portable air cleaners, and air disinfection can be achieved by using ultraviolet devices (*4*) while avoiding unproven technologies. The necessity of such measures and their effective per-person additional removal rate, and thus their efficacy in risk reduction, can be incorporated into risk assessment and prospectively modeled.

None of this means that every indoor space should become a biosafety facility. It means that a building should be designed and operated according to its purpose and the activities conducted there, so that airborne infection risk is maintained below an acceptable level. Such measures cannot easily be taken during the current pandemic because most building systems have not been designed for limiting respiratory infection, building owners and operators were not trained to operate the systems during the pandemic, and ad hoc measures are often not sufficient. Such training, and appropriate measures, should form a part of national strategies to prevent the spread of airborne diseases and infections.

The only types of public buildings where airborne infection control exists are health care facilities, where requirements for ventilation rates are typically much higher than for other public buildings (*9*). However, although modern hospitals comply with relevant standards set to control infection, this may not always be the case for some hospitals located in very old buildings. Comparing health care ventilation requirements with those for non–health care venues suggests that non–health care rates should be higher for effective infection control or that more recirculation with better filtration should be used.

There needs to be a shift in the perception that we cannot afford the cost of control, because economic costs of infections can be massive and may exceed initial infrastructure costs to contain them. The global monthly harm from COVID-19 has been conservatively assessed at $1 trillion (*10*), but there are massive costs of common respiratory infections as well. In the United States alone, the yearly cost (direct and indirect) of influenza has been calculated at $11.2 billion (*11*); for respiratory infections other than influenza, the yearly cost stood at $40 billion (*12*).

It is not known exactly what fraction of infections could be prevented if all building and transport ventilation systems on the planet were ideal (in terms of controlling airborne infections), or the cost of design and retrofitting to make them ideal. However, the airborne transmission route is potentially the dominant mode of transmission (*1, 2, 13*). Estimates suggest that necessary investments in building systems to address airborne infections would likely result in less than a 1% increase in the construction cost of a typical building (*14*). For the vast inventory of existing buildings, although economic estimations are more complex, there are numerous cost-effective, performance-enhancing solutions to minimize the risk of infection transmission. Although detailed economic analyses remain to be done, the existing evidence suggests that controlling airborne infections can cost society less than it would to bear them.

The costs of infections are paid from different pockets than building and operating costs or health care costs, and there is often resistance to higher initial expenditure. But ultimately, society pays for all the costs, and costs and benefits are never evenly distributed. Investment in one part of the system may generate savings in a different part of the system, so cross-system reallocation of budgets must be facilitated. The benefits extend beyond infectious disease transmission. An improvement in indoor air quality may reduce absenteeism in the workplace from other, noninfectious causes, such as sick building syndrome and allergic reactions, to the extent that the reduction in productivity losses may cover the cost of any ventilation changes.

A PATH FORWARD

We encourage several critical steps. First and foremost, the continuous global hazard of airborne respiratory infection must be recognized so the risk can be controlled. This has not yet been universally accepted, despite strong evidence to support it and no convincing evidence to refute it.

Global WHO IAQ guidelines must be extended to include airborne pathogens and to recognize the need to control the hazard of airborne transmission of respiratory infections. This includes recommendations on preventive measures addressing all modes of respiratory infection transmission in a proper and balanced way, based on state-of-the-art science. The recently published WHO Ventilation Roadmap (*15*) is an important step but falls short of recognizing the hazard of airborne respiratory infection transmission and, in turn, the necessity of risk control.

National comprehensive IAQ standards must be developed, promulgated, and enforced by all countries. Some countries have IAQ standards, but none are comprehensive enough to include airborne pathogens. In most countries that have IAQ standards, there are no enforcement procedures. Most countries do not have any IAQ standards.

Comprehensive ventilation standards must be developed by professional engineering bodies. Organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers and the Federation of European Heating, Ventilation and Air Conditioning Associations have ventilation standards, and during the COVID-19 pandemic, they have proposed building and system-related control actions and design improvements to mitigate risk of infection. However, standards must be improved to explicitly consider infection control in their statements of purpose and definitions. New approaches must be developed to encourage implementation of standards (e.g., "ventilation certificates" similar to those that exist for food hygiene certification for restaurants).

Wide use of monitors displaying the state of IAQ must be mandated. At present, members of the general public are not well aware of the importance of IAQ and have no means of knowing the condition of the indoor spaces that they occupy and share with others. Sensor technologies exist to display numerous parameters characterizing IAQ (most commonly, but not exclusively, CO_2). Existing IAQ sensor technologies have limitations, and more research is needed to develop alternative indicator systems. However, visible displays will help keep building operators accountable for IAQ and will advance public awareness, leading to increased demand for a safe environment.

The COVID-19 pandemic has revealed how unprepared the world was to respond to it, despite the knowledge gained from past pandemics. A paradigm shift is needed on the scale that occurred when Chadwick's *Sanitary Report* in 1842 led the British government to encourage cities to organize clean water supplies and centralized sewage systems. In the 21st century, we need to establish the foundations to ensure that the air in our buildings is clean with a substantially reduced pathogen count, contributing to the building occupants' health, just as we expect for the water coming out of our taps.

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14. P. Wargocki et al., "Indoor climate and productivity in offices," REHVA Guidebook (2006).
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SUPPLEMENTARY MATERIALS

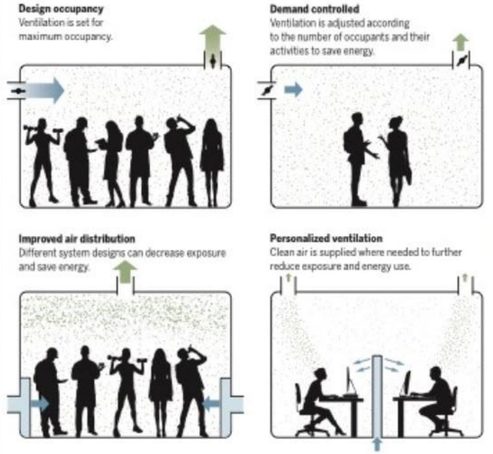
science.sciencemag.org/content/372/6543/689/suppl/DC1

10.1126/science.abg2025

Affiliations are listed in the supplementary materials.
Email: l.morawska@qut.edu.au

Flexible ventilation systems, dependent on the building's purpose

Ventilation airflow rates must be controlled by the number of occupants in the space and their activity.



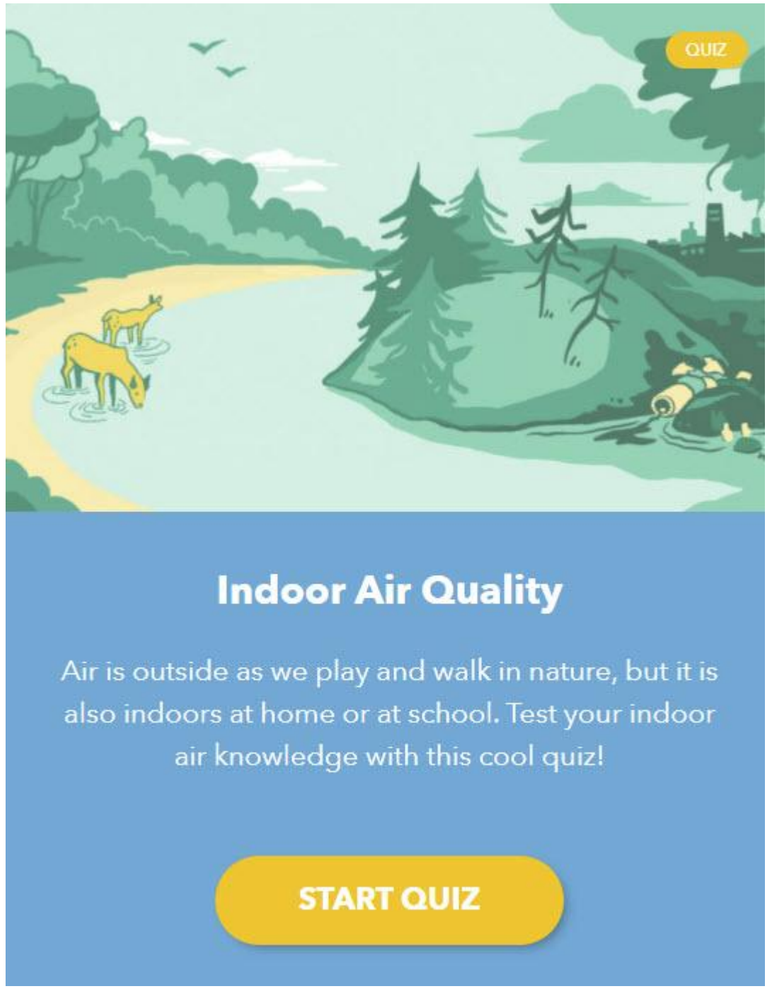
4.12 Air For Kids (#AirforKids) - Airthings

Educational website for kids, educators, parents to learn about AIR (Outdoor air pollution and Indoor Air Quality (IAQ))

Learn about outdoor air, pollution, indoor air and all the tiny things that make up the air we breathe in everyday - HERE

Air for kids was designed with one goal; **air quality education**. The air we breathe in is paramount to our health and wellbeing. Not to mention the impact the air has on our planet's ecosystem. We believe learning about air quality is a vital subject that everyone should know more about. As part of Airthings' commitment to the **UN Global Compact initiative**, we have therefore set the ambitious goal of educating one million children about air quality by 2026!

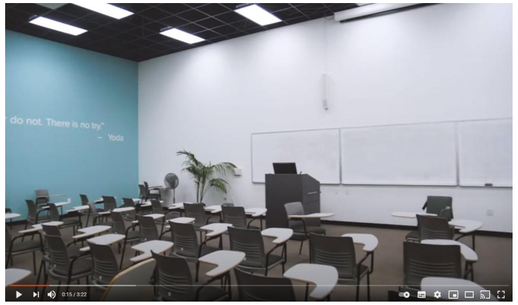
Quizzes - HERE



4.13 Indoor Air Quality - Airthings

Global Distribution to North America, Europe and UK - Ensure a safe and healthy environment in kindergartens, schools, colleges and universities

IAQ Sensors for Home, Schools and Businesses - www.airthings.com

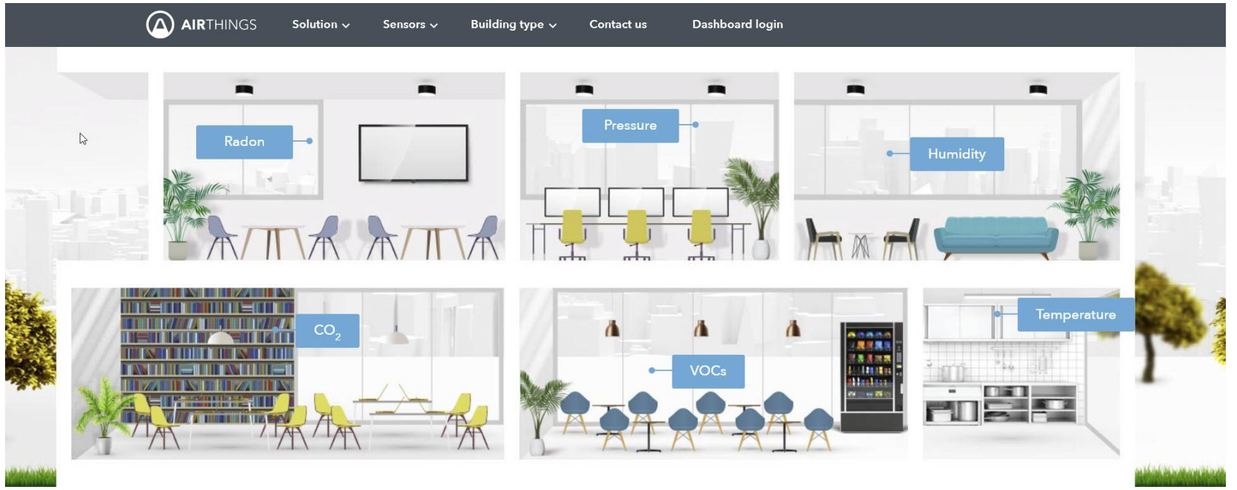


View Plus

The most advanced smart air quality tech on the market measuring radon, particulate matter (PM), CO2, and more, plus a customizable display.

The importance of IoT in monitoring IAQ

Healthy Schools - good indoor air improves productivity, reduces sick leave and decreases airborne disease transmission



An out-of-the-box solution for any building

The Airthings for Business solution is set up in a matter of minutes. The wireless monitors run on long-lasting batteries, making the solution easily scalable.

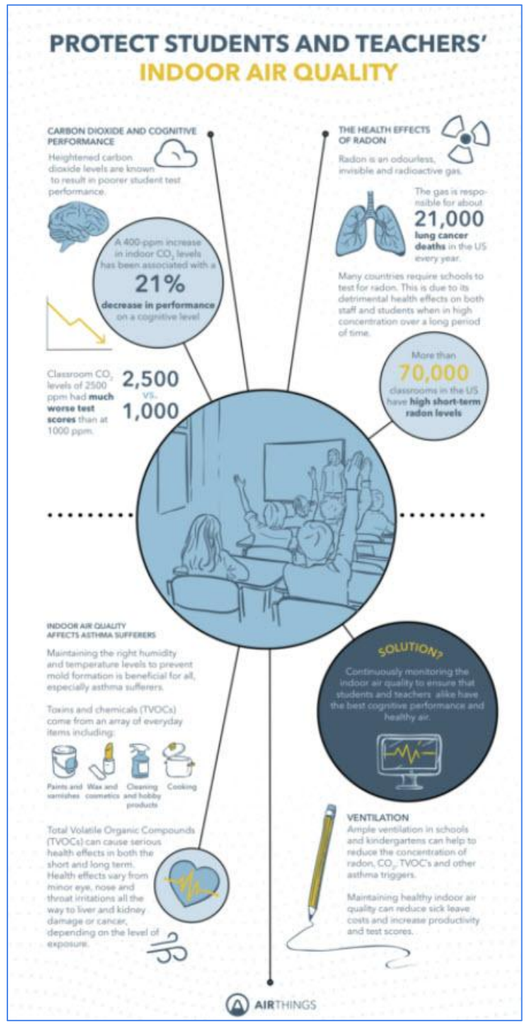
The monitors connect to a hub which gives you instant access to your indoor air quality data which you can view in a simple and customizable dashboard, on a screen on the wall or easily connected via API into your other systems.

After only a few minutes you'll see live data on CO_2, temperature, humidity, airborne chemicals, radon, light, occupancy and pressure.

4.13 Indoor Air Quality - Airthings

Indoor Air Quality Guide for Schools

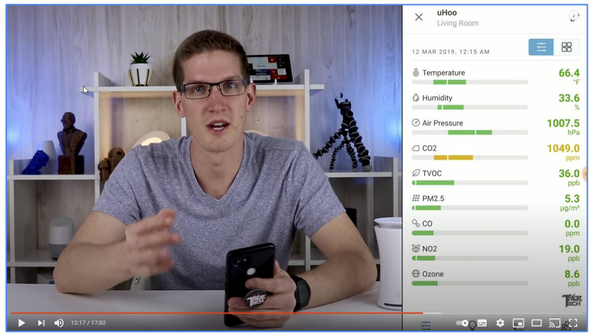
Indoor Air Quality Guide HERE



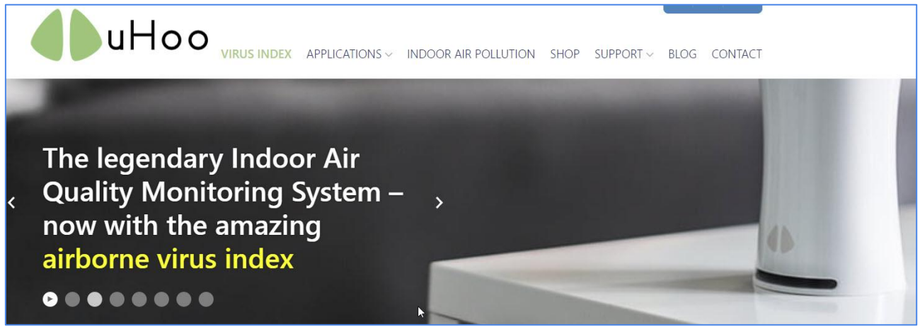
4.14 Indoor Air Quality - uHoo

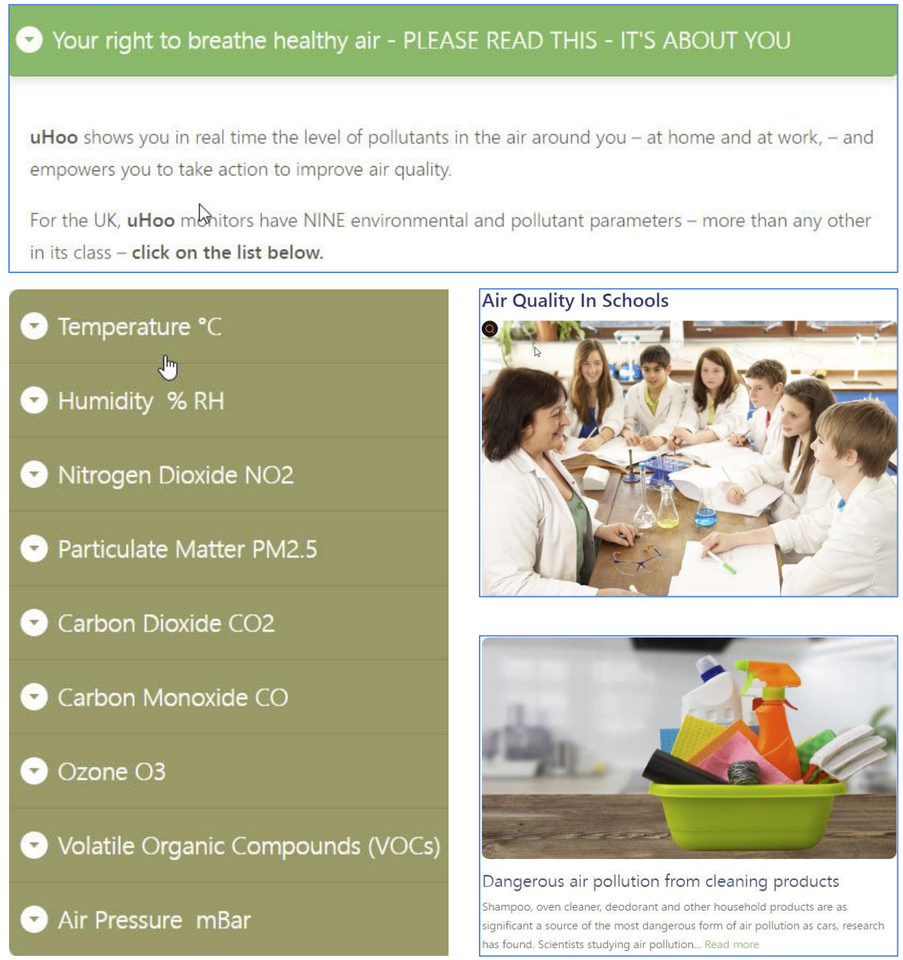
Legendary Indoor Air Quality Sensor - Nine Environmental and pollutant parameters

Videos



Schools, Healthcare, Homes, Hotels, Restaurants, Entertainment, Public Sector, Enterprise and SMART Buildings www.uhooair.co.uk



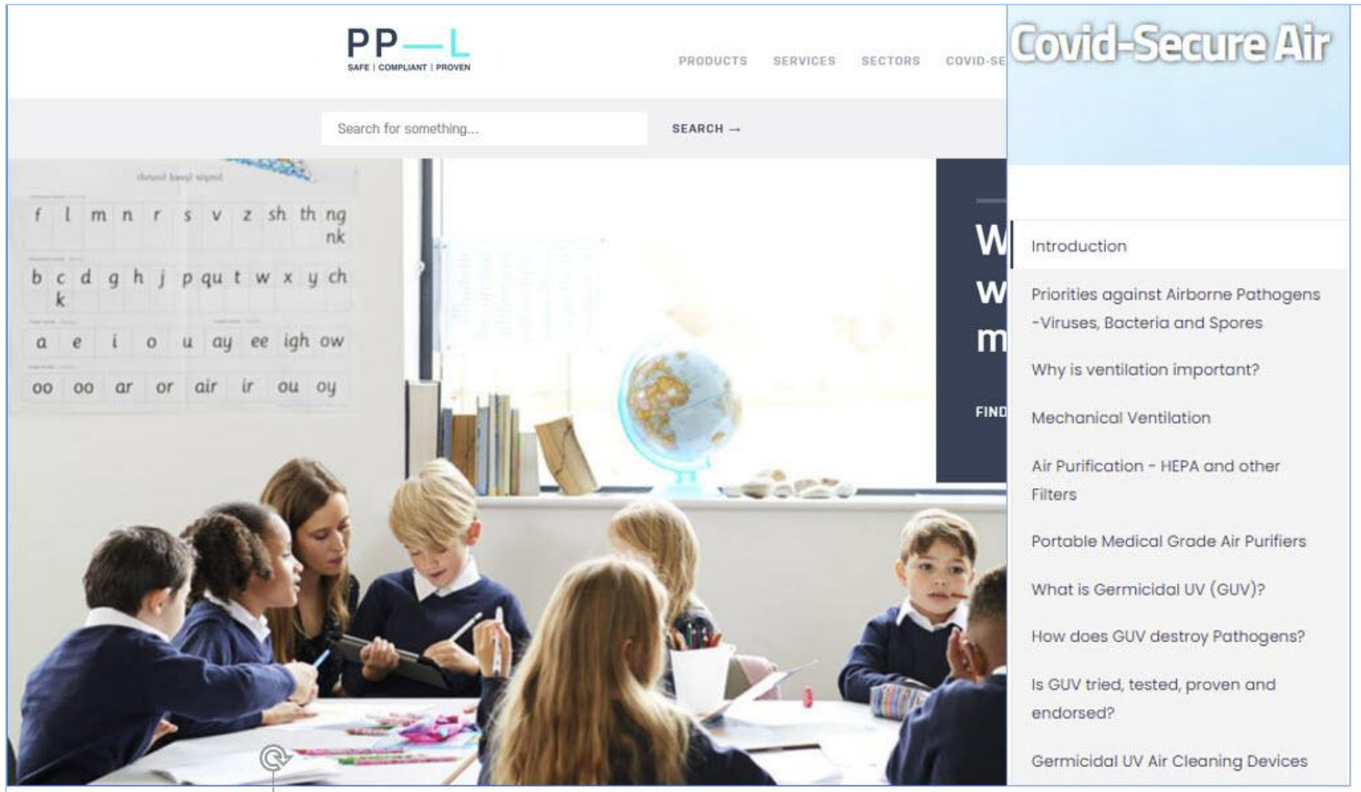


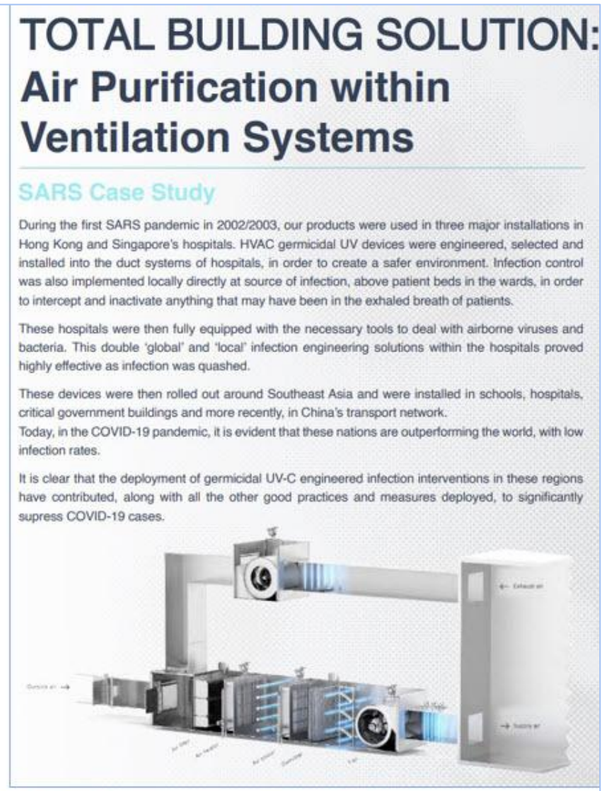
Achieve LEED Certification with uHoo Auru

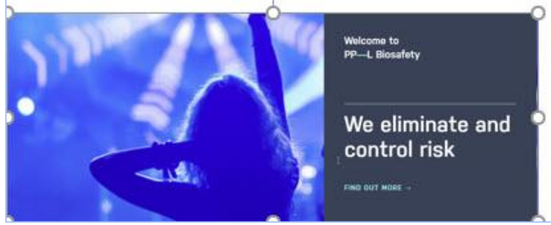
4.15 PP-L Biosafety

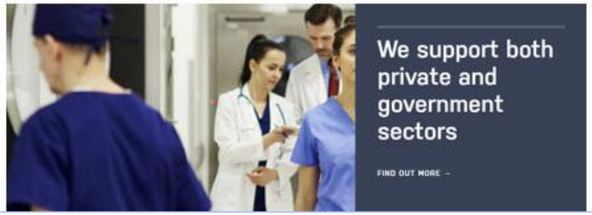
UK Government COVID-19 Specialist Suppliers www.ppl-biosafety.com

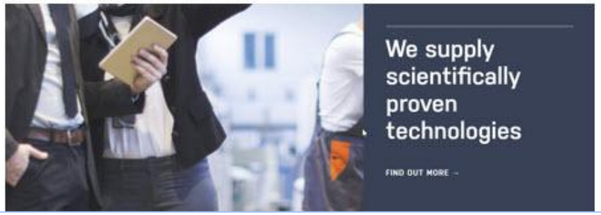
Design, install and maintain solutions for infection prevention with bacteria, micro-organisms pathogens in the air

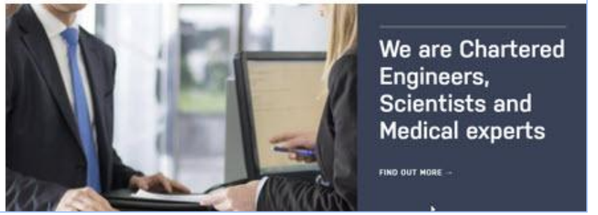












Case Study: Air Disinfection Solutions in a Sensitive Educational Support & Care Setting

Rainbow Stars - February 2021

Introduction

Rainbow Stars, Lincolnshire, is a specialist educational group that focuses on supporting the needs of children with Autism, ADHD, Asperger's Syndrome and other behavioural issues. During the COVID-19 pandemic the registered charity could only welcome a reduced number of children but with such important work, staff and volunteers continued supporting the learning and wellbeing of their most vulnerable children.
With the safety of their volunteers and children being number one priority, when Covid-19 was announced, the staff ensured that everybody entering their space was temperature checked upon arrival, hygiene was significant, and Covid-Secure Guidance followed to the letter.

Nevertheless, Rainbow Stars contacted PP-L in early 2020, not long after the pandemic was announced, to explore options of reducing the risk of COVID-19 and ensure maximum safety of those in their care and in their workplace environment. The Rainbow Stars hub has no mechanical ventilation and only one external wall with small windows. PP-L's diverse team of Chartered Engineers, Scientists and Medics were early in providing defences for clients in the war against Covid-19 when it emerged strongly in the UK in early 2020, knowing that because coronaviruses are primarily an airborne pathogenic hazard, their experience from the interventions in SARS 2003 with their products and also other ARI's, they worked on the same basis, that this coronavirus, which causes Covid-19, SARS-CoV-2 was primarily airborne too. Hygiene solutions would be important and easy to implement and so PP-L Biosafety prioritised the infection prevention solution proportionally – 80:20 rule of air purification : surface cleaning effort.

The ventilation in the classrooms was typical of many such older buildings (ventilation limited to small openable windows, no mechanical ventilation) and so, given that back in early 2020, given the lack of suitable, non-VOC emitting and validated portable HEPA Filters (proven since in lab tests (ref.5) at 93% effective against SARS-CoV-2 which is excellent but not as effective as UVC with the 100% of the virus undetectable.), the best course of infection intervention to protect occupants was to use **germicidal UVC upper room filters** in both sides of the hub to ensure that the air in the rooms could be disinfected safely.
These Upper Room UVC devices have been used for decades against pathogens and ARI's and PPL-Biosafety deemed them perfect for this educational setting. Whilst the amount of data available on their successful application in higher risk clinical and laboratory settings is inordinate, Government is currently trailing them in **30 Bradford Schools**.

Then, a COVID Case…

All through the pandemic of 2020, with Rainbow Star's high levels of Covid-secure compliance and more, with the upper room UVC air disinfection filters, the support work at the school continued safely, normally and without incident for the whole of 2020.
At the start of 2021, however, COVID-19 risk was unwittingly brought into the hub by a member of staff who did not have any symptoms, signed-in as feeling healthy & normal, and passed the temperature test to access.

What happened next? Covid is transmitted by people breathing. The exhaled emissions from any individual can result in a major concentration of tiny invisible particles in those breaths (droplets, micro-droplets, aerosol as referred to by the scientists) and within 30-60 minutes in a small confined environment, one person who is infected with COVID in a small poorly ventilated space, just like the charity's rooms, can infect other occupants who inhale the infected particles, if thorough infection intervention isn't in place (Source) [1].

Case Study: Air Disinfection Solutions in a Sensitive Educational Support & Care Setting

Rainbow Stars - February 2021

The pre-symptomatic volunteer spent the entire day at the Rainbow Stars Hub on 2 February 2021 along with 5 other staff/volunteers, sharing and breathing that same indoors air for most of the day. It was a cold day, and the windows were closed. None of the other occupants had at that time been vaccinated, nor had Covid or Covid symptoms previously and so, no disease immunity could reasonably be assumed.

That one staff member felt ill on the next day and tested positive for COVID-19. Upon learning of the positive case, all other individuals who shared the room fo the day previous, were instructed to isolate and COVID test.
All five of these other individuals received negative test results for COVID-19, despite the significant risk from spending a whole day in a room with an infectious colleague, which save for the UVC mitigation, would be otherwise, be classified as a poorly ventilated room.

“Receiving five negative tests for all five occupants after a close and a long duration of exposure to COVID in such a high-risk situation cannot be down to luck. For us, it does support our decision to invest in the UV infection protection measures that we put in place and as far as we are concerned, just goes to show the power of how engineering & technology solutions can help us control COVID risks and feel safer.”, said Jane Peck, the Charity’s CEO.

The use of upper room UVC Filters has been scientifically proven as an effective method for combating COVID-19. (Source)[2] . As well as this real life incident (averted), recently an independent laboratory tested the efficiency of one of PPL’s solutions against a COVID-19 substitute in a sealed test room which is the average office size. After 7 minutes, the room air containing a surrogate virus to SARS-CoV-2 was disinfected; after 45 minutes:- an 8-LOG (99.999999%) reduction of all the virus in the air was recorded; and after 60 minutes there were no recoverable viable viral particles.

This is sterilisation of the air equivalent to a level equivalent to x10,000 better than most sanitiser hand gels. Clearly in real life settings where a variety of microbes will be present, sterilisation of air is unlikely but if specified correctly, the air can be continuously disinfected with upper room based UVC devices.

What is GUV UVGI?

UV-C light is also known as germicidal light as it renders the DNA and RNA of microbes inactive by breaking bonds between the Thymine and Adenine pair and “glues” two adjacent Thymine nucleotides together. This process is irreversible and stops the microbes from undergoing mitosis, inactivating them.
Germicidal UV air disinfection has proven efficacy against the transmission of measles, probably one of the most infectious diseases known to mankind, as well as Tuberculosis, SARS-CoV, SARS-CoV-2 (Covid-19), MERS-CoV, Influenza A, and “Bird Flu”, as well as many other bacteria and viruses. These have all been successfully inactivated by UV Air Treatment solutions in HVAC and via Upper Room Emitters, both in the labs, and in practical applications over decades. (see our supplementary references document.)
Coronaviruses, are easily inactivated by calculated UVC exposure. (Source)[3]. The data from 2004 and 2020, shows how easily Coronavirus is inactivated by UV-C technology. “The survival ability of SARS coronavirus in human specimens and environments seems to be relatively strong. Ventilation and UV irradiation can efficiently eliminate the viral infectivity” (Source)[4]

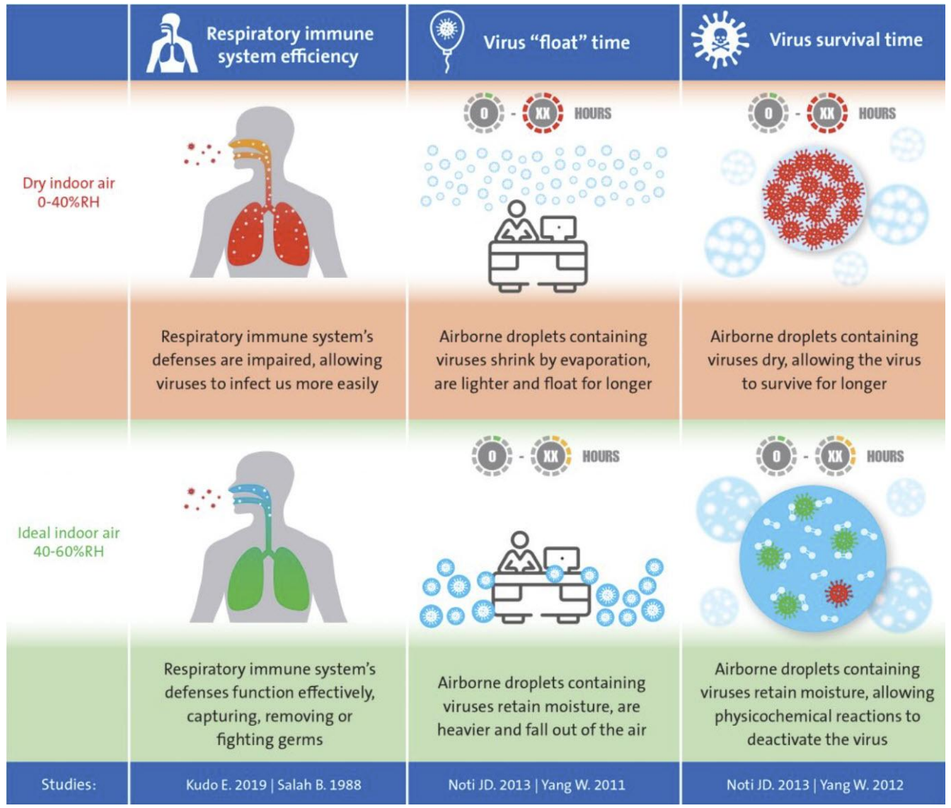
4.16 Relative Humidity and Temperature

Managing Relative Humidity and Temperature levels will be important as people spend more time indoors

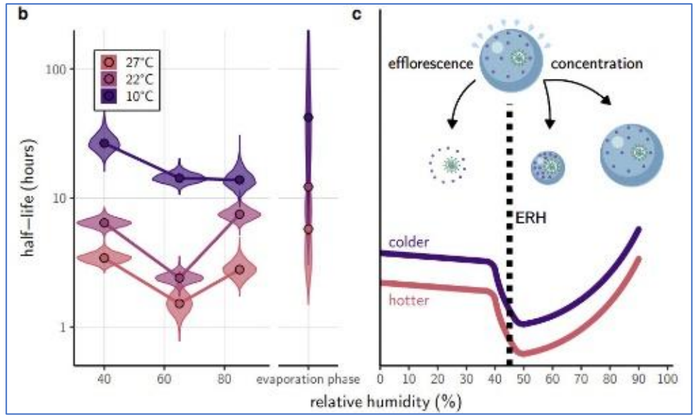
Summary

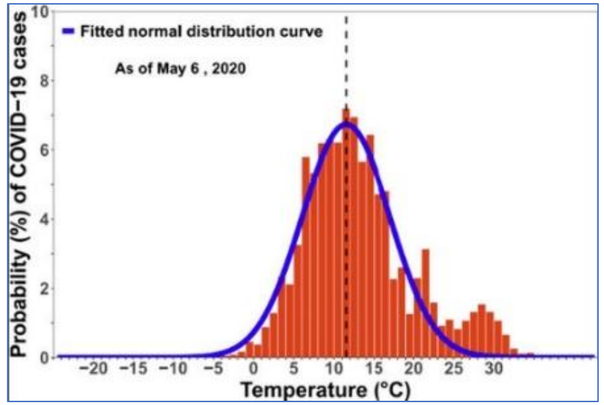
1. **Relative Humidity** for classrooms should be between 40% and 60%. The probability of COVID infection increases as temperature and humidity drops. Similar to Spring (2020) when the hot-spot COVID-19 outbreaks were in the yellow zone – below (Wuhan, New York, Seattle, cities in Iran, Italy, Spain, France, UK and Ireland) at 5°C to 11°C, low absolute humidity
2. **Temperature** for classrooms, the thermal comfort, operative temperature during heating season (BB 101 Table 7.2 - classrooms normal 20°C / max 25°C). In Scotland, School premises regulations (Table X) states the legalised minimum temperature to be 17°C. In England the minimum temperature in classrooms per H&S Workplace Regulations England – NASUWT is 16°C. It's essential to be aware of Optimal temperature zone for the dispersal of COVID-19. A China study (September 2020) found that 60% of confirmed cases of COVID-19 occurred in places where the air temperature ranged from 5°C to 15°C, with a peak in cases at 11.54°C (study below)

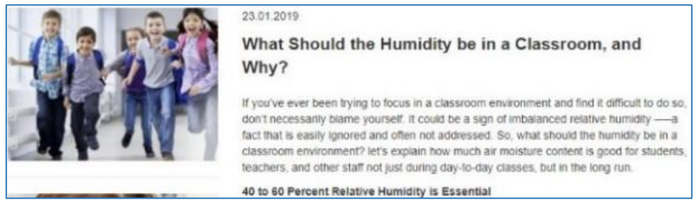
Humidity – Respiratory immune system efficiency – 40to60RH.com

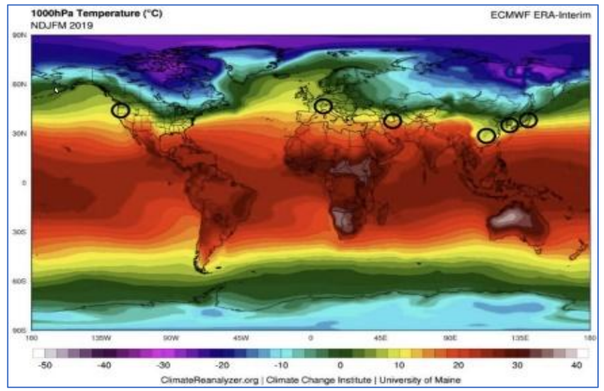


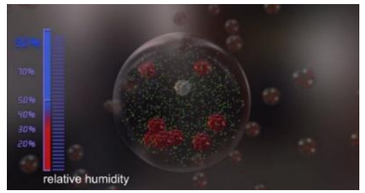
Relative Humidity / Optimal Temperature Zone for COVID

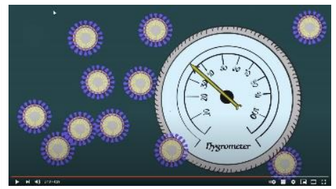












4.17 Air-Cleaning – Guidance from USA and Canada

Air-Cleaning Units – to remove bacteria and particulates from the indoor air

Summary - USA

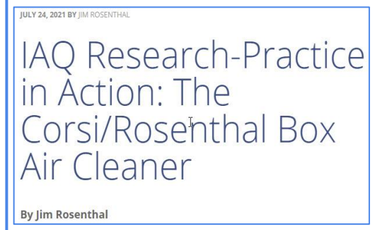
1. Ideal in situations where indoor spaces are difficult to ventilate (e.g. no windows, windows unable to open / open slightly) OR where outside air is polluted (e.g. in cities and heavy traffic).
2. Harvard-CU Boulder Portable Air Cleaner Calculator** includes air-cleaning examples for classrooms. (NOT endorsements)
3. CDC MMWR - A **SIMULATED** infected meeting participant who was exhaling aerosols was placed in a room with two simulated uninfected participants and a simulated uninfected speaker. Using two HEPA air cleaners close to the aerosol source reduced the aerosol exposure of the uninfected participants and speaker by up to 65%. A combination of TWO HEPA air cleaners next to the infected source and universal masking reduced exposure by up to 90%. HERE
4. United States Environmental Protection Agency (EPA) - Takes Aim at Purification Devices HERE - Refer to slide #4.21

Indoor Air-Quality Improves students' performance

EPA Takes Aim At Purification Devices

- UV Solutions Magazine article HERE
- Air Filters and purifiers, including ultraviolet (UV) light Technology are subject to a heightened EPA scrutiny as part of COVID-19 related enforcement initiative
- Refer to slide #4.21

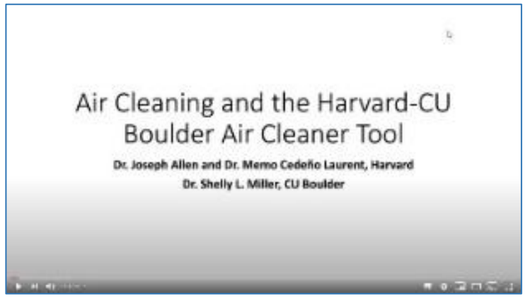
Air Cleaning Articles

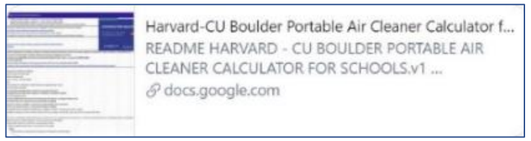


EU / UK CE Certification required for Air-Cleaner units deployed in a European / UK public space (e.g. schools)

Healthy Buildings – Schools for Health

Harvard-CU Boulder Tools





**Includes air-cleaning examples for classrooms

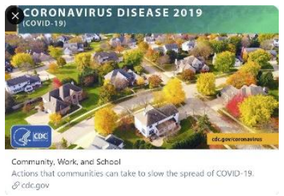
Case Studies - Schools

Article HERE

Video – 6mins

Video – 6mins

US – CDC School Guidance



ASHRAE Guidance

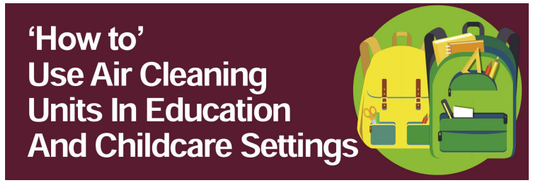
4.18 Air-Cleaning – Guidance from CoSchools, DfE, CIBSE, REHVA, Ireland, SAGE-EMG

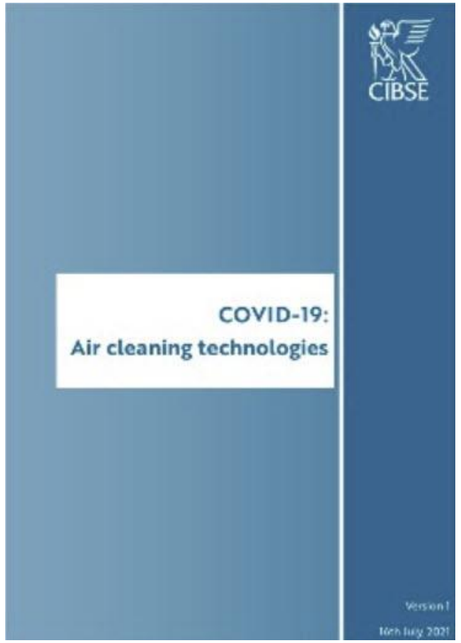
Air-Cleaning Units – to remove bacteria and particulates from the indoor air

Summary - UK

1. Ideal in situations where indoor spaces are difficult to ventilate (e.g. no windows, windows unable to open) OR where outside air is polluted (e.g. in cities and heavy traffic)
2. What is a HEPA Filter - High-Efficiency Particulate Air Filter - listen to expert in HEPA ISO and international standards HERE
3. Guidance below from SAGE-EMG report (04 Nov 2020). Please Note: Air-cleaning business is NOT regulated in the UK.
4. **CoSchools and DfE Resources:** HERE
    - DfE - How to use Air Cleaning Units in Education and Childcare Settings (including important factors to consider when selecting an air cleaning unit) HERE
    - DfE - How to Apply for a DfE-funded air cleaning unit HERE
5. **CIBSE**: COVID-19 Air Cleaning Technologies - Guidance and flowchart re selection of air cleaning devices, inc performance, risks and general maintenance HERE
    - Is CADR suitable for room size of room (can multiple units be used), is product CE or UKCA marked?, does the device include novel technology?
    - If novel technology, - Is there testing or certification data against known risks (e.g. ozone), does it have testing or certificate to demonstrate any harmful chemicals it can generate will be below recommended (WHO) limits in operation. Does it require regular maintenance to maintain efficacy?
    - Does it have independent, third party testing data to demonstrate its efficacy?, is operation and maintenance information available and clear?
6. Bradford: Air purifier & UV light (£1.75m) pilot to combat school virus spread. 30 Schools - 10 HEPA, 10 UVC, 10 control group with no devices. 1st results due end 2021 HERE . Interim report will be made available in early 2022 HERE . Full report not due to be published until October 2022 HERE
7. England - 7,000 air purifiers promised for schools 'nowhere near enough' to cover 300,000 classrooms HERE
8. AIR CLEANING GUIDANCE (other)**:**
    - **REHVA** criteria room air cleaners for particulate matter: CADR, Noise, Energy Efficiency, Placement, Generation of pollutants, Operation, Service & Maintenance HERE
    - **Ireland Schools** - Room Air Cleaner Guidance and FAQ answered - HERE **Europe** - Guide for Ventilation towards Healthy Classrooms (includes Air-Cleaning) HERE

CoSchools, DfE and CIBSE Air Cleaning Guidance





SAGE-EMG: Potential application of air cleaning devices and personal decontamination to manage transmission of COVID-19. 04 November 2020 HERE

1. Application of air cleaning devices may be a useful strategy to reduce airborne transmission risks in poorly ventilated spaces.. Air cleaning devices have limited benefit in spaces that are already adequately ventilated.
2. Air cleaning devices are not a substitute for ventilation, and should never be used as a reason to reduce ventilation; all occupied spaces must have some background ventilation to be suitable for human habitation and to comply with building and workplace regulations. Ventilation should be assessed, and if possible improved, first before considering whether there is a need to use an air cleaner
3. With respect to the candidate air cleaning technologies there is some evidence for effectiveness against other coronaviruses, but there is as yet little data that demonstrates the effectiveness of most candidate technologies against SARS-CoV-2. Advice in this SAGE paper is therefore based on potential effectiveness drawn from the known efficacy of devices against other viruses and the principles of virus transmission
4. There may be unintended consequences from application of air cleaning devices including emissions that could cause health effects, noise, changes in temperature & drafts.
5. To use air cleaning devices effectively, urgent action is therefore needed to support industry & consumers in ensuring they are selecting and using devices safely and effectively
6. Table 2: performance of two commercial air cleaning devices with and without HEPA filters Table 3: Potential application of air cleaning devices in different scenarios (inc large office / education environment with 20-30 people)

4.19 Air-Cleaning Trials - Bradford Primary Schools

Air Purifier & Ultraviolet light (UV-C) pilot (£1.75M) to combat school virus spread - 30 Primary Schools: 10 HEPA, 8 UV-C, 12 Control Group with no devices

Summary - University of Leeds updated article - 5 Nov 2021 HERE

1. Study is investigating two different approaches to cleaning the air with the use of portable or wall-mounted devices. One is based on filtering the air by passing it through a HEPA (High Efficiency Particulate Air) filter, which captures most airborne viruses. The second approach involves cycling the air through an enclosed unit where it is exposed to an ultraviolet germicidal light, which inactivates microorganisms including viruses.
2. Based on the outcome of modelling and experimental analysis, the scientists involved in the study are confident that the technologies will reduce the risk of COVID-19 being spread by microscopic respiratory particles carried in the air, also known as aerosol transmission.
3. Good room ventilation helps keep the air clean, but ventilation alone is not enough when children are talking loudly, singing or walking around the room. The respiratory aerosol that is created can hang in the air for extended periods and use of air purification technology could provide a solution
4. Eight schools are in the process of having ultraviolet light (UV-C) technology fitted on classroom walls. These are sealed units which take in air and expose it to ultraviolet light. No ultraviolet light is emitted from the unit and if a device is tampered with, it deactivates. By the end of this month (November), UV-C units will be operating in four schools, and in all eight by Christmas.

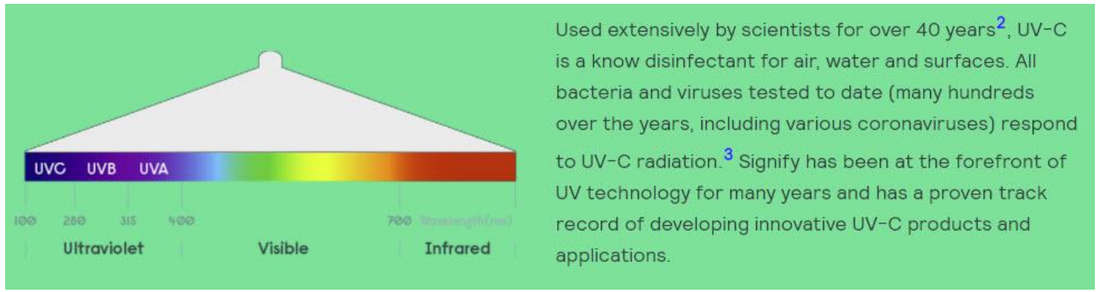
Bradford: Air purifier & UV light (£1.75m) pilot to combat school virus spread. First results due end 2021. Original BBC Article 12 Aug 2021 HERE
Interim report will be made available in early 2022 HERE. Full report not due to be published until October 2022 HERE

Environmental Technology: HEPA and Ultraviolet light (UV-C)

HEPA air filtration

"The devices are being supplied by Philips. HEPA (High Efficiency Particulate Air) filters trap unwanted particles such as dust, pollen, bacteria, viruses and hair from the air while allowing clean air to be pushed back out into the environment. Philips Air Purifiers employ **NanoProtect HEPA filters**. NanoProtect HEPA uses a combination of mechanical and electrostatic action over three layers. The mechanical action inner layer catches the bigger particles, such as dust and hair. The active carbon layer neutralizes harmful gases and odours, and finally electrostatic action is used to capture the smaller particles such as bacteria and viruses down to 0.03 microns. This triple later filter design enables optimum size, better air circulation, increased speed of air cleaning and lower energy consumption".

Ultraviolet light (UV-C) devices supplied by Signify. "The UV-C Active air device is designed to clean the air during day-to-day activities while people are present. It can be installed on a wall or on a ceiling across many applications, for example, within restaurants and bars, stores, offices and schools. Ventilators pull the air from the room inside the device which then filters and cleans it. The clean air comes out of the UV-C Active air device back into the room"



Used extensively by scientists for over 40 years[2], UV-C is a know disinfectant for air, water and surfaces. All bacteria and viruses tested to date (many hundreds over the years, including various coronaviruses) respond to UV-C radiation.[3] Signify has been at the forefront of UV technology for many years and has a proven track record of developing innovative UV-C products and applications.

General Comments

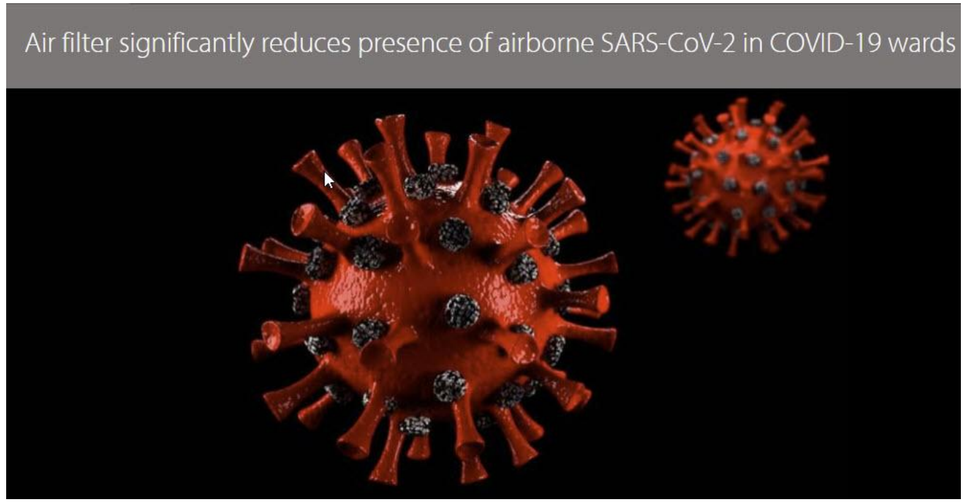
- Air-Cleaners should be positioned with sufficient clearance on all sides, otherwise airflow could be restricted (as above)

- Masks are not mandated in England's primary schools

4.20 Portable Air filtration/UV Sterilisation devices reduces SARS-CoV-2 in COVID-19 Wards

This study examined the effect of air filtration and ultra-violet (UV) light sterilisation on detectable airborne SARS-CoV-2 and other microbial bioaerosols.

Summary - HERE



"When a team of doctors, scientists and engineers at Addenbrooke's Hospital and the University of Cambridge placed an air filtration machine in COVID-19 wards, they found that it removed almost all traces of airborne SARS-CoV-2".

1. The team installed a High Efficiency Particulate Air (HEPA) air filter/UV steriliser. HEPA filters are made up of thousands of fibres knitted together to form a material that filters out particles above a certain size. The machines were placed in fixed positions and operated continuously for seven days, filtering the full volume of air in each room between five and ten times per hour.
2. In the surge ward, during the first week prior to the air filter being activated, the researchers were able to detect SARS-CoV-2 on all sampling days. Once the air filter was switched on and run continuously, the team were unable to detect SARS-CoV-2 on any of the five testing days. They then switched off the machine and repeated the sampling – once again, they were able to detect SARS-CoV-2 on three of the five sampling days.
3. On the ICU, the team found limited evidence of airborne SARS-CoV-2 in the weeks when the machine was switched off and traces of the virus on one sampling day when the machine was active.
4. Additionally, the air filters significantly reduced levels of bacterial, fungal and other viral bioaerosols on the both the surge ward and the ICU, highlighting an added benefit of the system.

Conclusions: These data demonstrate the feasibility of removing SARS-CoV-2 from the air of repurposed 'surge' wards and suggest that air filtration devices may help reduce the risk of hospital-acquired SARS-CoV-2. Preprint document HERE

Medical Grade Portable Air Filtration/UV Sterilisation Device

4.21 USA Environmental Protection Agency (EPA) - Takes Aim at Purification Devices

Air Filters and purifiers, including ultraviolet (UV) light Technology are subject to a heightened EPA scrutiny as part of COVID-19 related enforcement initiative

Summary - UV Solutions Magazine article HERE

After two years since COVID-19 Pandemic began, Indoor Air Quality and safety remain widespread. In homes and workplaces, demand has grown for Air Filters and Purifiers, including those that use ultraviolet (UV) light technology.

- United States Environmental Protection Agency (EPA) has cited concerns that consumers may be misled about the efficacy of such products in minimizing exposure to COVID-19
- In April 2021, EPA published a notice, declaring that it would scrutinize product labels and online marketing materials to ensure that devices entering US commerce are not misbranded
- In implementing this mandate, EPA is NOT limiting its review to new claims that product manufacturers have made directly in response to the pandemic. Rather, EPA is considering the totality of marketing claims that appear on product labels and labeling - including long standing statements that passed muster when reviewed in the past or may have gone unnoticed

Where efficacy claims are deemed to be deficient, EPA has alleged that distribution of filters and purifiers would constitute a violation of FIFRA Section 12(a)(1)(E), which makes it unlawful for any person to distribute or sell a misbranded product. As a result, affected businesses with existing products must re-evaluate their marketing.

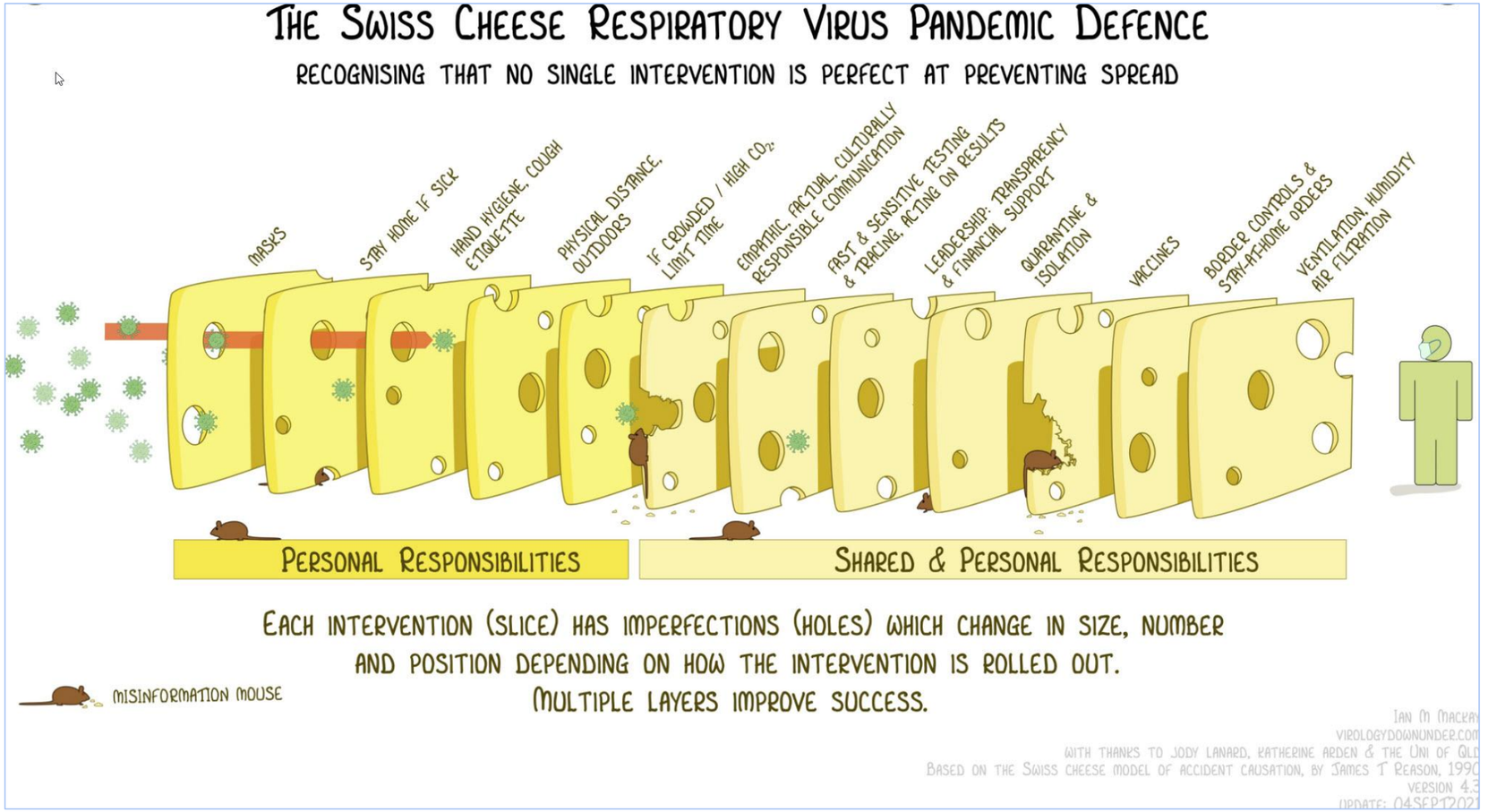
The Agency is taking a narrow view of the extent to which companies can base their marketing on extrapolations of scientific literature, test data, and product specifications and is therefore scrutinizing product efficacy claims and rejecting those that it deems overly broad.

Types of Claims that EPA is Scrutinizing	Conclusion
The notices of refusal issued by EPA to those companies deemed in violation have not always been accompanied by detailed explanations of the alleged deficiencies. However, it seems that EPA generally is focused on the following types of claims: 1. Unqualified or generic claims about a purifier or filter's ability to kill, capture or otherwise eradicate "germs," "viruses," "bacteria," "mold" or "fungus" without specifying the species of microorganism on which the product has been tested or other supporting data. 2. Claims that UV lights are "germicidal lights" and are "effective against most viruses, spores and cysts," unless the claims are qualified on labeling and supported by **efficacy testing**. 3. Claims that fail to distinguish whether **efficacy testing** was performed on a virus or a virus surrogate. 4. Discrepancies between labels and labeling, especially as between statements included in product containers and information on company websites. 5. Claims that a given product or device is more effective than competing brands, without specifying the brands in question. ***Even if such companies can demonstrate HEPA efficacy, they are being required to couch their efficacy claims in terms of specific organisms that have been the subjects of efficacy testing. More general claims that such filters capture 99.97% of germs, bacteria, viruses, mold, fungus and other microbial pests with a diameter of 0.3 microns or more are being rejected***	EPA is adopting an aggressive enforcement posture, which reflects its apparent viewpoint that safeguarding against potentially misleading claims outweighs the risks of further disrupting the supply of air filters and purifiers at a time when such products are in high demand. The agency's current stance has important implications for both manufacturers and importers, especially since the EPA is not restricting its enforcement mandate based on the past acceptability of a given claim. Accordingly, manufacturers and importers may wish to closely review their product claims and reconsider their marketing goals in view of heightened enforcement risks.

4.22 The Swiss Cheese Respiratory Pandemic Defence Model and Japan's 3Cs

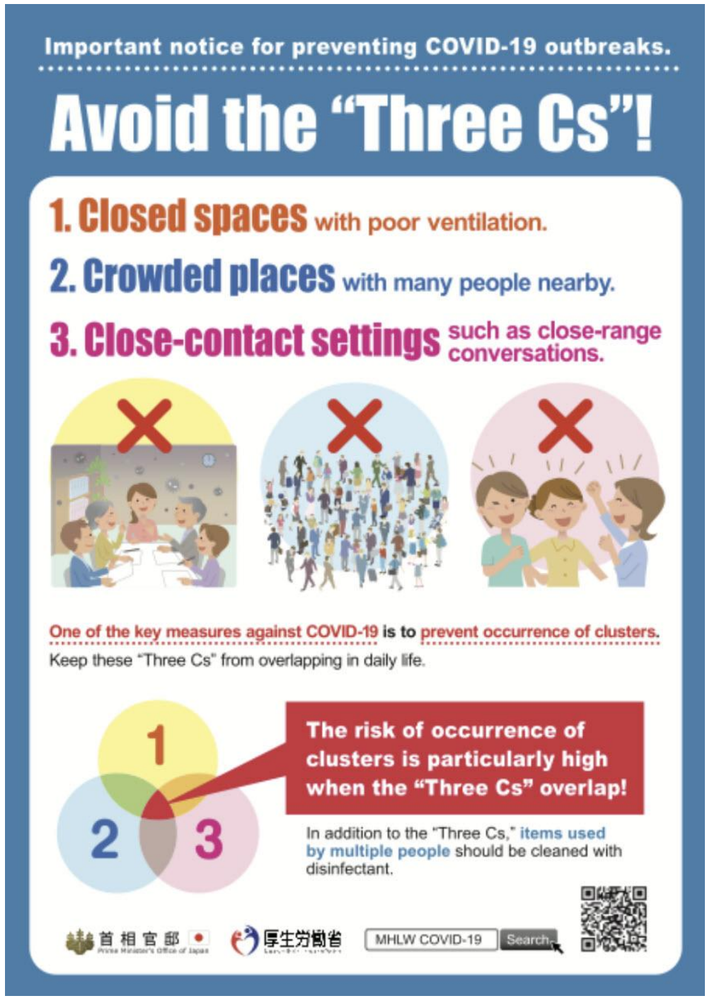
Multiple Layers Improve Success – no single intervention is perfect but combined - infection risk is reduced

Recognises that no single intervention is perfect at preventing the spread of the coronavirus. Each intervention (layer) has holes



Japan's Successful 3Cs

Used since the beginning of the pandemic



5. Disclaimer

Disclaimer

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Carbon Dioxide (CO2) Non-Dispersive Infrared (NDIR) individual sensors and Indoor Air Quality (IAQ) sensors available from circa £100 to £250+ dependent on sensor and vendor – (refer to Appendices). CO2 monitor accuracy needs to be within 50 parts per million (ppm)

All companies and products (including CO2 sensors, IAQ sensors and air-cleaning units) listed in the report are for educational purposes only and are NOT endorsements by the author.