Where and when is SARS-CoV-2 transmitted?

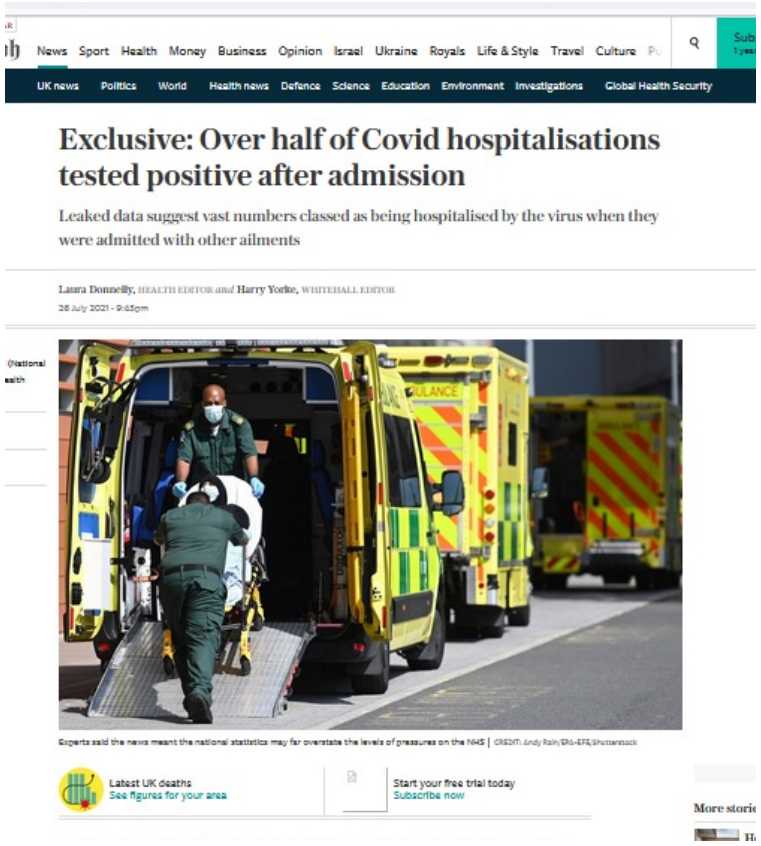
Transmission by location: Households

- Meta-analyses show that the **risk of infection from exposure to a single infected household member ranged from 5.9% to 18.1%. Household contacts generate the greatest number of infections, other than hospitals and carehomes.**
- Risk was higher from symptomatic vs asymptomatic index subjects and from adults vs children.
- The total pooled household secondary attack (SAR) of child index cases was 0.20 and was consistently lower than in adults. The pooled SAR from children and young people was markedly lower in school studies; school infection prevalence broadly reflected contemporary community incidence.
- With respect to VOCs, infected children spread SARS-CoV-2 to an equivalent number of household contacts as infected adults and were equally as likely to acquire SARS-CoV-2 VOCs from an infected family member.
- Sharing a bedroom (OR 5·38) and being spoken to by an index case for ≥30 min (OR 7·86) were associated with SARS-CoV-2 transmission among household contacts. Among household contacts, indirect contact, meal sharing and lavatory co-usage were not independently associated with SARS-CoV-2 transmission.
- Crowded indoor environments should be high-risk settings for the transmission of COVID-19, yet what is remarkable about these studies is that so few household members caught the virus from one of their number.

Transmission by close contact: work, social

- The secondary attack rate (SAR) is the probability that contact from an infectious individual will give rise to infection in another individual.
- Studies have shown that generally the secondary attack rate (SAR) was **around 1·3% for work and social contacts (compared to up to 18% in the home).**
- Among non-household contacts, exposure to more than one case, being spoken to by an index case for ≥30 min and sharing a vehicle with an index case were risky activities but indirect contact, meal sharing and lavatory co-usage were not independently associated with SARS-CoV-2 transmission.
- Densely populated cities had a higher infection rate than rural areas.
- Scottish FOI requests revealed that there were **zero Covid deaths in working-age populations most in contact with the public** (https://www.ukcolumn.org/article/scottish-foi-zero-covid-deaths-in-working-age-populations-most-in-contact-with-the-public)

Transmissions in UK hospitals



https://www.telegraph.co.uk/news/2021/07/26/exclusive-half-covid-hospitalisations-tested-positive-admission/

- Leaked data from an NHS daily situation report showed that **56% of the 'COVID' patients were not admitted because of COVID but, rather, only tested positive after admission** during routine testing done on all patients.
- 'Experts said it meant the **national statistics,** published daily on the government website and frequently referred to by ministers, **may far overstate the levels of pressures on the NHS.'**
- Greg Clark, MP, chairman of Commons Science and Technology Select Committee said…"If hospitalisations from Covid are a key determinant of how concerned we should be, and how quickly restrictions should be lifted, it's important that the data is not presented in a way that could lead to the wrong conclusions being drawn".

Global transmission in hospitals

- **An early 2020 meta-analysis found that close to 50% of COVID infections were hospital-acquired,** although much of the evidence was low quality. Most of the hospital-acquired infections occurred among hospital staff. (Zhou Q, et al. Nosocomial infections among patients with COVID-19, SARS and MERS: a rapid review and meta-analysis. Ann Transl Med. 2020 May;8(10):629)

- And a **2021 meta-analysis** of 21 studies found that the **risk of mortality was 1.3 times greater in patients with nosocomial (i.e. contracted in hospital) infection, compared to community-acquired.** (Ponsford MJ, et al. A Systematic Review and Meta-Analysis of Inpatient Mortality Associated With Nosocomial and Community COVID-19 Exposes the Vulnerability of Immunosuppressed Adults. Front Immunol. 2021 Oct 6;12:744696)

Transmission by location: Outdoors

- Most studies show that **outdoor-derived transmission is minimal,** unless the public area is extremely crowded.
- A systematic review found that **<10% of infections were derived from outdoor contact, whereas risk from indoor transmission was 18.7 times higher.**
- The authors of a study from northern Italy concluded that the probability of airborne transmission due to respiratory aerosol is very low in outdoor conditions.
- Quite apart from the known benefits of sunshine, **outdoor air is known to have germicidal properties, known as germicidal open-air factor (OAF),** to a greater extent than indoor air. These properties were clearly overlooked. **Furthermore, infectious particles are more rapidly diluted and dispersed.** (Hobday R, Collignon P. An Old Defence Against New Infections: The Open-Air Factor and COVID-19. Cureus. 2022 Jun 20;14(6):e26133).
- A 2018 meta-analysis and systematic review of 143 studies showed that greenspace exposure is associated with numerous health benefits (Twohig-Bennett C, Jones A. The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. Environ Res. 2018 Oct;166:628-637).

So if the virus spreads mostly indoors…..

What is the logic for lockdown, enclosing healthy people indoors with the sick?

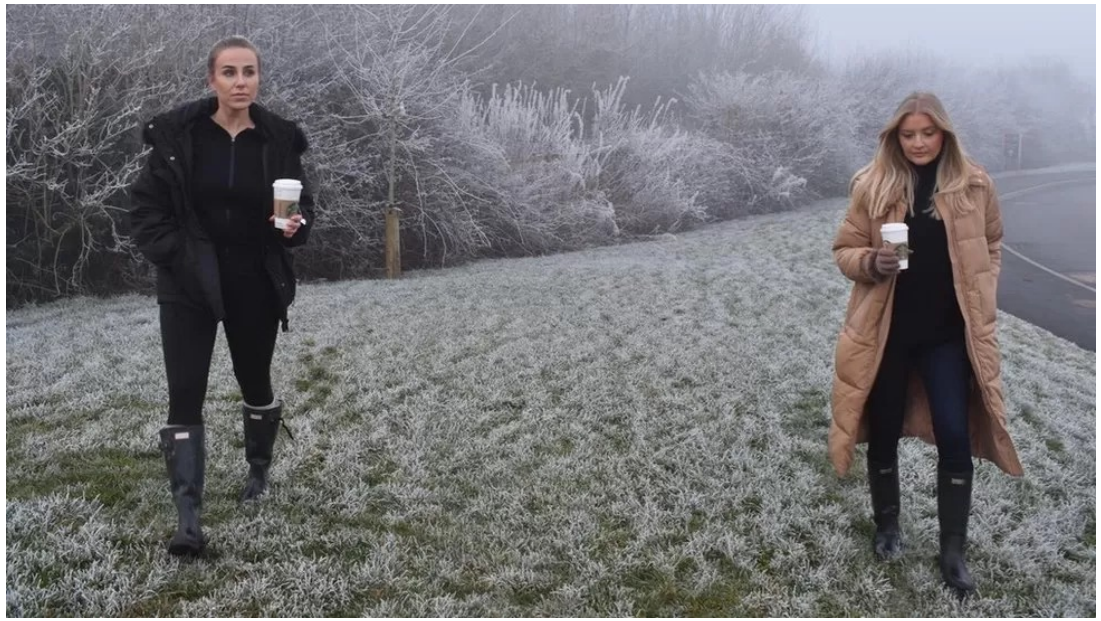
- **The odds that a primary case, transmitted COVID-19 in a closed environment was 18.7 times greater compared to an open-air environment.**

(Nishiura H, https://www.medrxiv.org/content/10.1101/2020.02.28.20029272v2.full.pdf)
Note: still a preprint

- Furthermore, a US study investigating the effect of 'shelter in place' (SIP) orders found **no "detectable effects of these policies on disease spread or deaths".**

(Berry CR, et al. Evaluating the effects of shelter-in-place policies during the COVID-19 pandemic. Proc Natl Acad Sci U S A. 2021 Apr 13;118(15):e2019706118

Covid: Women on exercise trip 'surrounded by police'



https://www.bbc.co.uk/news/uk-england-derbyshire-55560814

Transmission by mother to neonate

- A 2022 meta-analysis of 472 studies found that **1.8% of the babies born to mothers with SARS-CoV-2 infection tested PCR-positive.** Severe maternal covid-19, maternal admission to an ICU and maternal death were associated with SARS-CoV-2 positivity in offspring.
- A 2022 systematic review of 22 papers found that “the risk of vertical mother-to-child transmission of SARS-CoV-2 from mother to foetus is **very low and is considered a rare but possible event.**”
- The placenta continues to act as a barrier, as with other viruses, as there is little likelihood of transmission occurring through it. In the few studies that provide data from neonates testing positive, the infection seems likely to be due to the mother’s breath during breast feeding. Breast milk itself showed no trace of SARS-CoV-2 proteins.

Transmission to and from children

- **The risk of transmission is significantly lower in children** compared to adults.
- **A 2020 systematic review of over 700 publications showed that children are unlikely to be the main drivers of the pandemic.** They accounted for a small fraction of COVID-19 cases and mostly had social contacts with peers or parents, rather than putting older people at risk of severe disease. Household transmission studies showed that children were rarely the index case and case studies suggested that children with COVID-19 seldom caused outbreaks. They concluded that **opening up schools and kindergartens was unlikely to impact COVID-19 mortality rates in older people.**
- Among PCR positive-children the **median duration of infectivity with the Omicron variant was 3 days; at the time the CDC was recommending isolating for 10 days.**
- In a US study showed that in households with a COVID patient, there had been no transmission from child to patient.
- Similarly, transmission within childcare centres and from children infected at childcare centres into households was low.

Transmission by location: Schools

- **Although studies do find transmission within schools, the rate is lower than in other settings.**
- An EU survey found **little indication that school settings played a significant role in the transmission of COVID-19.** Secondary transmission in schools, either from child-to-child or from child-to-adult, was perceived to be rare. Countries where schools had re-opened by the time of the survey stated that they had not seen an increase in cases in these settings. There appeared to be no child-to-teacher transmission. **The survey concluded that children were not the primary drivers of SARS-CoV-2 transmission** to adults in the school setting.
- A study of London schools found no secondary transmission in 28 bubble contacts, representing ten bubble classes. Across 8 non-bubble classes, 2% of pupils tested positive, but these were asymptomatic and unrelated to the original index case.
- Fomite SARS-CoV-2 was identified in 2% of samples in bubble classrooms, 2% of samples in non-bubble classrooms and 4% of samples in washrooms. This contrasted with fomites in households, where SARS-CoV-2 was identified in 11%-27%, depending on room sampled.
- A CDC study of 11 elementary schools concluded that SARS-CoV-2 transmission was low despite high community incidence.
- Air sampling identified SARS-CoV-2 RNA in just 2% of school air samples, compared with 25% of air samples taken in homes.
- Even a Royal Society study conceded that reopening schools in Jun 2020 was unlikely to push the R number above one.
- Among 8 Massachusetts school districts with 70 US schools and >33,000 children over a period of 4 months, there were 435 (<1.3%) COVID infections. Another US study found low child-to-child transmission but no child-teacher transmission.

So virtually all studies and reviews conclude that there is minimal danger in school reopening

UK studies

- UK Study author Dr Shamez Ladhani, Medical Director of Public Health England (PHE) confirmed that **'schools are not hubs of infection'.**

(https://www.gov.uk/government/news/covid-19-study-finds-lower-prevalence-in-schools)

- Another English study concluded that **"there is no significant evidence to suggest that schools are playing a substantial role in driving spread in the community."**
- **"In fact, schools actually lagged cases in the community."**

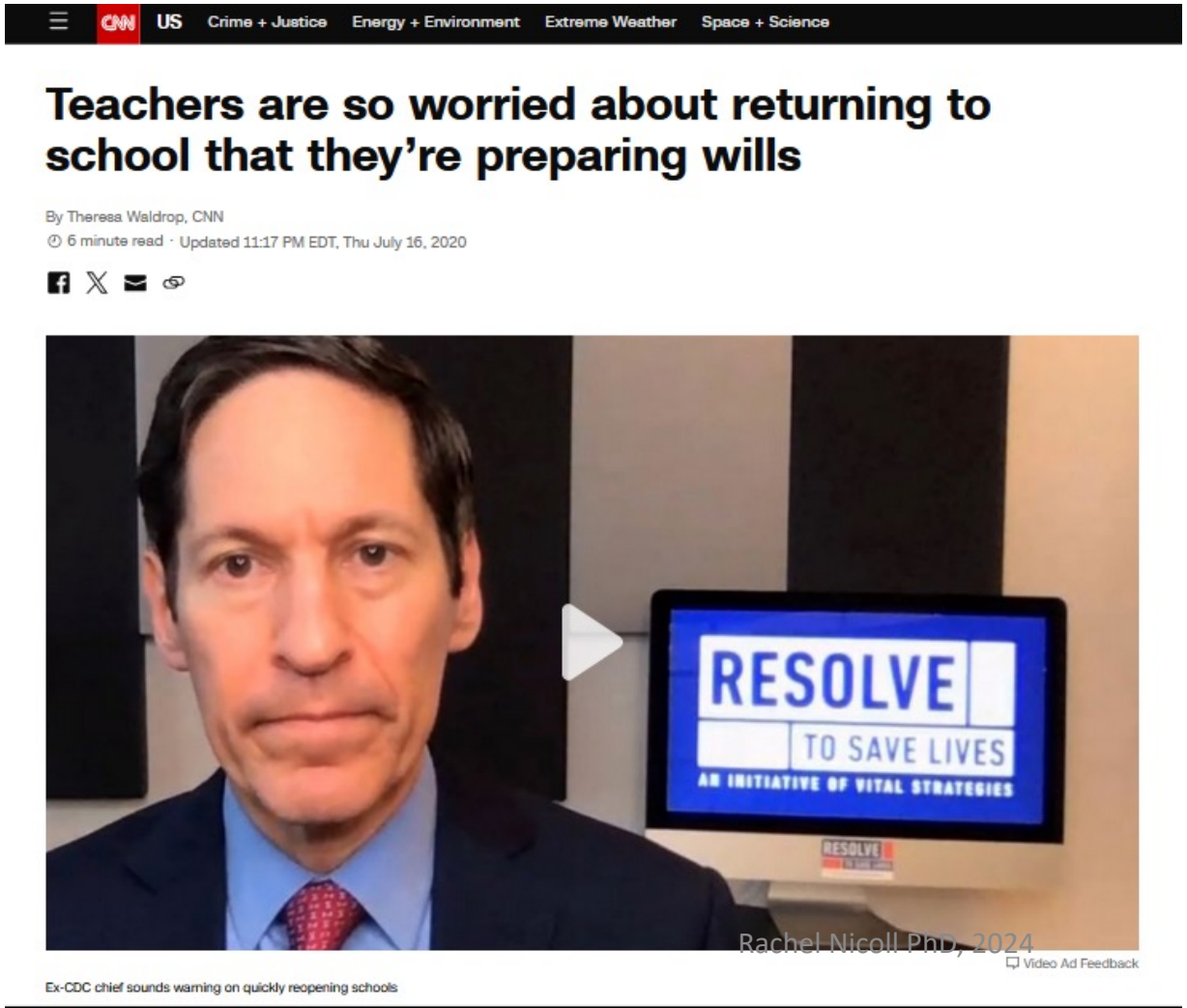
(Southall E, et al. An analysis of school absences in England during the COVID-19 pandemic. BMC Med. 2021 Jun 7;19(1):137)

German study

- "We show that neither the summer closures nor the closures in the fall had a significant containing effect on the spread of SARS-CoV-2 among children or a spill-over effect on older generations."
- "There is also **no evidence that the return to school at full capacity after the summer holidays increased infections among children or adults.**

(von Bismarck-Osten C, et al. The role of schools in transmission of the SARS-CoV-2 virus: quasi-experimental evidence from Germany, Economic Policy, Volume 37, Issue 109, January 2022, Pages 87–130)

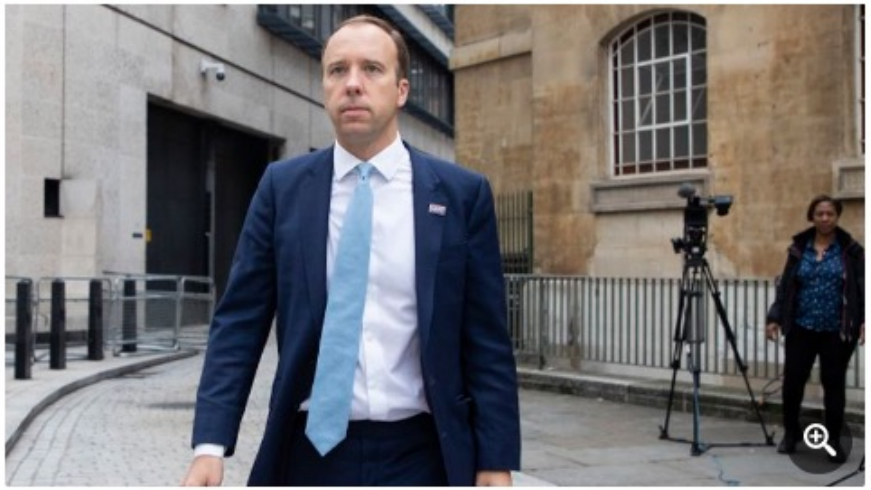
But teachers weren’t listening!



https://edition.cnn.com/2020/07/16/us/coronavirus-teachers-preparing-wills/index.html

“Don’t kill Granny” - surely one of the worst psychological manipulations of the pandemic era!

Don’t kill granny! Hancock warns young as he considers crackdown on seeing friends and family



https://www.mailplus.co.uk/news/23931/dont-kill-granny-hancock-warns-young-as-he-considers-crackdown-on-seeing-friends-and-family

Children were made to feel as though they were mini weapons of mass destruction.

PNAS

Proc Natl Acad Sci U S A. 2022 Aug 16; 119(33): e2204141119. PMCID: PMC9388132
Published online 2022 Jul 27. doi: 10.1073/pnas.2204141119 PMID: 35895714

Risk of severe COVID-19 infection among adults with prior exposure to children

In a large, real-world population, exposure to young children was strongly associated with **less** severe COVID-19 illness, after balancing known COVID-19 risk factors.

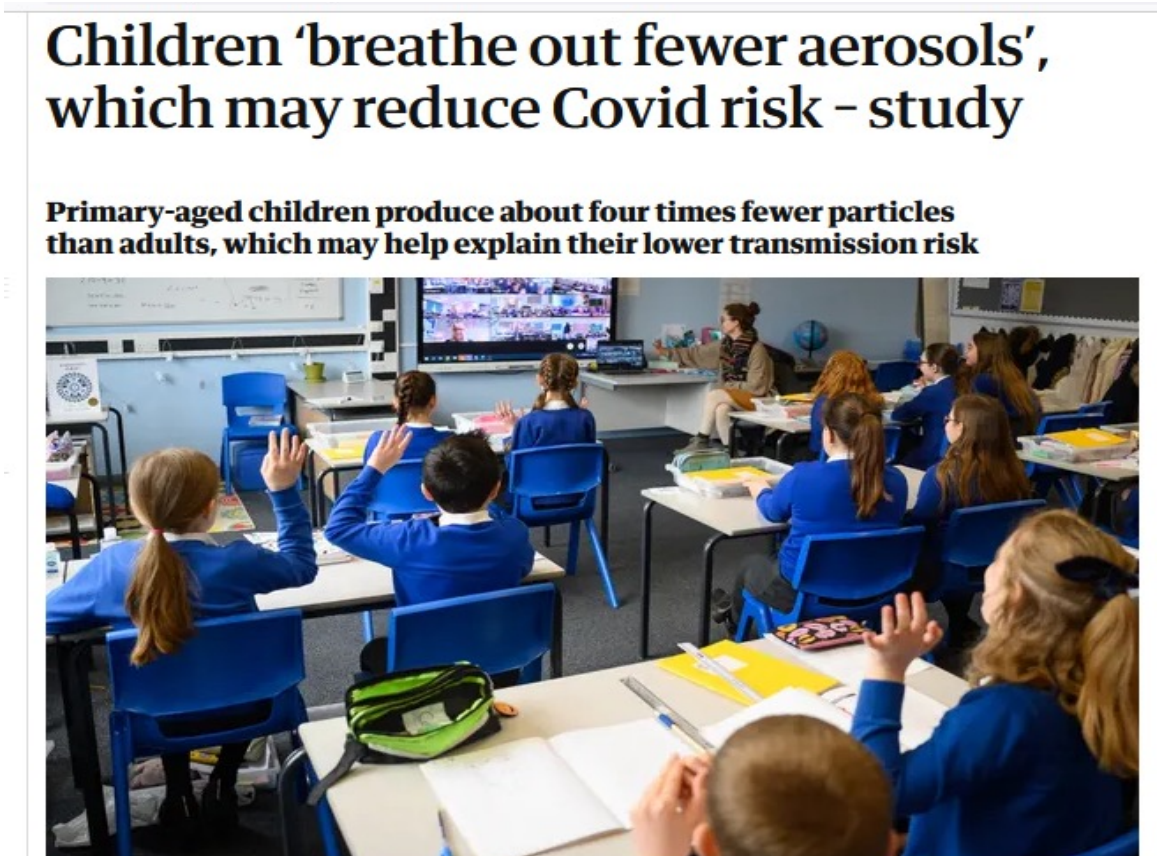
This was likely due to endemic coronavirus cross-immunity.

(Solomon MD, et al. Risk of severe COVID-19 infection among adults with prior exposure to children. Proc Natl Acad Sci U S A. 2022 Aug 16;119(33):e2204141119)

Why might children present a lower risk?

- In children aged 8-10, virus particle emission rates while breathing at rest, speaking, singing and shouting were significantly lower compared with adults (reduced by a factor of almost 5).

(Fleischer M, et al. 2022. Pre-adolescent children exhibit lower aerosol particle volume emissions than adults for breathing, speaking, singing and shouting. J. R. Soc. Interface.19202108332021083 3)



Children 'breathe out fewer aerosols', which may reduce Covid risk – study

Primary-aged children produce about four times fewer particles than adults, which may help explain their lower transmission risk

https://www.theguardian.com/world/2022/feb/23/children-breathe-out-fewer-aerosols-which-may-reduce-covid-risk-study

Seasonality, temperature and humidity

- **Seasonal variation has a known influence on the transmission of several respiratory viral infections,** including the common cold coronaviruses.
- Several studies found **significant inverse correlations between temperature and humidity and the COVID death rate.**
- SAGE reported: "Virus survival in air decreases with increasing temperature and humidity. In most environments this effect is likely to be less important than the ventilation rate, however **environments with low temperature and low humidity…may pose an enhanced risk.**
- A US study found that **lower ultraviolet radiation** was significantly **associated with increased transmission** but humidity played a larger role than temperature and U/V radiation.
- Increased indoor humidity was associated with a reduction in COVID spread, while indoor temperature had no statistically significant effect. Earlier studies have shown that an indoor relative humidity of 40–60% was optimal for human health.
- A 2022 study (not published until 2024 due to its inconvenient results) found that the seasonality of human beta-coronaviruses had more impact on 'cases' and deaths than government interventions in six temperate Northern European countries.

Seasonality mechanisms

- Breathing air that is below recommended relative humidity levels irritates respiratory passages, drying out the mucous linings if the airways. It is the mucous layer that acts as a defence against viral particles and other invading foreign substances.
- If airway linings are dried out, viral particles have a greater ‘docking’ potential at airway receptor sites, which can lead to an increased risk of infection.
- Lower relative humidity also aids airborne transmission of water droplets and aerosols.
- The human immune system also manifests seasonal cycles that go a long way to explaining why people are more susceptible to contagious diseases like flu and Covid during the winter months.
- The immune system has a profound pro-inflammatory transcriptomic profile during the European winter, with increased levels of soluble IL-6 receptor and C-reactive protein. These are risk indicators for cardiovascular, psychiatric and autoimmune diseases that have peak incidence in winter.
- Vitamin D levels are also lower due to absence of sun on skin.

Where and when is COVID transmitted: summary

- Household contacts generate the greatest number of infections, other than institutions.
- Transmission risk from work and social contacts is much lower.
- In UK hospitals, 56% of patients contracted COVID in hospital. This means that pressure on the NHS has been overstated.
- Outdoor-derived COVID transmission is minimal. In fact sunshine and outdoor air is beneficial.
- Transmission of COVID from mother to foetus or neonate is possible but rare.
- The risk of transmission is significantly lower in children. Studies are agreed that children are unlikely to be the main drivers of the pandemic, including in schools. Transmission rate is lower in schools than in other settings.
- 'Don't kill Granny' was a psychological manipulation, which was unjustified as a study showed that exposure to young children was associated with less severe COVID.
- COVID deaths are seasonal; high temperature and high humidity are associated with lower COVID deaths.

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