



SARS-CoV-2/COVID-19 - an epidemiological and global perspective

NIOH COVID-19 Centenary Webinar, 21 April 2022

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science & innovation
Department of Science and Innovation
REPUBLIC OF SOUTH AFRICA

CAPRISA hosts a
DSI-NRF Centre of Excellence in
HIV Prevention



National
Research
Foundation



UNAIDS
CAPRISA is the UNAIDS Collaborating
Centre for HIV Research and Policy



CAPRISA hosts a MRC HIV-
TB Pathogenesis and
Treatment Research Unit

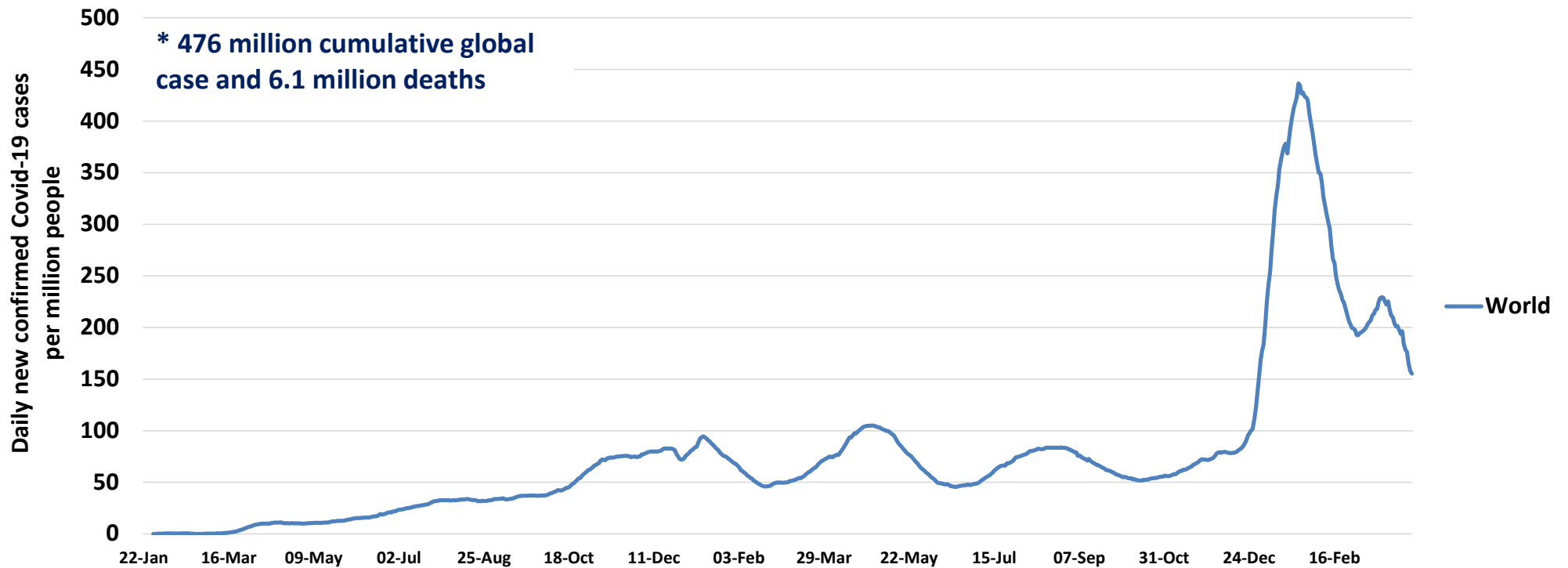


Outline

- **The global Covid-19 pandemic**
- **Why the concern about variants...**
- **Rapid evolution of SARS-CoV-2 variants**
- **Effect of evolving variants on vaccines**
- **Lessons for the future – what's next?**

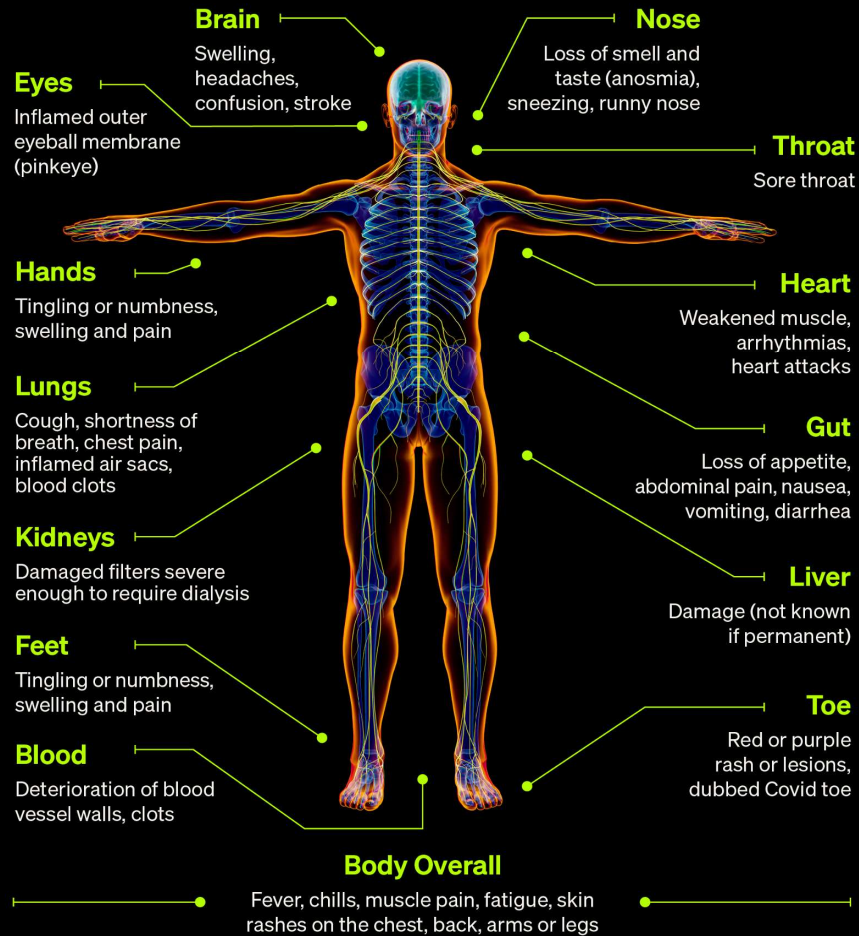
The global COVID-19 pandemic

Daily new confirmed Covid-19 cases per million people
7-day rolling average – up to 6 April 2022



Data Source: Our World in Data; NICD

People with Covid-19 might experience no symptoms, or just one or a few of these, or several in severe cases.



nature

Every Covid-19 Symptom We Know About Right Now, From Head to Toe

The most perplexing things about a disease that has proved vexing, deadly, and 'unprecedented in many ways'

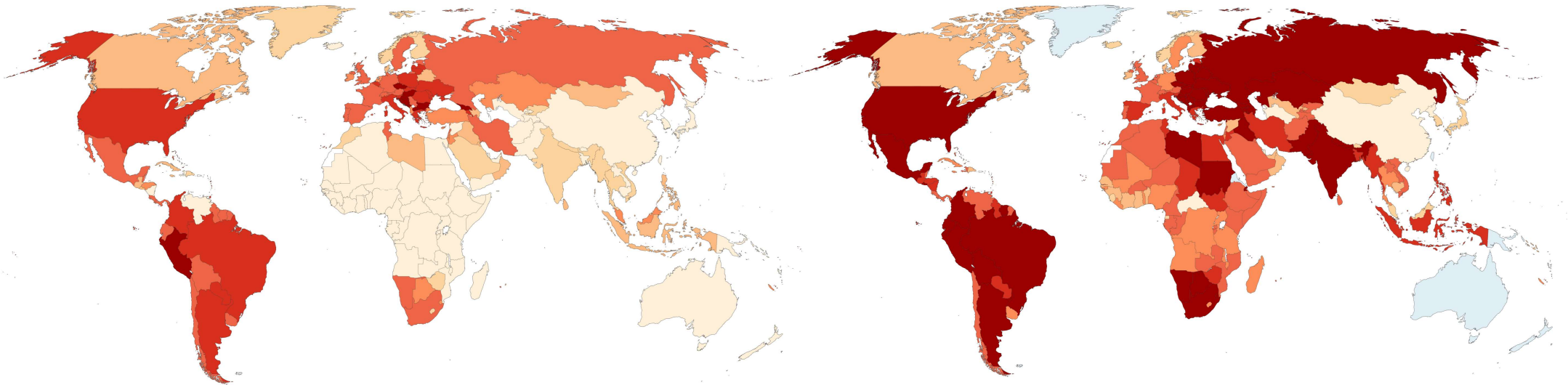
Ee+

SOURCES: Stanford University; Johns Hopkins University; Baylor College of Medicine Medical Center; Cleveland Clinic; Harvard University; Science Magazine; CDC; Mahalia Desruisseaux, MD, Yale University; Robert Salata, MD, Case Western Reserve University

High death toll of Covid-19 – excess & reported deaths

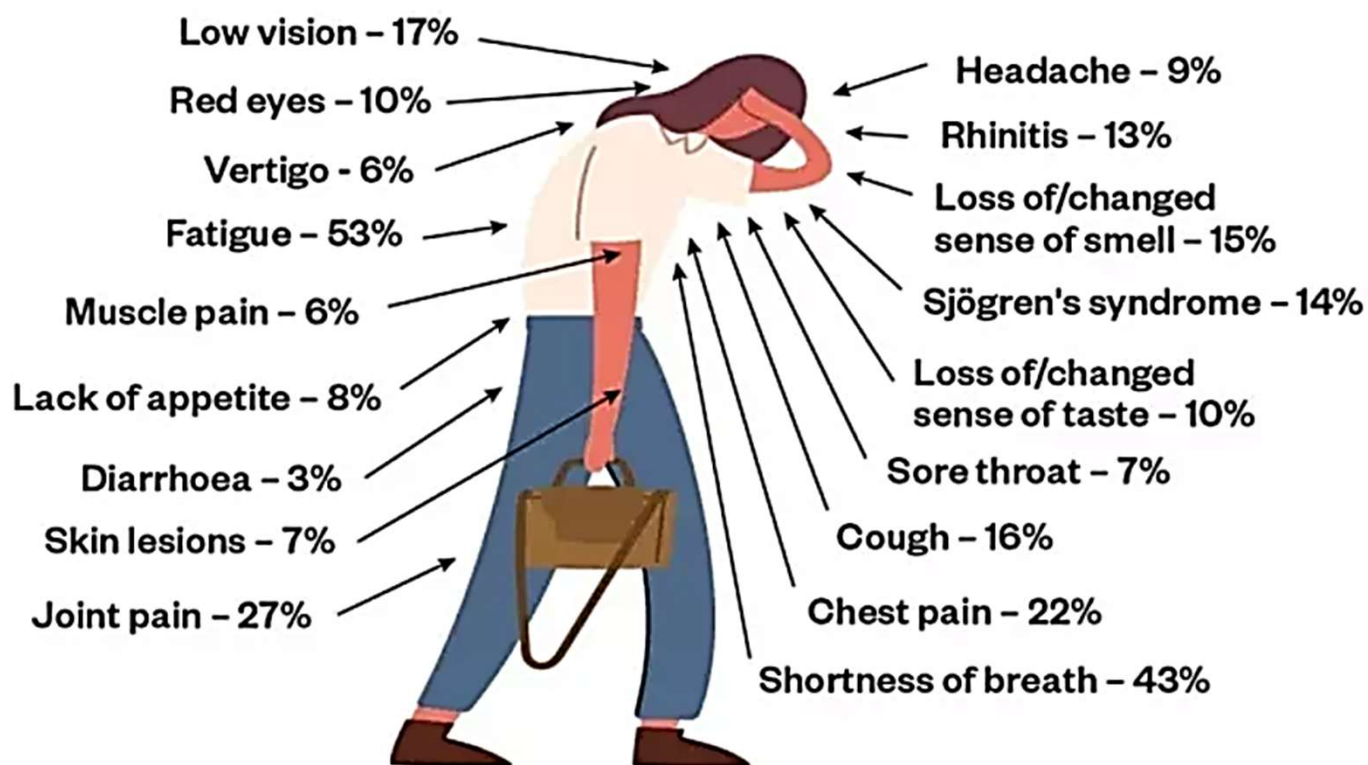
Reported Covid-19 deaths: 6 million

Estimated 20 million (14m – 24m) excess deaths worldwide during the pandemic



Source: *The Economist*: <https://economist.com/briefing/2021/05/15/there-have-been-7m-13m-excess-deaths-worldwide-during-the-pandemic>

Long COVID-19: the burden of “brain fog”



- Study of a cohort of 3762 people in 56 countries
- Time to recovery in >90% exceeded 8 months
- Most frequent symptoms after 6 months:
 - Fatigue
 - post-exertional malaise
 - cognitive dysfunction & memory problems

Source: Lancet eClinicalMedicine, 38, 101019, 2021

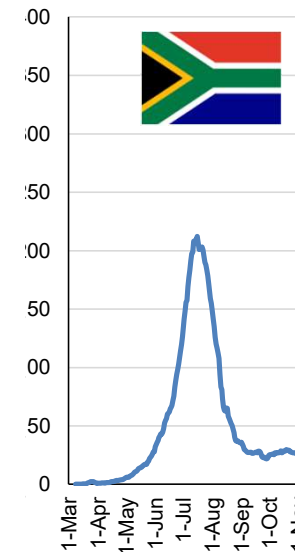
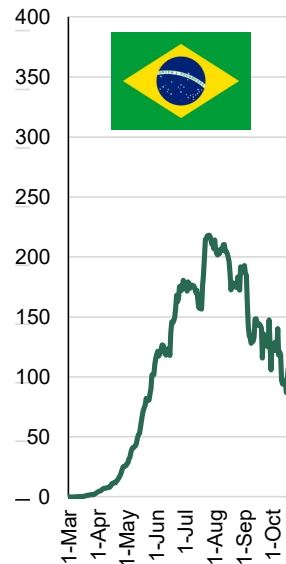
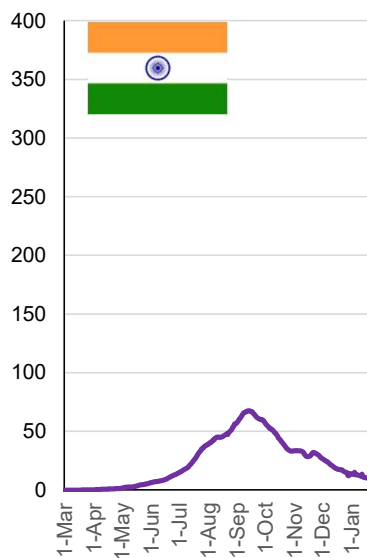
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Variants have changed the Covid-19 endgame

Covid-19 surges due to variants of concern in India, Brazil and SA

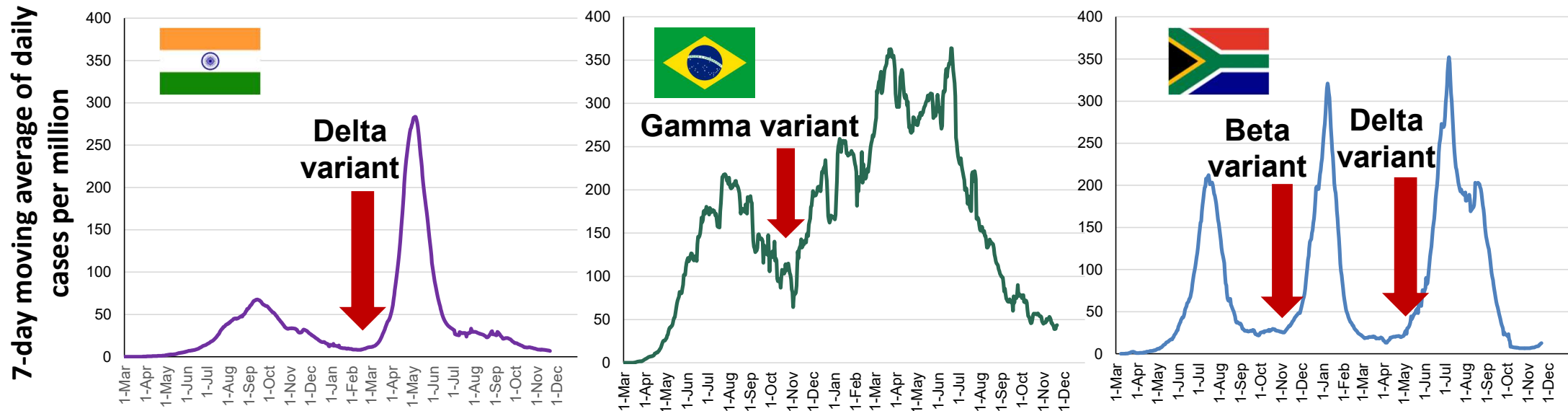
7-day moving average of daily cases per million



Source: *Our World in Data*

Impact of Variants of Concern on the pandemic

Covid-19 surges due to variants of concern in India, Brazil and SA

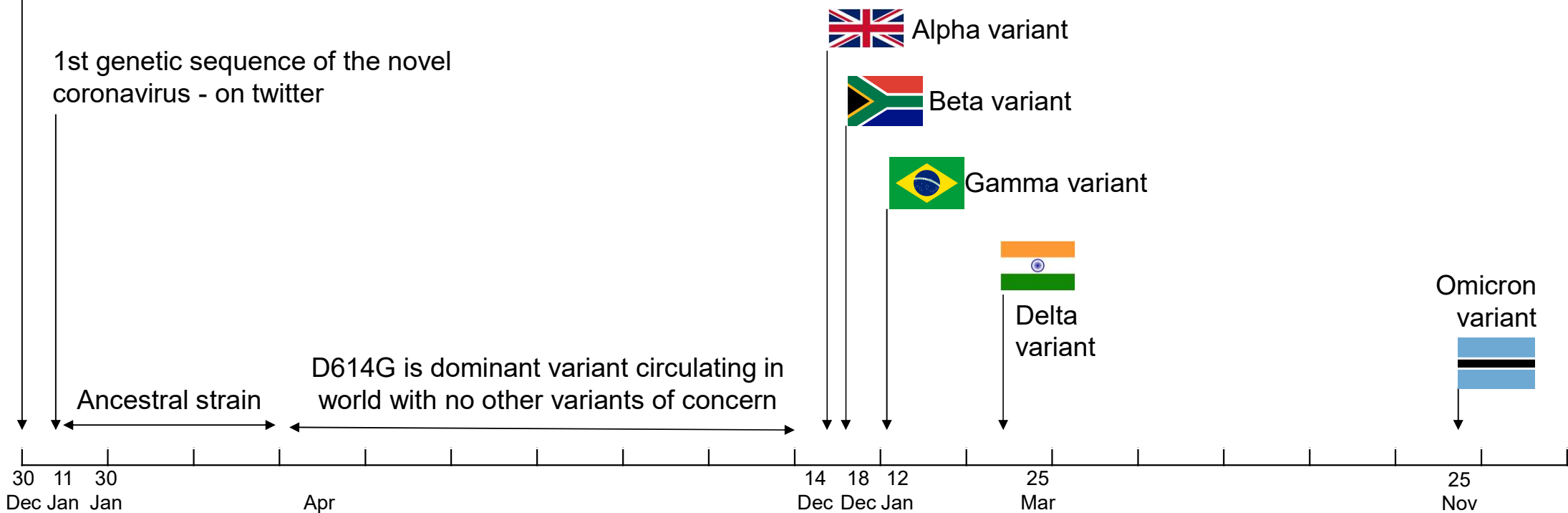


Source: *Our World in Data*

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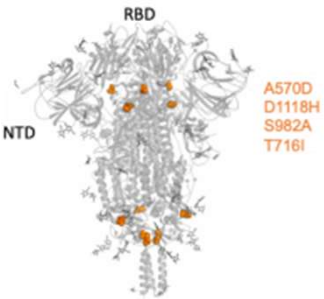
5 SARS-CoV-2 Variants of Concern from 4 continents



***Flags of countries where the variant was first identified & reported**

Key mutations in the spike protein for each variant of concern

Alpha α
(B.1.1.7, 20I/501Y.V1, VOC 202012/01)

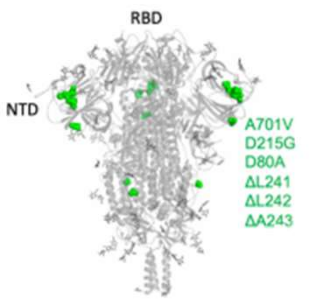


A570D
D1118H
S982A
T716I

4 key mutations

Sep, 2020

Beta β
(B.1.351, 20H/501Y.V2)

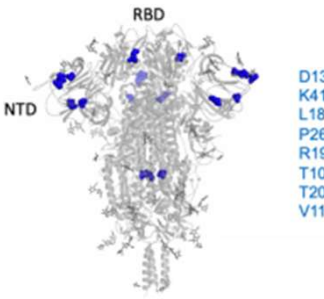


A701V
D215G
D80A
 Δ L241
 Δ L242
 Δ A243

6 key mutations

Aug, 2020

Gamma γ
(P.1, B.1.1.28.1, 20J/501Y.V3)




D138Y
K417T
L18F
P26S
R190S
T1027I
T20N
V1176F

8 key mutations

Jul, 2020

Delta δ
(B.1.617.2, 21J)

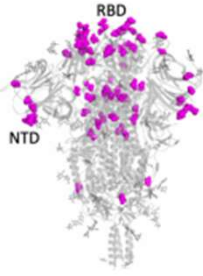


D950N
E156G
L452R
P681R
T19R
 Δ F157
 Δ R158

7 key mutations

Dec, 2020

Omicron \omicron
(B.1.1.529, BA.1, BA.2)



A67V
D796Y
E484A
G339D
G446S
G496S
L212I
L981F
N440K
N679K
N764K
N856K
ins214EPE

N969K
Q493R
Q498R
Q954H
S371L
S373P
S375F
S477N
T547K
T95I
Y505H
 Δ V143
 Δ N211

26 key mutations

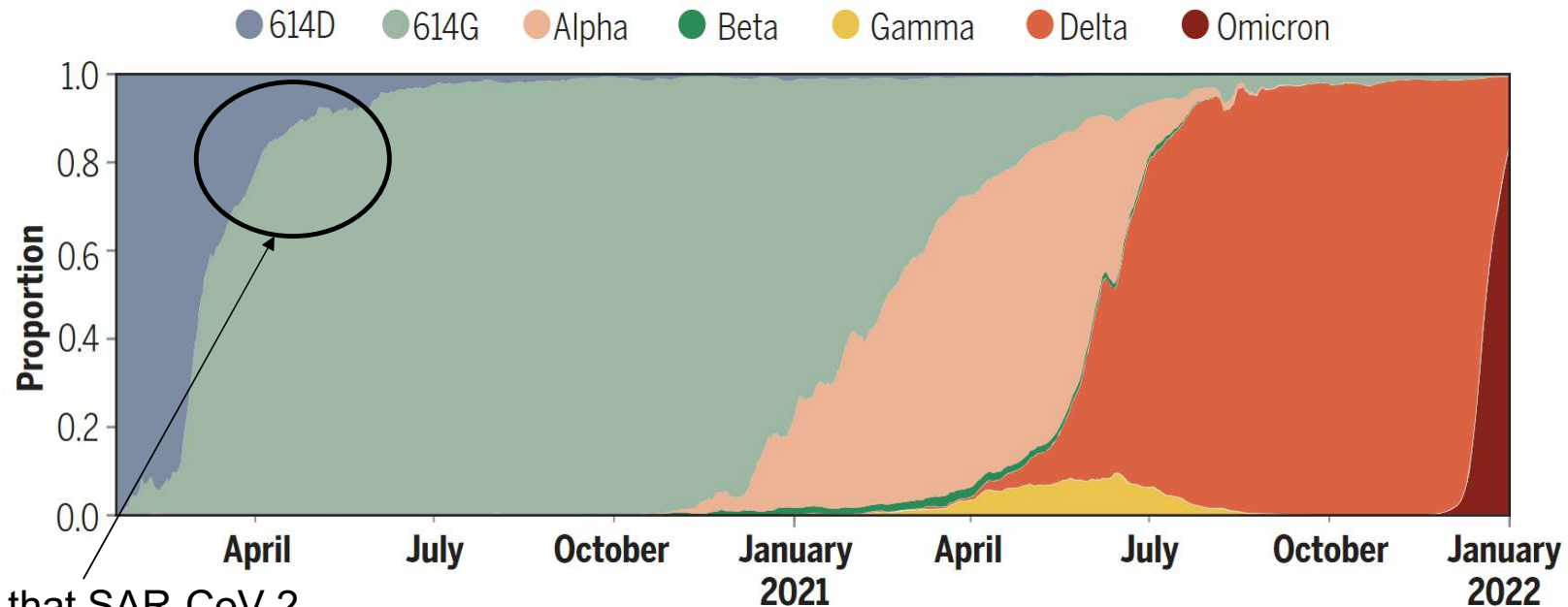
Dec, 2021

Science

The changing epidemiology of SARS-CoV-2

Katia Koelle^{1*}, Michael A. Martin^{1,2}, Rustom Antia¹, Ben Lopman^{3,4}, Natalie E. Dean^{3,5}

The frequencies of SARS-CoV-2 variants of concern over time



1st indication that SAR-CoV-2 was adapting to humans

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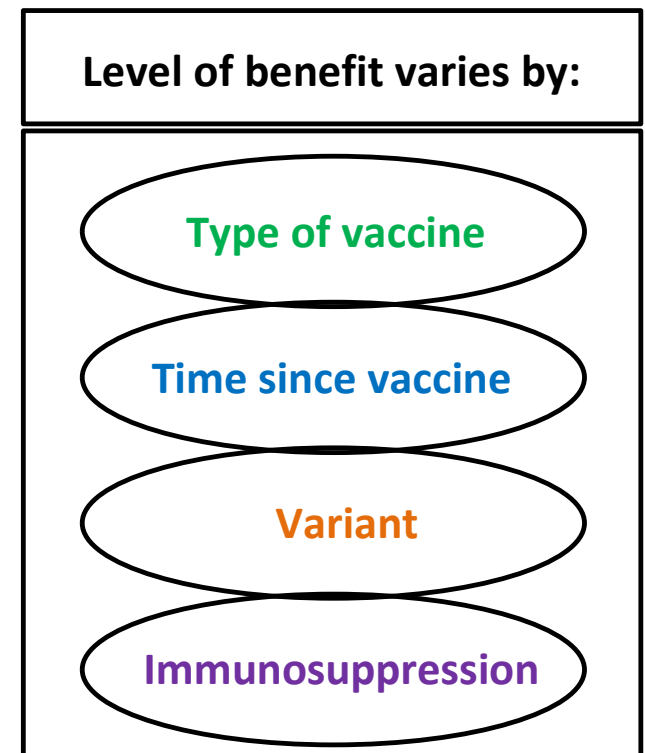
The 5 benefits of Covid-19 vaccines

- **Individual benefits:**

1. ↓ asymptomatic infections
2. ↓ clinically apparent infections
3. ↓ severity / hospitalisations / deaths
4. ↓ progression to long Covid

- **Community benefits:**

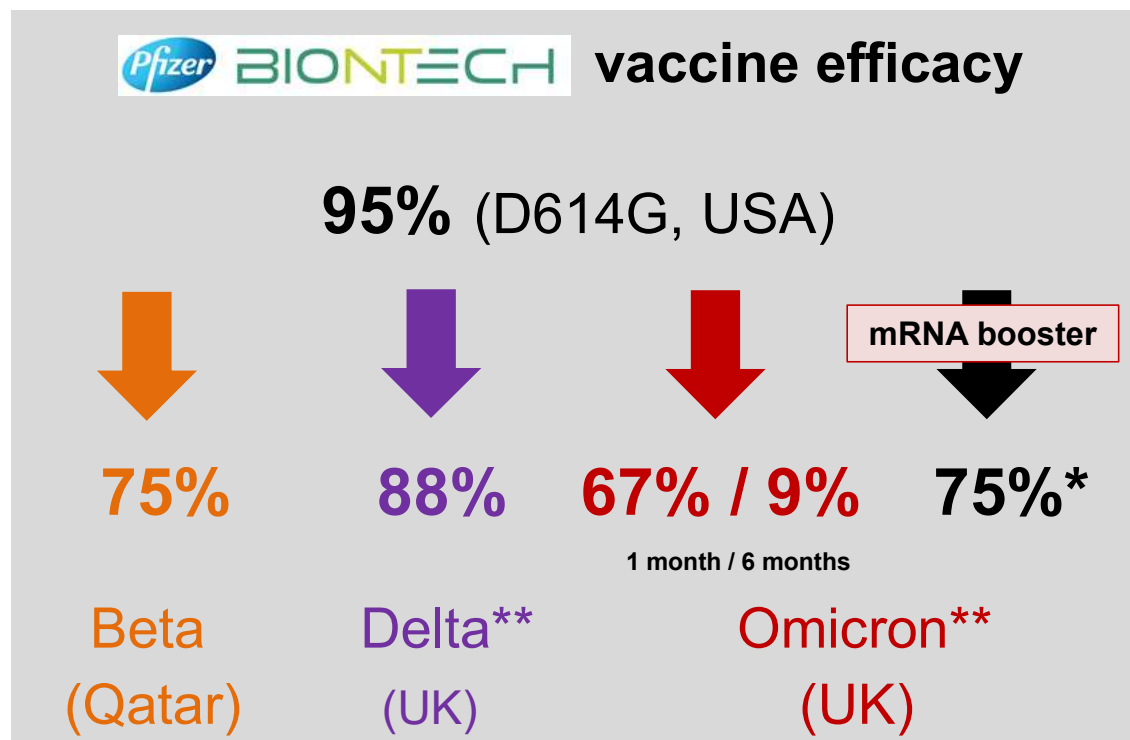
5. ↓ secondary attack rate to close contacts
 - ↓ infectious if infected when vaccinated
 - ↓ period of infectiousness when vaccinated



1 & 2. Vaccines prevent silent asymptomatic infections and clinical infection – but impact varies by variant

Two doses of Pfizer vaccine:

1. 66% fewer asymptomatic infections
2. 95% fewer clinically mild infections



*Booster benefit duration not known – likely to be short-lived

Sources: Liu et al., NEJM 2021; 384(15): 1466-8; Abu-Raddad, et al., NEJM 2021; 385:187-189; Bernal et al., NEJM 2021; 385:585-594; Andrews et al., NEJM DOI: 10.1056/NEJMoa2119451

3. Vaccines effective over time for all past variants for severe Covid-19, hospitalization & deaths

New York State (n=8,834,604) ≥ 65 years

(efficacy for severe disease and hospitalization for Alpha or Delta variant infection)

- Pfizer-BioNTech: **95%** to **89%** four months later
- Moderna: **97%** to **94%**
- J&J: **86%** to **83%**

US data on Covid-19 deaths:

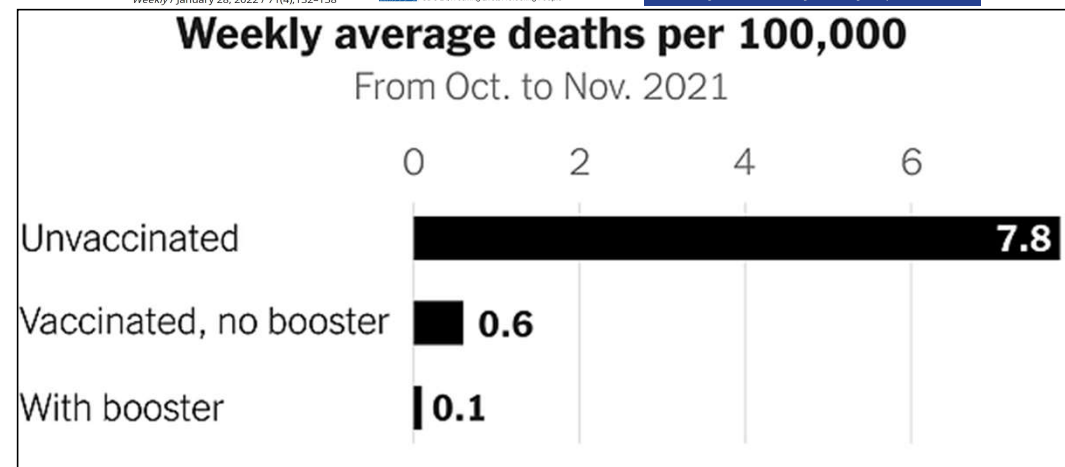
Boosted people have 78 times lower risk of dying of Covid-19

COVID-19 Incidence and Death Rates Among Unvaccinated and Fully Vaccinated Adults with and Without Booster Doses During Periods of Delta and Omicron Variant Emergence — 25 U.S. Jurisdictions, April 4–December 25, 2021

Weekly / January 28, 2022 / 71(4):132–138

CDC Centers for Disease Control and Prevention
CDC-267: Saving Lives. Protecting People™

Morbidity and Mortality Weekly Report (MMWR)



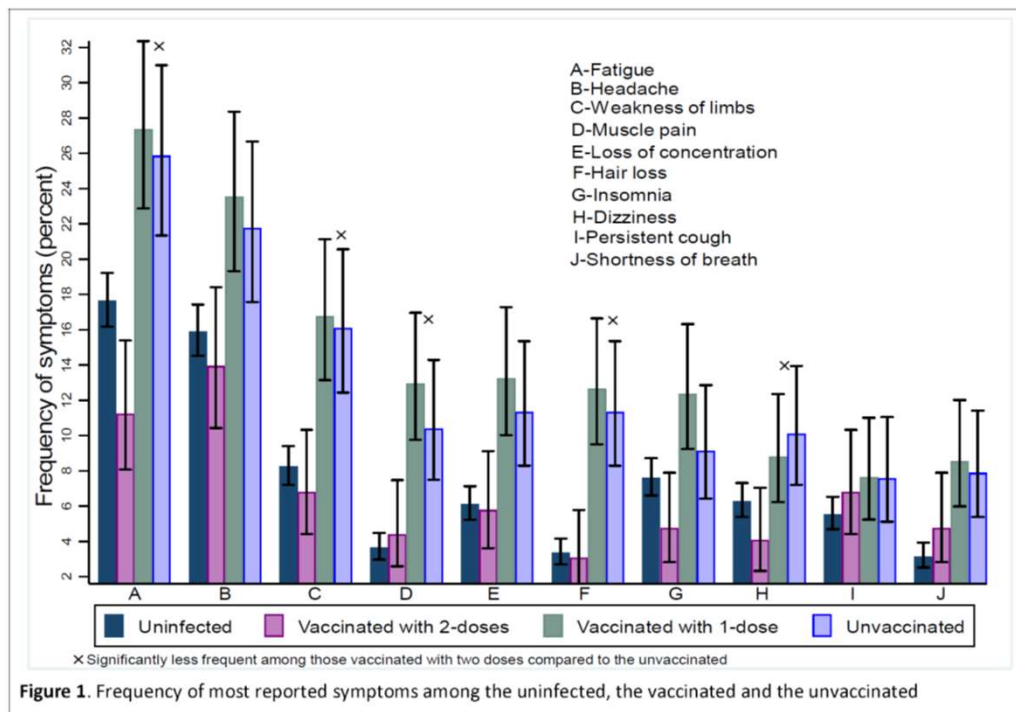
Source: Rosenberg et al. NEJM 2022;386(2): 116-27.

4. Two doses of Pfizer vaccine reduces long Covid

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES

Association between vaccination status and reported incidence of post-acute COVID-19 symptoms in Israel: a cross-sectional study of patients tested between March 2020 and November 2021

Paul Kuodi¹, Yanay Gorelik¹, Hiba Zayyad^{1,3}, Ofir Wertheim³, Karine Beiruti Wiegler², Kamal Abu Jabal^{1,2}, Amiel A. Dror^{1,4}, Saleh Nazzal³, Daniel Glikman^{1,3}, Michael Edelstein^{1,2}



54% to 64% reduction in the 4 most common persistent long Covid symptoms:

- Fatigue
- Headache
- Weakness
- Muscle pain

5a. Vaccination reduces SARS-CoV-2 transmission

Science

Indirect protection of children from SARS-CoV-2 infection through parental vaccination

Samah Hayek¹, Galit Shaham¹, Yatir Ben-Shlomo¹, Eldad Kepten¹, Noa Dagan^{1,2,3,4}, Daniel Nevo⁵, Marc Lipsitch⁶, Ben Y. Reis^{3,4,7}, Ran D. Balicer^{1,8}, Noam Barda^{2,1,3,4*}

Direct Protection Effect

Protection of parents from having been vaccinated

94%



Indirect Protection of Household members

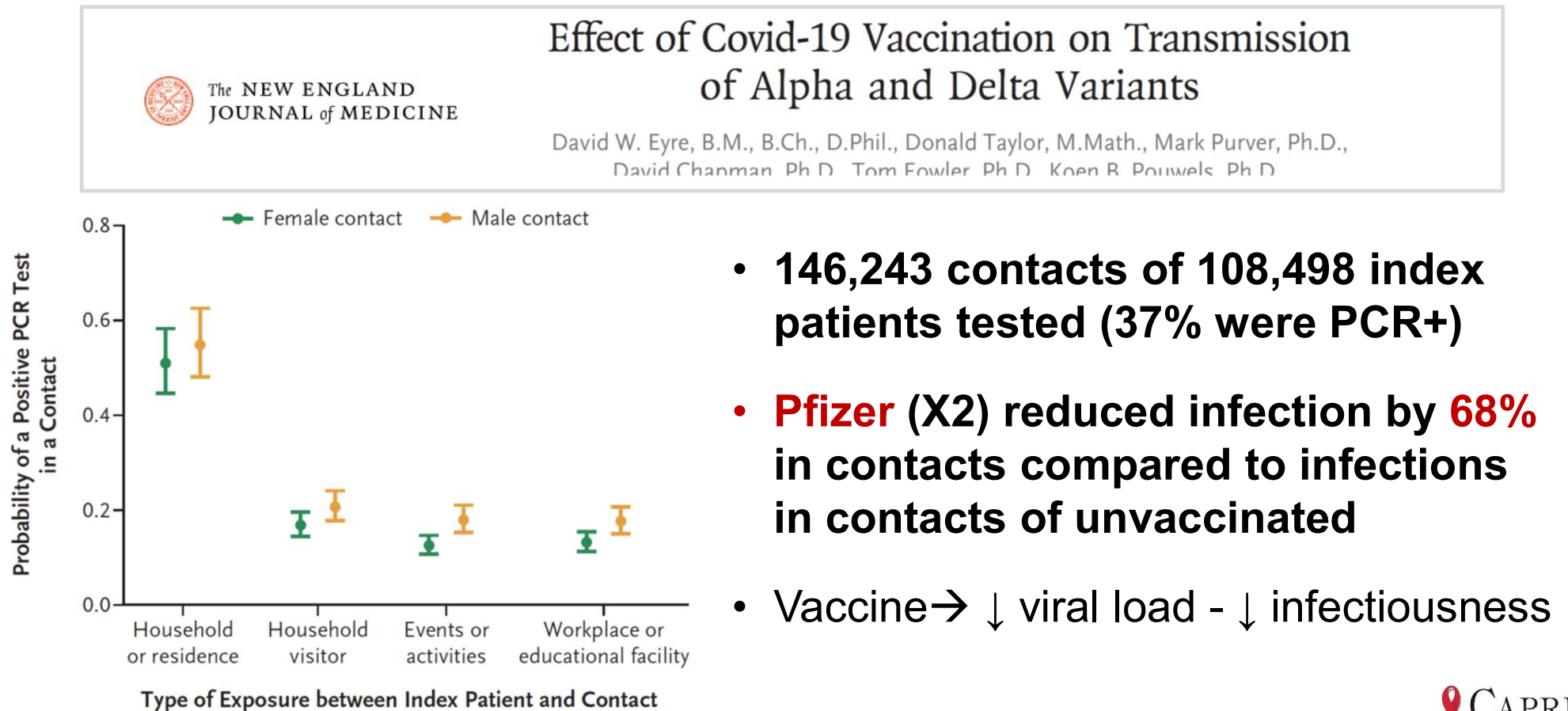
Reduction in Risk of transmission from infected parent to unvaccinated child

72%



- Two-parent homes with at least one vaccine-ineligible child
- Children with vaccinated parents - 72% lower risk of getting infected

5b. Vaccination reduced SARS-CoV-2 transmission to household & workplace contacts (in two variants)



5c. Vaccines reduce viral spread by lower infectiousness & shorter duration of infectiousness



Initial report of decreased SARS-CoV-2 viral load after inoculation with the BNT162b2 vaccine

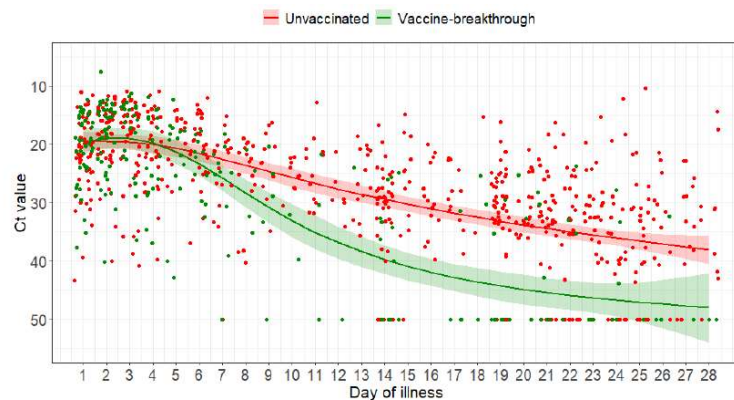
Matan Levine-Tiefenbrun^{1,6}, Idan Yelin^{1,6}, Rachel Katz², Esmā Herzal², Ziv Golan³, Licita Schreiber³, Tamar Wolf³, Varda Nadler³, Amir Ben-Tov^{2,4}, Jacob Kuint^{2,4}, Sivan Gazit²



Clinical Microbiology and Infection

Virological and serological kinetics of SARS-CoV-2 Delta variant vaccine breakthrough infections: a multicentre cohort study

Chia PY, Ong SW, Chiew CJ, Ang LW, Chavatte JM, Mak TM, Cui L, Kalimuddin S, Chia WN, Tan CW, Chai LY.

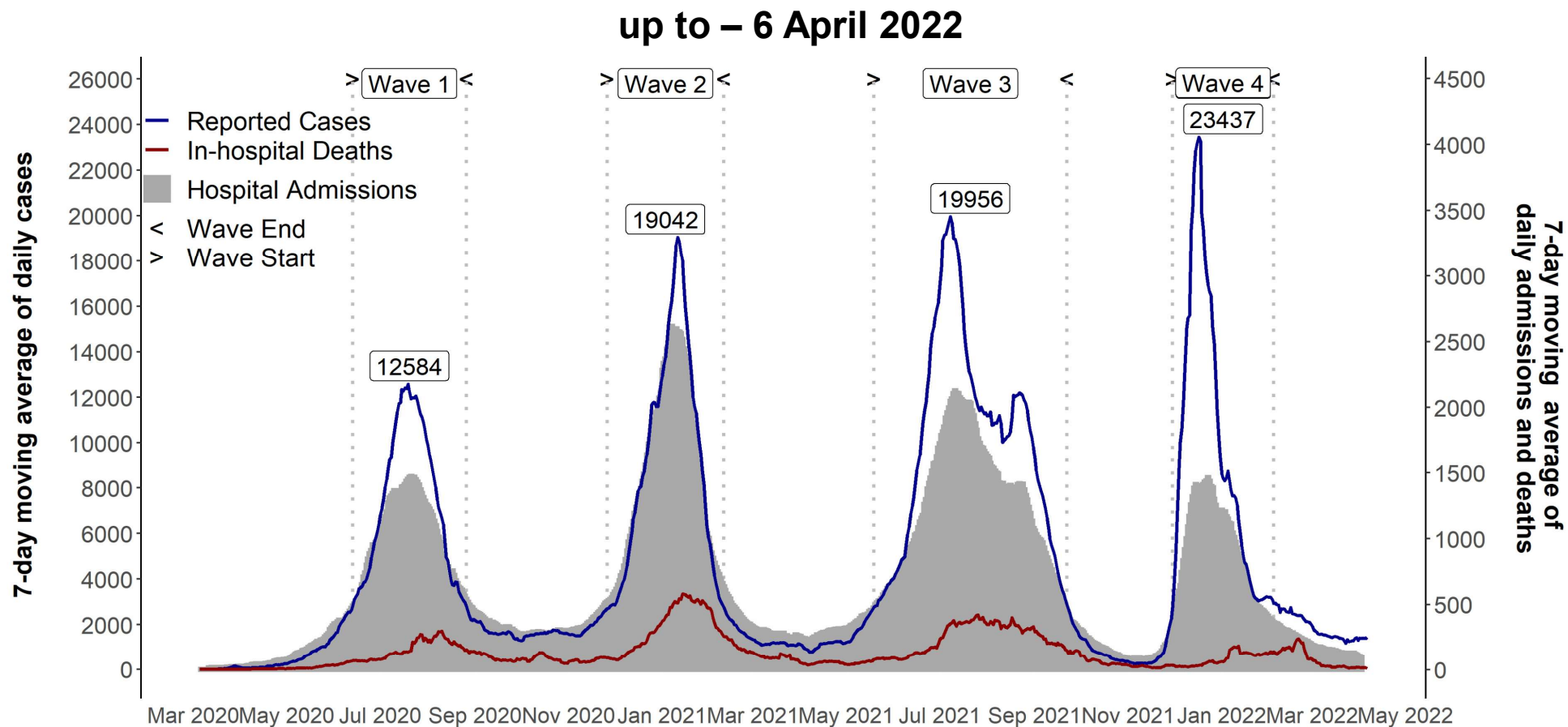


- 218 individuals in Singapore: (88 vaccinated, 130 unvaccinated)
- Delta - viral loads ↓ faster in vaccinated

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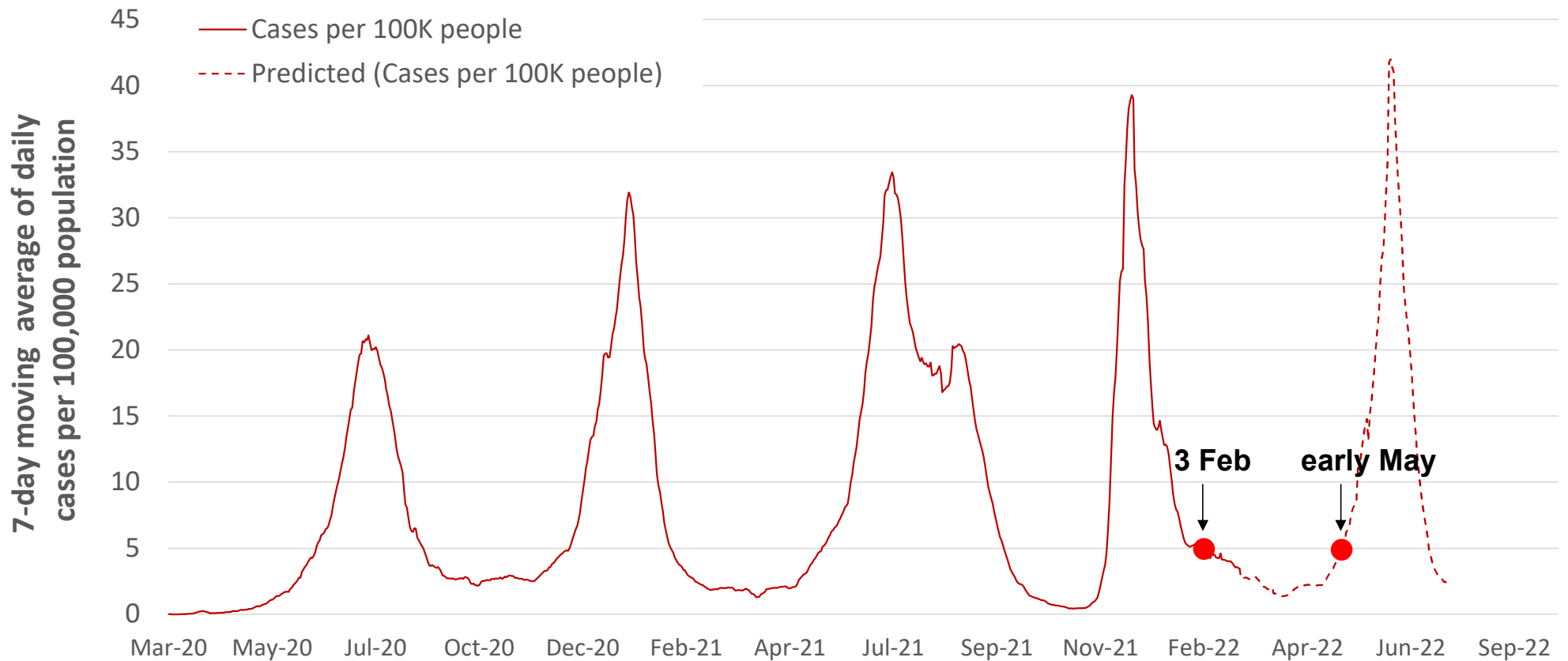
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COVID-19 in South Africa – what's next?



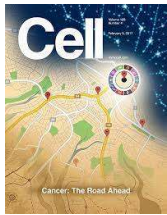
Source of hospital admissions data: Lucille Blumberg, Richard Welch and Waasila Jassat – DATCOV, NICD

If there is a 5th wave in South Africa, when?



Note: New variant and other factors may change epidemic trajectory. These estimations are based on several assumptions and not on mathematical modelling

What will Pi look like? - Predicting the impact of future immune escape variants on the pandemic



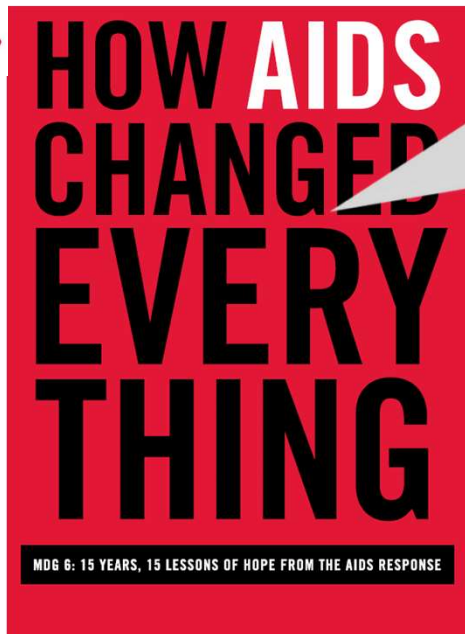
Population impact of SARS-CoV-2 variants with enhanced transmissibility and/or partial immune

Mary Bushman^{1*}, Rebecca Kahn^{1†}, Bradford P. Taylor^{1†}, Marc Lipsitch¹, William P. Hanage¹

Characteristics of future variants:

- *More transmissible – faster doubling time*
- *Immune escape – causes infection in those with natural & vaccine immunity*
- *Moderate immune escape poses a low risk unless there is \uparrow transmissibility*
- *Severity due to viral virulence & existing immunity – past infection & vaccination*

A key lesson from HIV for Covid-19: Importance of mutual interdependence & shared responsibility



“The AIDS movement demonstrates that with a shared vision, shared responsibility and through global solidarity... ..we can change the course of history.”

– UNAIDS 2015

- **Global solidarity** – essential for access to life-saving medication, e.g. Global Fund & PEPFAR
- **Shared responsibility:** Countries where individuals see caring for fellow citizens as important do better than those where individuals focus on themselves first
- **No-one is safe until everyone is safe!**