COVID-19
Aktuelle epidemiologische Entwicklungen

Univ. -Prof. Mag. Phil. Dr. med. univ. Eva Schernhammer, MPH DrPH
Abteilung für Epidemiologie, Meduni Wien

23. Wiener Forum Arbeitsmedizin, 22. April 2022

1

Overview

- 2019/11: Origin and beginnings of pandemic
- 2020/03: global pandemic declaration by WHO
- 2022/03 and 2022/10: Ancestral SARS-CoV-2, wave 1 and 2 (2020), lockdowns, high case fatality among the elderly
- 2022/12: Milestone: first vaccine
- 2021/01: Implementing testing strategies to help keep schools open
- 2021/03: British variant wave → vaccination program rolls out
- 2021/10: Low vaccine acceptance and recognizing that vaccines loose effectiveness
- 2021/11: Delta wave ("unvax") : boostering Austria out of the lockdown (and vaccine mandate)
- 2021/12: Omicron BA.1
- 2022/03: Omicron BA.2
- 2022/04: End of all restrictions, population increasingly acquires immunity – scenarios for the fall

2

COVID-19

- **First described in late December 2019** in the metropolis Wuhan (Province Hubei)
- The disease that is triggered by SARS-CoV-2 is commonly referred to as COVID-19
- Coronaviruses belong to the family of **RNA-Viruses**, which can infect both animals and humans
- In humans, they lead to diseases of the airways, ranging from modest flu-like symptoms to severe pneumonia

- Exact source of origin unclear, though likely wet market:

3

Origin and course

- First described in late December 2019 in the metropolis Wuhan (Province Hubei)
- Exact source of origin unclear, though likely wet market
- Jan 2020 Epidemic in China
- Jan 24: Chinese New Year with travels comparable to Thanksgiving in the US

4

The first cases out of Wuhan

- By 16th January, 41 confirmed COVID-19 cases in Wuhan, China.
- Three cases detected abroad (2 in Thailand, 1 in Japan).

Source: Adam Kucharek
UK Online Talk 07/08/20

5

Origin and course: Milestones

- First described in late December 2019 in the metropolis Wuhan (Province Hubei)
- Exact source of origin unclear, though likely wet market
- Jan 2020 Epidemic in China
- Jan 24: Chinese New Year with travels comparable to Thanksgiving in the US

- Jan 30, 2020: WHO declares outbreak a public health emergency of international concern (PHEIC)
- Feb 2, 2020, WHO declares an official name for the disease:

  COVID-19 (coronavirus disease 2019)
- The name of the pathogen is changed from 2019-nCoV auf SARS-CoV-2

6

Our globalized world – the issue of connectivity

- When considering social systems, more interconnected networks have positive and negative impacts, visible at different scales from the local to the global level:

ADVANTAGES:

- On the one hand, strongly interconnected social systems may facilitate more efficient exchange, use of essential resources and social capital

DISADVANTAGES:

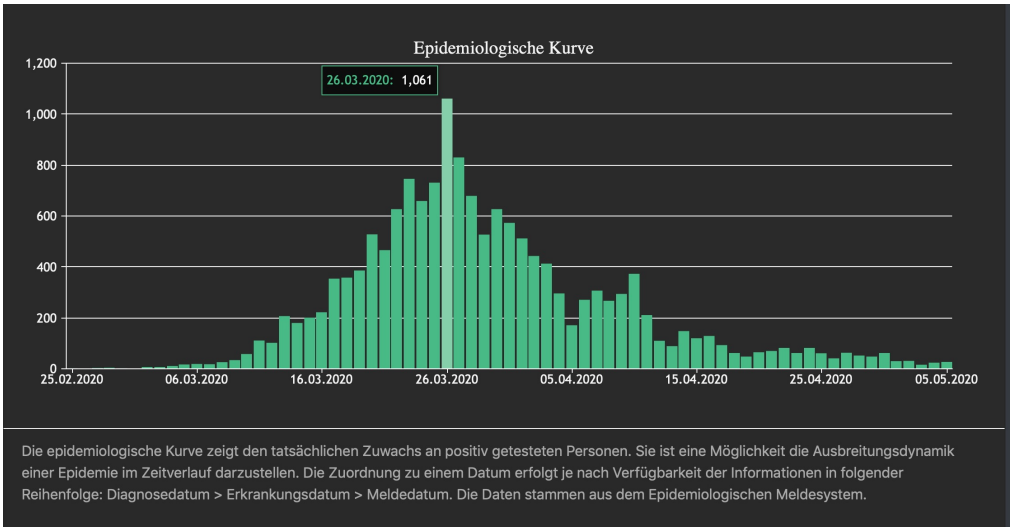
- However, as evidenced by pandemic threats such as COVID-19, **denser social networks can also act as catalysts for crises, turmoil and destruction**.

7

WHO declares the novel COVID-19 outbreak on March 11, 2020 a global pandemic

8

Austria: Exponential growth and peak of new COVID-19 cases (n=1,061) on March 26, 2020. Lock down implemented on March 16



Data source: Austrian Ministry of Health

9

A few guiding principles can help define and better understand the severity and uncertainties of any epidemic outbreak:

1) Basic reproduction number R_0
2) Herd immunity threshold (HIT)
3) Duration of its incubation period (e.g., the time between exposure to the infectious agent and the appearance of first symptoms)
4) Dispersion parameter K
5) Lethality associated with the pathogen (e.g., the case fatality rate, measured as the proportion of infected persons who die from the infection)
6) Number of individuals immune to the pathogen in a given population.

10

1) The *basic reproduction number* R_0

- Not to be confused with the doubling rate (in days)
- Provides a sense of the speed at which a disease spreads, i.e. its contagiousness

  If one person, on average, infects just one other person, R_0=1

  If one person infects on average two other persons, R_0=2, and so forth
- Any R_0>1 has the potential to lead to an outbreak, as the number of cases is prone to increase
- For COVID-19, R_0 was assumed to fall between **1.5-3.5**
- COVID-19's R_0 contrasts with the R_0 of, for example, measles (~12.0), the flu (~1.2-2.2), or Ebola (2.0)
- To successfully eliminate a disease from a population, R_0 needs to be <1

2) *Herd immunity threshold* (HIT)

- The herd immunity threshold **$(R_0-1)/R_0$** is the proportion of a population that must be immune in order for an infectious disease to reach R_0<1 and thus stopping its spread
- For COVID-19 to reach R_0<1, with a conservatively estimated R_0 of 1.5, 33% of the population must be immune, and if R_0=3.5, at least 71% of a given population must be immune for the infection to stop spreading
- Additional influencing factors include environmental factors, population density, health status, or average population age.

3) The *incubation period*

- Period between exposure to pathogen and emergence of first symptoms
- The *incubation period* of COVID-19 (median 5.1 days, spanning up to 15.6 days) was unfavorable compared to that of 1-2 days for the flu
- Infectivity starts 1-2 (sometimes even up to 3) days before first symptoms

13

4) Parameters of relevance in the super-spreading context: *secondary attack rate (SAR)* and *dispersion parameter K*

- The secondary attack rate (SAR) captures the likelihood of an infection occurring within a close setting such as among household members or close contacts, as for example during the now infamous après-ski parties in Ischgl
- Current estimates for COVID-19 suggest a SAR of 35% (95%CI, 27%-44%)
- R_o may be misleading as it is an averaged number that does not accurately represent the actual spread:
  - if each of a group of ten infects one other person, R0 is 1;
  - and, without considering SAR, R0 would also remain 1 in a highly different scenario: i.e. if one of a group of ten infects 10 other people, whereas the remaining 9 of the group do not infect anyone.
  - Depending on these scenarios, which both have an R0=1, the spread would be remarkably different.

14

To take this variance into account, the dispersion parameter (K) is often used as a key parameter in studying outbreak dynamics

- K is helpful in estimating the individual difference among infectious people transmitting a pathogen (i.e. whether some individuals infect few, and others infect large numbers of contacts; or each infected person infects roughly the same number of others)
- A K number above 1 indicates low variation in spreading patterns, i.e. infected persons infect about the same amount of others
- A K number below 1 indicates high variation, i.e. certain persons infect a considerably higher number of persons than others do
- A low K value implies that more transmission comes from a small number of infectious persons, i.e. "superspreaders"

15

COVID-19's dispersion parameter K:

- Even before the COVID-19 pandemic lockdowns occurred its K was estimated between 0.1 and 0.5
- This would mean that about 10%-20% of COVID-19-infected persons have infected 80% of those infected so far, due to the heterogeneities in the transmission of infectious agents
- Several studies, including a large one from India confirmed this: among over a Million COVID-19 infected and their contacts, only 5% were responsible for infecting 80% of the total study population

16

5) *Lethality (i.e. case fatality)*

- For example, while the high R_0 of measles implies that many people will become infected, its mortality (e.g., case fatality) rate is low (~0.2%)
- In contrast to Ebola, which has a much smaller R_0 and hence is less contagious, but which is far deadlier (mortality rate 22.0-88.0%)
- For COVID-19, projections from China, with some variation, indicate a 2.3% case fatality rate
- This was corroborated by subsequent studies (Levin et al., October 2020): close to zero for children and younger adults but rises exponentially with age, reaching 0.4% at age 55, 1.4% at age 65, 4.6% at age 75, and 15% at age 85

17

6) *Immunity*

- Because COVID-19 was new, the virus could spread unchecked in a global population with essentially 100% susceptibility (e.g. due to no source of prior immunity).
- The prospect of reaching herd immunity was dim
- A vaccine was on the horizon, but until then, ??
- Together, these factors implicated COVID-19 as a serious global threat

18

The evolution of SARS-Cov-2

	Ancestral SARS-CoV-2 1st and 2nd wave Spring and Fall 2020
R_0	1.5-3.5[1]
HIT	33% - 71%
Incubation period	mean 6 days (5.6 – 6.5 days)[6]
Dispersion parameter K	0.1 (10% account for 80% of infections)[11]
Case fatality	Variation by age- and risk-group
Vaccination rate	0%

1) Basic reproduction number R_0
2) Herd immunity threshold (HIT)
3) Duration of its incubation period (e.g., the time between exposure to the infectious agent and the appearance of first symptoms)
4) Dispersion parameter K
5) Lethality associated with the pathogen (e.g., the case fatality rate, measured as the proportion of infected persons who die from the infection)
6) Number of individuals immune to the pathogen in a given population.

19

Mitigating factors

Mitigating factors that could slow the spread of transmission and lower R_0 include:

- the availability of measures to control the disease, e.g., therapies or vaccines, or
- the *level of immunity* acquired in a population

20

eR_0 - the effective reproduction number

- Of note, the proportion of susceptible in the population has implications for the R_0; the term "effective" reproduction number, eR_0, factors population susceptibility into the estimation of the number of new individuals that an infected person can infect.
- eR_0 can readily be estimated using the formula **$eR_0=R_0x$**, where x is the fraction of the host population that is susceptible
- For example, if R_0 for measles is 12 where half of the population is immune, the eR_0 for measles is 12x0.5=6 (a single case of measles would produce an average of 6, not 12, new secondary cases).

So what can we do, in the absence of immunity or a vaccine?

- Essentially, want to create "herd immunity" by other means
- **<u>These other means could include:</u>**
  - Wearing masks
  - Distancing ("Baby Elephant")
  - Personal Protective Equipment in hospitals etc.
  - Avoidance of large gatherings
  - Particular protection for vulnerable groups (e.g., nursing, elderly homes)
  - Home-office when/if possible
  - School closures (though massive side effects and aggravating inequality need to be considered as well)
  - Contact tracing + testing + quarantine

Due to rising infection rates and projected exhaustion of Intensive Care Units, extended Corona measures were implemented on October 19, 2020

- To limit social gatherings, a maximum of 6 individuals are permitted to meet each other indoors

23

Public Debates

24.10.2020 16:12 | NACHRICHTEN > POLITIK

FILZMAIER ANALYSIERT

Neue Maßnahmen: Corona und die öffentliche Meinung

(Bild: APA/ROLAND SCHLAGER)

Ab sofort gelten wieder neue Maßnahmen zur Bekämpfung der Corona-Pandemie. Wir alle diskutieren deren Sinnhaftigkeit und Wirksamkeit. Wie groß ist die Bereitschaft, sich an Vorschriften und Empfehlungen zu halten? Haben die Österreicher genug Vertrauen in Politik und Regierung?

Quelle: Kronen Zeitung

24

Austrian COVID-19 Trust Study

MEDICAL UNIVERSITY OF VIENNA
BRIGHAM AND WOMEN'S HOSPITAL
HARVARD MEDICAL SCHOOL

25

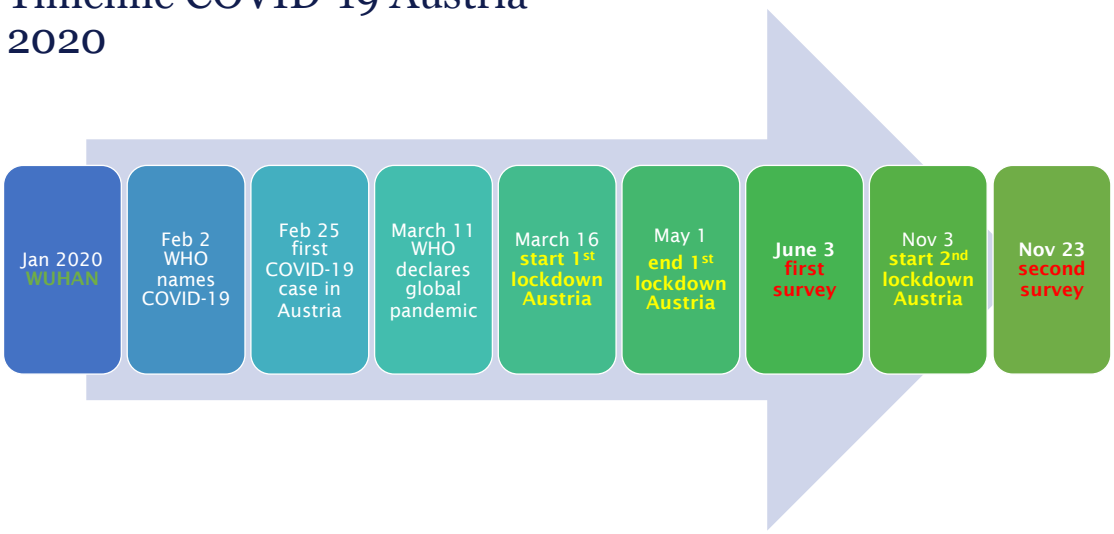
The following studies were conducted in collaboration with:

- **Gerald Steiner**, Danube University Krems and Complexity Science Hub, Vienna, Austria
- **Manfred D Laubichler**, School of Complex Adaptive Systems, Arizona State University, Tempe, AZ, USA and Complexity Science Hub, Vienna, Austria
- **Lukas Zenk**, Danube University Krems, Austria
- **Brenda M Birmann**, Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA, USA
- **Martin Bertau**, Institute for Technical Chemistry, TU Bergakademie Freiberg, Germany
- **Guido Caniglia**, Konrad Lorenz Institute for Evolution and Cognition Research, Klosterneuburg, and Complexity Science Hub, Vienna Austria
- **Carlo C Jäger**, Global Climate Forum, Berlin, Germany, and Arizona State University, Tempe, AZ, USA
- **Jakob Weitzer**, Department of Epidemiology, Medical University of Vienna, Austria

MEDICAL UNIVERSITY OF VIENNA

26

Timeline COVID-19 Austria 2020



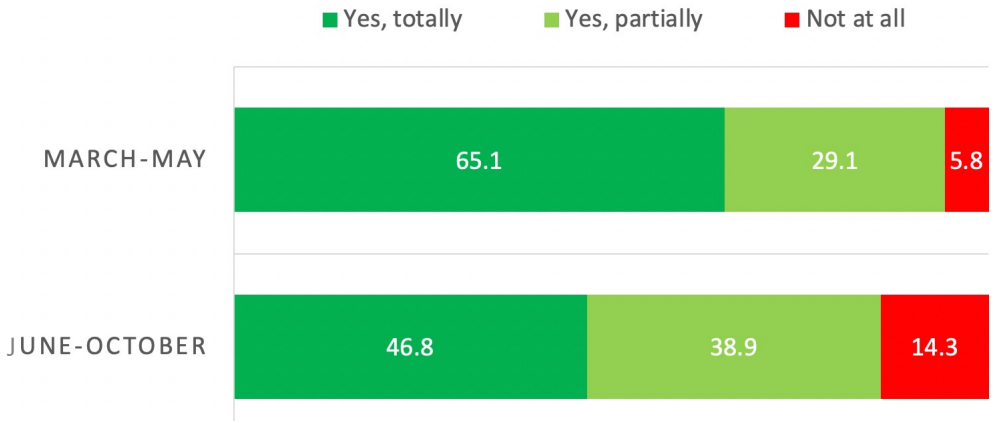
27

Characteristics of study participants

Characteristics	Survey 1 June 3-23 (N=1,010)	Survey 2 Nov 23-Dec 7 (N=1,007)
Age		
<35	319	321
35-59	590	583
60+	101	103
Gender		
Women	50.5%	50.6%
Men	49.5%	49.4%
County	26%	26%
Vienna	74%	74%
Other counties		

28

Willingness to adhere to Corona measures decreased over time

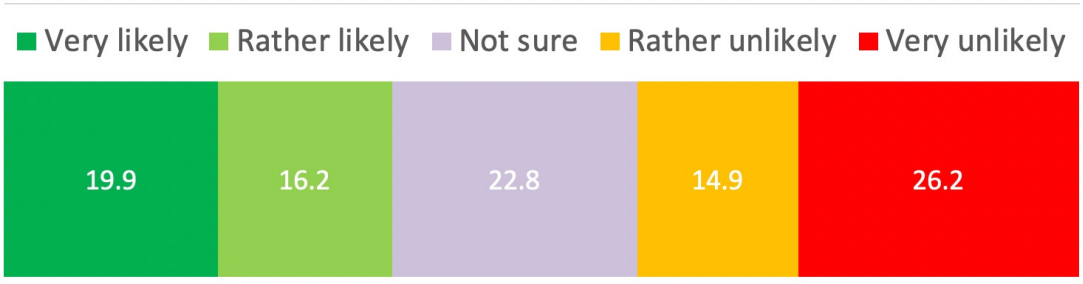


MEDICAL UNIVERSITY OF VIENNA

Adherence Corona measures over time

29

General willingness to receive COVID-19 vaccine in Austria once it is available

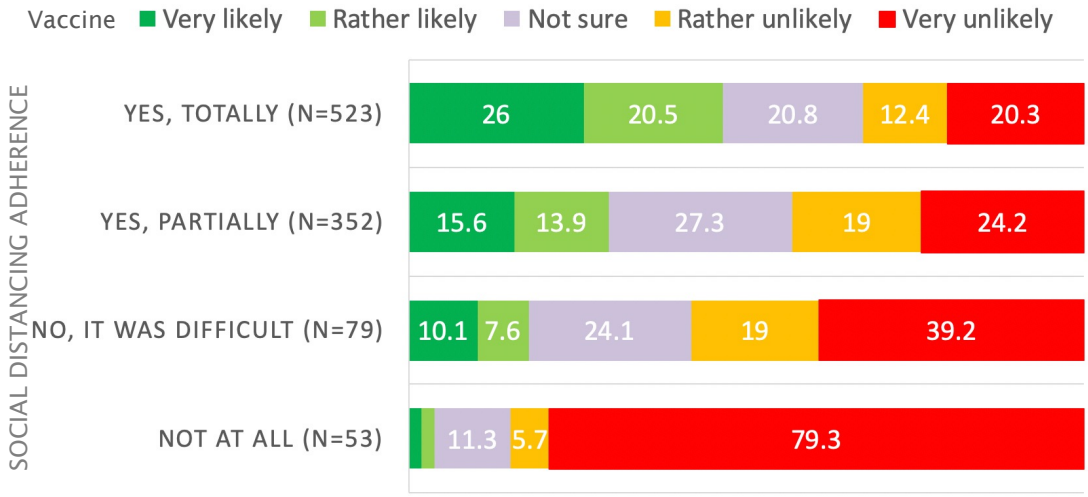


MEDICAL UNIVERSITY OF VIENNA

Willingness to get vaccinated

30

Willingness to get COVID-19 vaccine across strata of Adherence to social distancing (totally, partially, was difficult, not at all adhered)

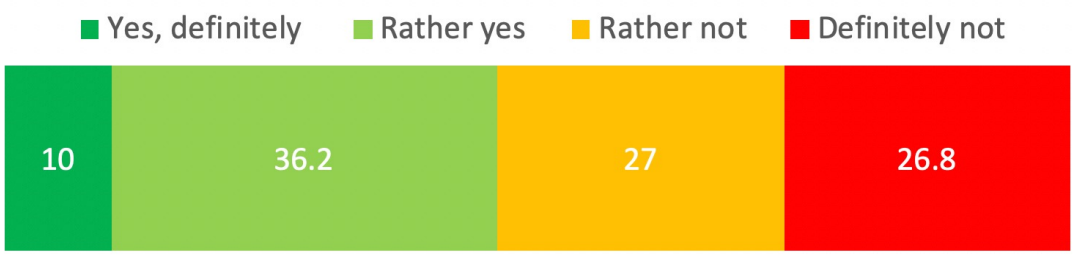


Correlates of vaccine hesitance

	Vaccine hesitancy				
	No or little hesitancy (N=363)	Undecided (N=230)		Intermediate or high hesitancy (N=414)	
	N (%)	*N (%)*	OR (95% CI)	*N (%)*	OR (95% CI)
Gender					
Men	230 (55.9)	117 (50.9)	0.80 (0.57-1.13)	178 (43.0)	**0.56 (0.41-0.76)**
Age					
<35 years	106 (29.2)	91 (39.6)	1	124 (30.0)	1
35-54 years	147 (40.5)	105 (45.6)	0.82 (0.54-1.23)	224 (54.1)	1.20 (0.83-1.73)
55-59 years	53 (14.6)	20 (8.7)	0.40 (0.22-0.76)	34 (8.2)	**0.48 (0.28-0.84)**
≥ 60 years	57 (15.7)	14 (6.1)	0.27 (0.14-0.54)	32 (7.7)	**0.37 (0.21-0.66)**
Area of residence					
Urban	197 (54.3)	105 (45.6)	1	170 (41.1)	1
Rural < 50.000 inhabitants	146 (40.2)	111 (48.3)	1.45 (1.02-2.07)	227 (54.8)	**1.86 (1.36-2.54)**
Education					
High school or less	123 (33.9)	86 (37.4)	1	191 (46.1)	1
Matura (university entry exam)	148 (40.8)	96 (41.7)	0.82 (0.55-1.22)	139 (33.6)	**0.64 (0.45-0.91)**
University degree	92 (25.3)	48 (20.9)	0.66 (0.41-1.05)	84 (20.3)	**0.58 (0.39-0.88)**
Political party preference					
Governing	201 (55.4)	124 (53.9)	1	154 (37.2)	1
Opposition	97 (26.7)	54 (23.5)	1.00 (0.66-1.52)	135 (32.6)	**2.06 (1.44-2.95)**
Did not vote (last elections)	65 (17.9)	52 (22.6)	1.16 (0.74-1.80)	125 (30.2)	**2.25 (1.53-3.30)**

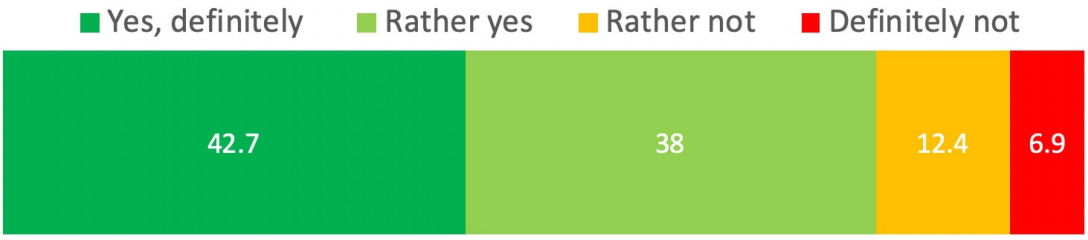
Multinomial regression models adjusted for gender, age, area of residence, education, political party preference, optimism, resilience, need for cognitive closure, main source of information, and subjective health status

Trust in the Austrian government to provide a safe vaccine

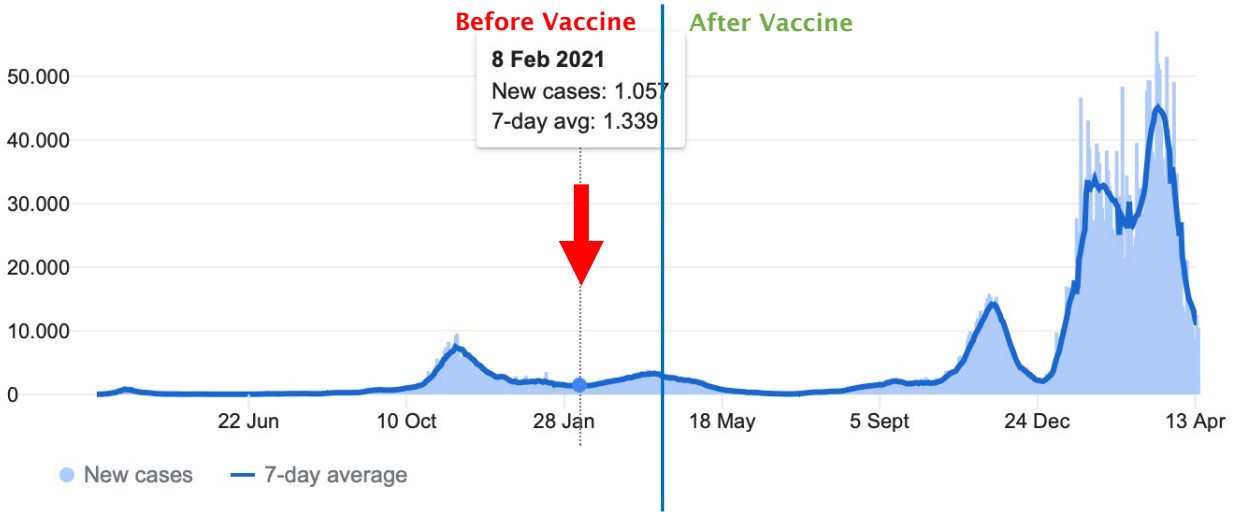


33

Will independent scientific evaluation of vaccine safety increase willingness to vaccinate?



34



35

Risky re-opening in midst of increasing resistance

POLITIK INLAND 01.02.2021

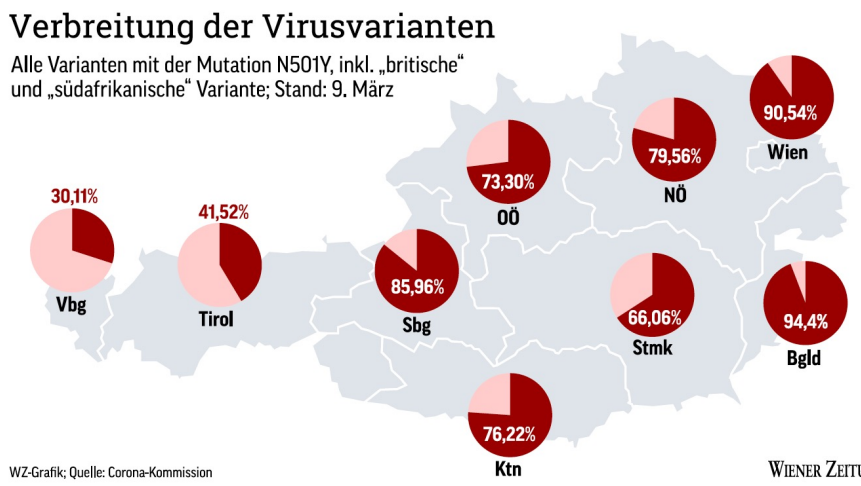
Lockerungen bis auf Widerruf: Schulen und Handel dürfen wieder öffnen

Ab 8.2. : Zwei Haushalte dürfen sich treffen. Empfindlichere Strafen bei Nicht-Einhalten der Maßnahmen. Bei 7-Tages-Inzidenz von 200 "müssen Alarmglocken schrillen".

Source: Kurier

36

The spread of the British variant in Austria, March 9, 2021



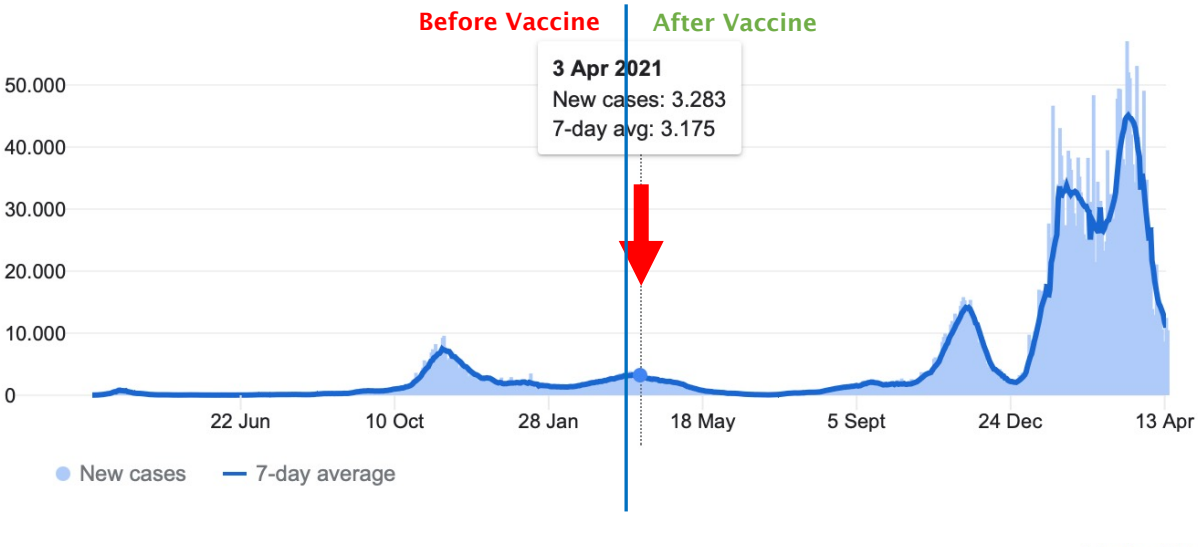
Source: Wiener Zeitung

37

The evolution of SARS-Cov-2

	Ancestral SARS-CoV-2 1st and 2nd wave Spring and Fall 2020	British/Alpha variant 3rd wave Spring 2021
R_0	1.5-3.5[1]	50% übertragbarer: 2.25-5.25[2]
HIT	33% - 71%	56% - 81%
Incubation period	mean 6 days (5.6 – 6.5 days)[6]	N/A
Dispersion parameter K	0.1 (10% account for 80% of infections)[11]	N/A
Case fatality	Variation by age- and risk-group	Hospitalization up, 60% higher death rates[3,4,5]
Vaccination rate	0%	<20%

38



39

Ende der 3. Welle (Alpha/Britische Variante) Ende März/Anfang April 2021

COVID-PROGNOSEN

Warum die dritte Welle haltmachte, lässt auch Experten rätseln

Für das im Sozialministerium installierte Covid-Prognose-Konsortium war zunächst kein Ende des Anstiegs absehbar

Michael Matzenberger 20. April 2021, 09:24 2.070 Postings

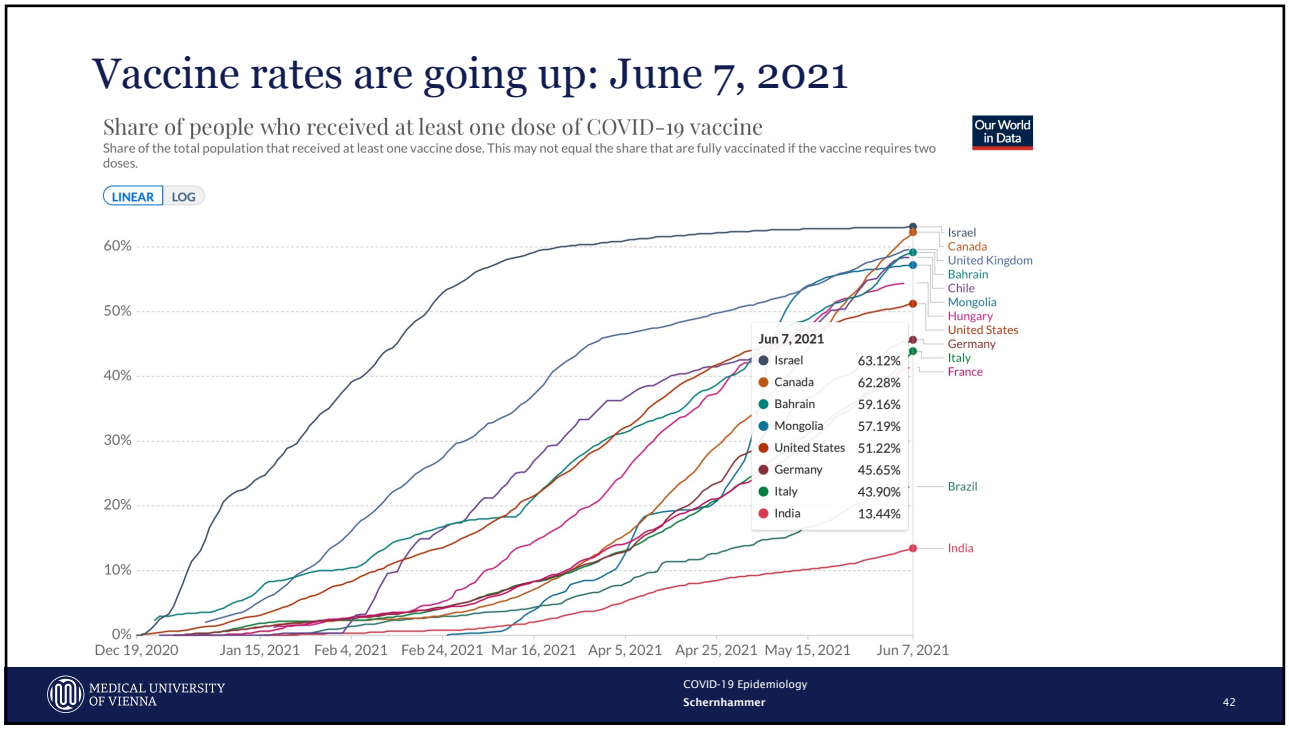
Saisonalität unterschätzt?
Regionale Massnahmen besser wirksam als gedacht?
Europaweiter Trend

Quelle: der Standard
20. April 2021

40


CORONA-KRISE
VIRUS-RADAR
So sieht es in Ihrem Kreis aus
Sommer, Sonne, Freiheit zurück
Deutschland impft sich glücklich
MEDICAL UNIVERSITY OF VIENNA
Quelle: Bild
COVID-19 Epidemiology
Schernhammer
41

41


Vaccine rates are going up: June 7, 2021
Share of people who received at least one dose of COVID-19 vaccine
Share of the total population that received at least one vaccine dose. This may not equal the share that are fully vaccinated if the vaccine requires two doses.
Our World in Data
LINEAR
LOG
60%
50%
40%
30%
20%
10%
0%
Dec 19, 2020
Jan 15, 2021
Feb 4, 2021
Feb 24, 2021
Mar 16, 2021
Apr 5, 2021
Apr 25, 2021
May 15, 2021
Jun 7, 2021
Jun 7, 2021
Israel 63.12%
Canada 62.28%
Bahrain 59.16%
Mongolia 57.19%
United States 51.22%
Germany 45.65%
Italy 43.90%
India 13.44%
Israel
Canada
United Kingdom
Bahrain
Chile
Mongolia
Hungary
United States
Germany
Italy
France
Brazil
India
MEDICAL UNIVERSITY OF VIENNA
COVID-19 Epidemiology
Schernhammer
42

42

Ende der Pandemie?

- Pause…

43

Mitte Juli 2021 beginnt das Blatt sich langsam wieder zu wenden

- COVID-19 Inzidenz steigt langsam wieder

Source: FAZ

Mehr Neuinfektionen – die Corona-Lage spitzt sich wieder zu

VON FRAUKE STEFFENS, NEW YORK - AKTUALISIERT AM 17.07.2021 - 13:56

In Amerika steigt die Inzidenz wieder. Vor allem in Gegenden mit geringen Impfraten. In New York genießen die Menschen derweil die Zeit ohne Einschränkungen, während Los Angeles wieder eine Maskenpflicht verhängt.

44

45

The evolution of SARS-Cov-2

	Ancestral SARS-CoV-2 1st and 2nd wave Spring and Fall 2020	British/Alpha variant 3rd wave Spring 2021	Delta (Indian) variant, wave of "unvax" Fall 2021
R_0	1.5-3.5[1]	50% übertragbarer: 2.25-5.25[2]	3.2-8 (mean 5.08)[7] 6
HIT	33% - 71%	56% - 81%	69% - 88%
Incubation period	mean 6 days (5.6 – 6.5 days)[6]	N/A	mean 4 days[8]
Dispersion parameter K	0.1 (10% account for 80% of infections)[11]	N/A	25-27% account for 80% of infections[12]
Case fatality	Variation by age- and risk-group	Hospitalization up, 60% higher death rates[3,4,5]	Similar to previous
Vaccination rate	0%	<20%	60%

46

Fall 2021: Delta variant is once more driving up COVID-19 incidence - though this time in a different pattern

- More young people affected
- Urban versus rural areas
- Within Vienna, in early September, four districts with the highest incidence rates: double to 3-fold higher than Austrian average (100/100.000): 10., 11., 12., 15. district
- Correlates with districts in Vienna with previously low testing participation

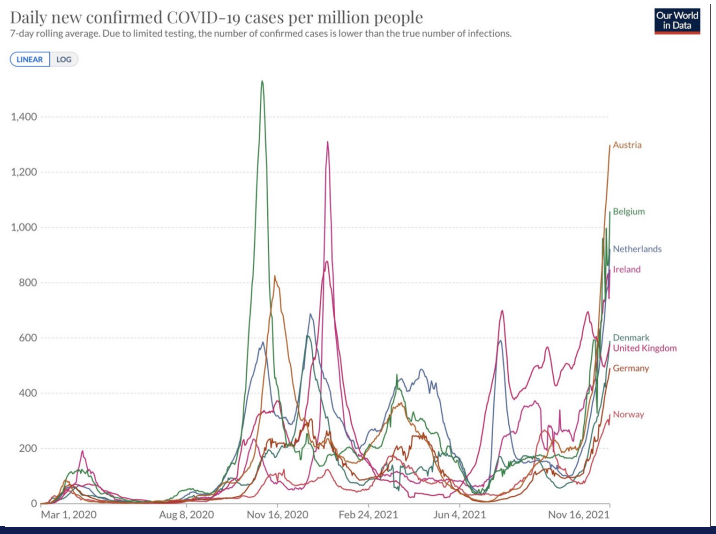
Source: Heute

47

Klare Korrelation zwischen Impffortschritt und Neuinfektionen

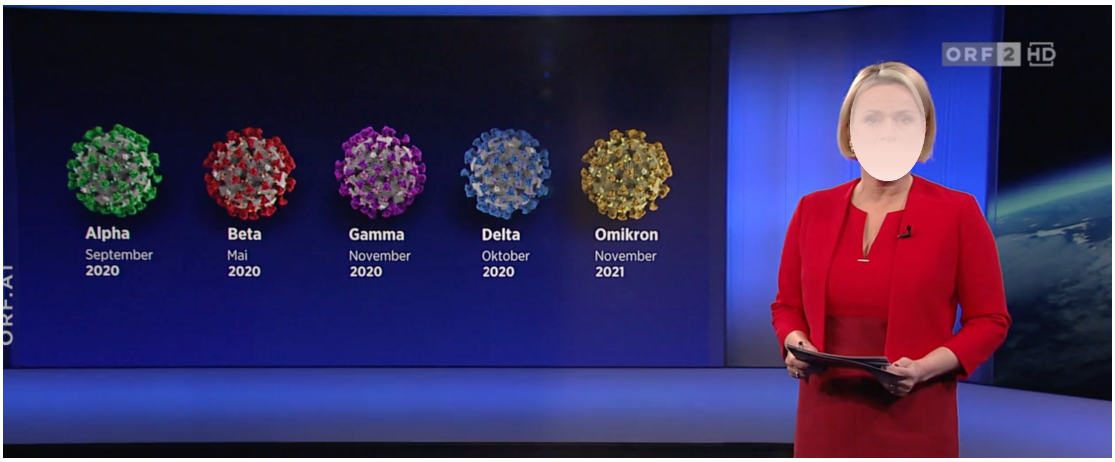
48

Austria becomes world leader



49

Neue Varianten



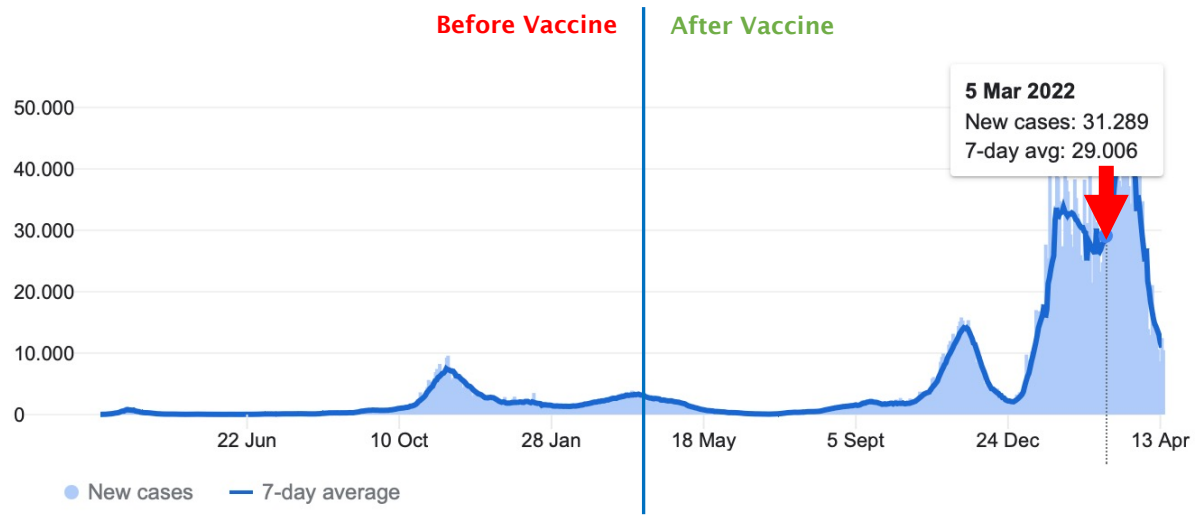
Quelle: ORF

50

The evolution of SARS-Cov-2

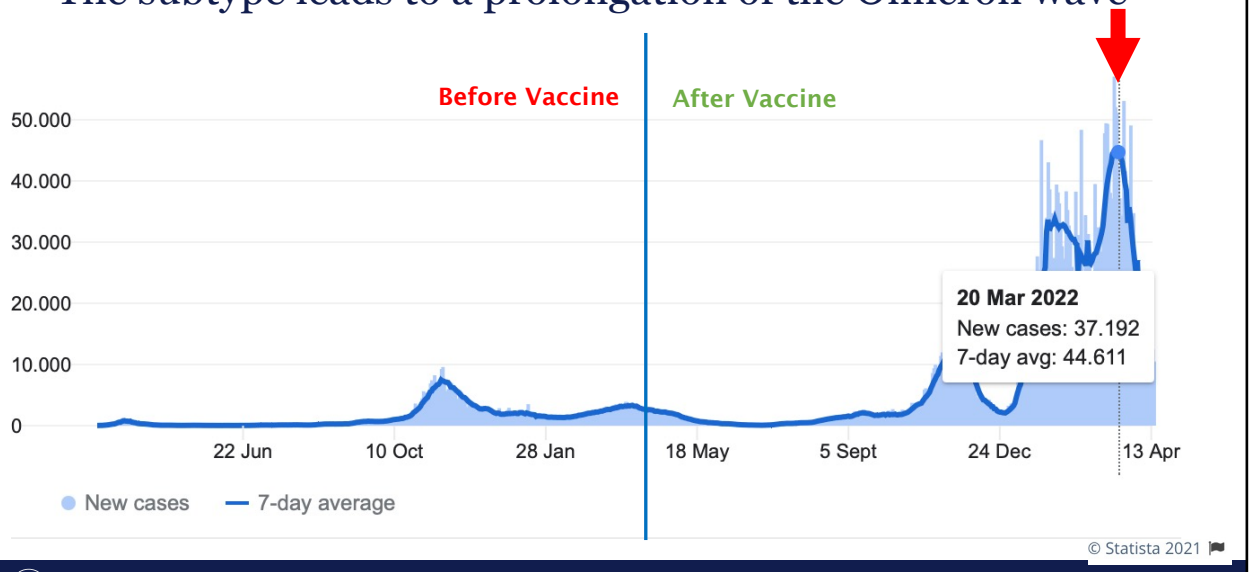
	Ancestral SARS-CoV-2 1st and 2nd wave Spring and Fall 2020	British/Alpha variant 3rd wave Spring 2021	Delta (Indian) variant, wave of "unvax" Fall 2021	Omicron variant Jan – April 2022 wave
R_0	1.5-3.5[1]	50% übertragbarer: 2.25-5.25[2]	3.2-8 (mean 5.08)[7] 6	+30-40%
HIT	33% - 71%	56% - 81%	69% - 88%	N/A with curr. vaccines
Incubation period	mean 6 days (5.6 – 6.5 days)[6]	N/A	mean 4 days[8]	1-2 days
Dispersion parameter K	0.1 (10% account for 80% of infections)[11]	N/A	25-27% account for 80% of infections[12]	N/A
Case fatality	Variation by age- and risk-group	Hospitalization up, 60% higher death rates[3,4,5]	Similar to previous	By ten-fold reduced severe cases
Vaccination rate	0%	<20%	60%	72% (50+% booster)

51



52

A final wrinkle in the COVID-19 story: Omicron BA.2
The subtype leads to a prolongation of the Omicron wave



53

So what's next? How will the fall of 2022 look like?

- How will immunity (after vaccine and/or disease) hold up?
- Which new variants may play a role in the fall of 2022?
- New therapies, and their acceptance by the public?
- Variant-adapted vaccines?
- Timing of vaccine so it protects during the time when it is most needed (Sept/Oct vaccine?)

- Some basic measures will return for a safe start into the fall: social distancing, hygiene, mask wearing

54

Remember: mask wearing helps

Source: Twitter, CDC

Longer-term Outlook – strengthen ONE Health approach

- Human-induced deterioration in habitat quality made further virus outbreaks more likely
- Enabled by high interconnectedness of social and economic systems

- System resilience crucial, i.e. adaptability of coupled human-nature systems to disturbances
- Adaptive capacities have to be strengthened by specific interventions and strategies in a proactive or reactive manner before, during, and after such threats as the SARS-CoV-2 virus
- A sufficient and rapid understanding of the behavior of complex systems is an important determinant for such sustainable system interventions; both in terms of pandemic threat preparedness and the ability to respond rapidly by organizations, countries and the international community as a whole in the event of a pandemic

Thank you!

eva.schernhammer@meduniwien.ac.at