Le epidemie da patogeni a trasmissione respiratoria

la programmazione regionale in preparazione alle emergenze di sanità pubblica

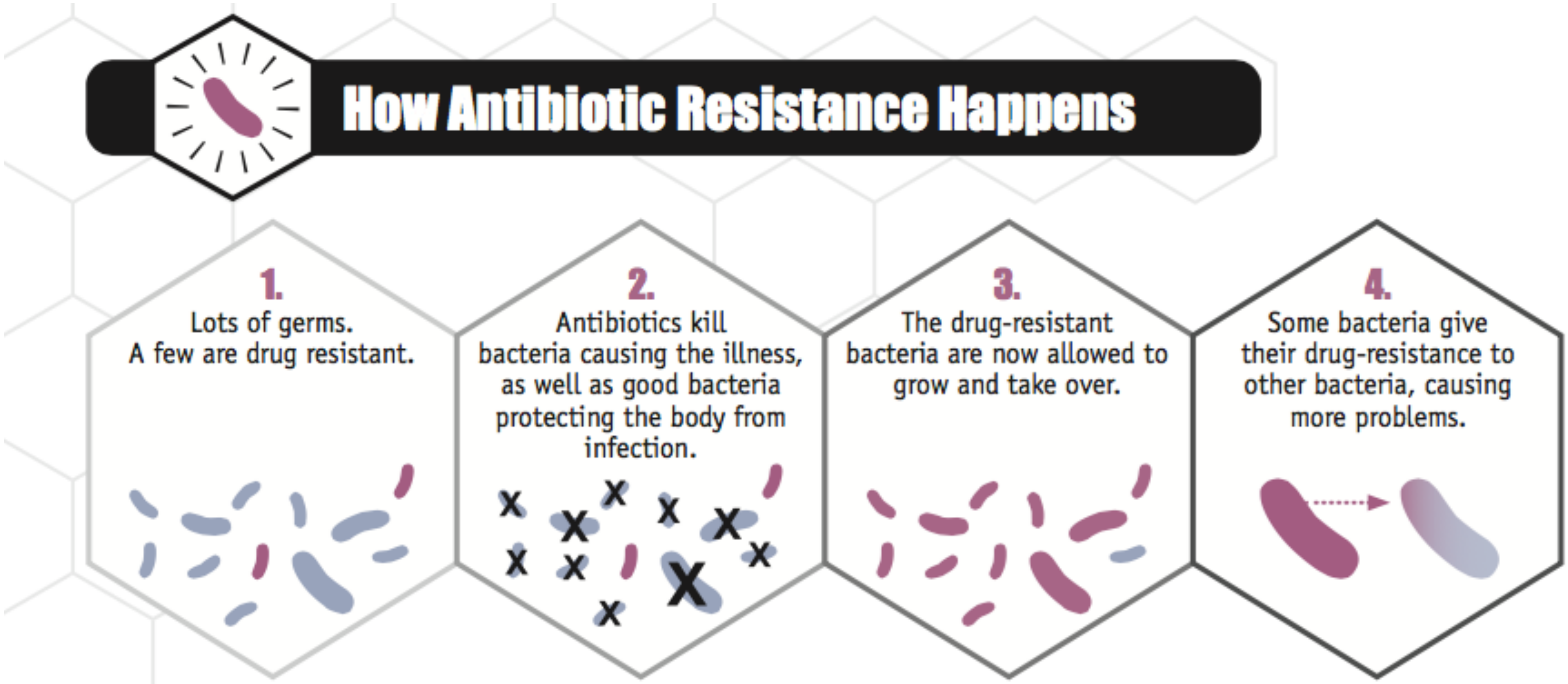
30 settembre 2024

Il cambiamento climatico e i patogeni a trasmissione respiratoria

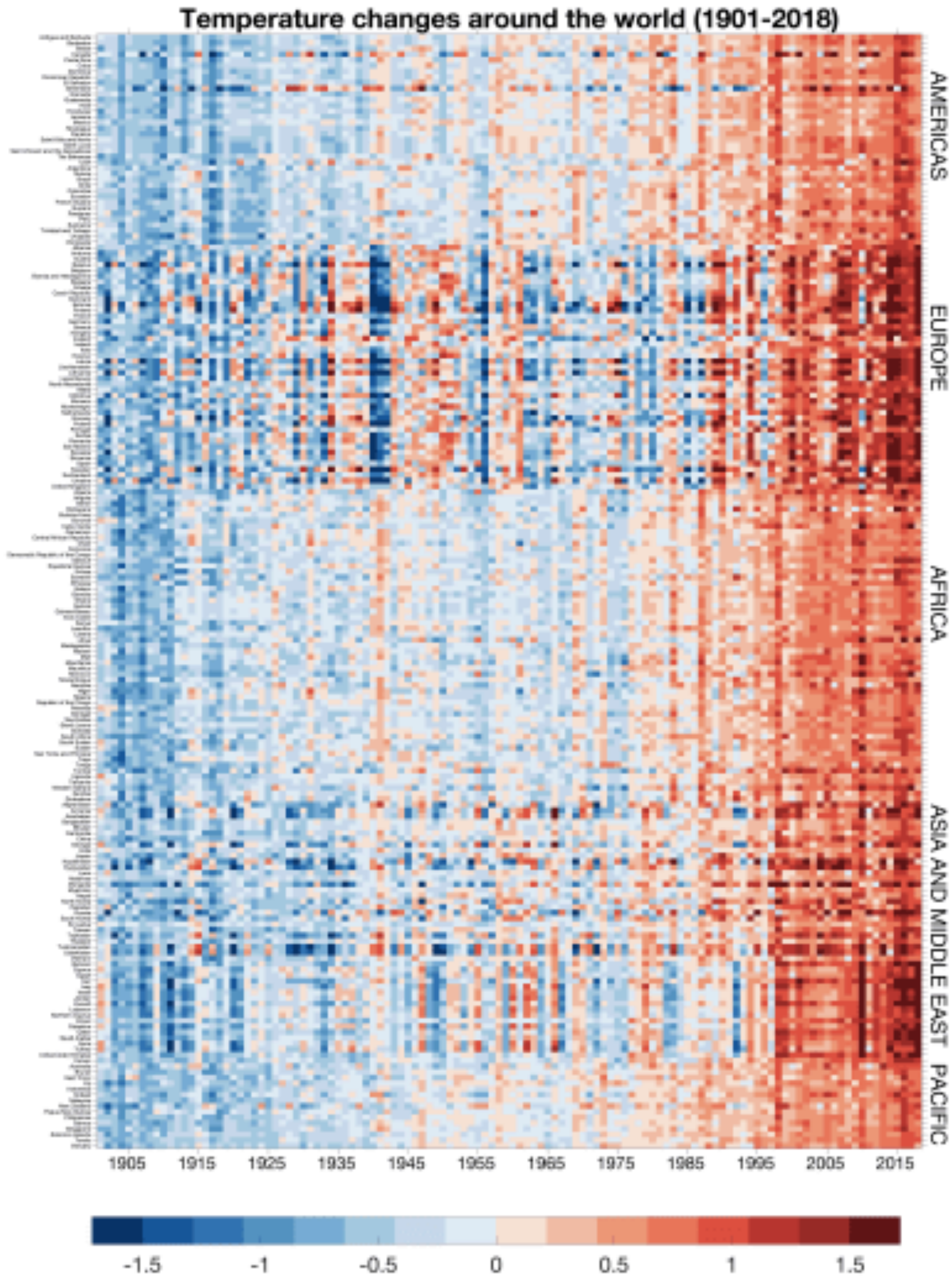
Dr Carlo Biagetti
UO Malattie Infettive Rimini
Programma SPIAR
AUSL Romagna

CLIMATE CHANGE

1. WHY YOU ?
2. PreCOVID era
3. Post COVID era


How Antibiotic Resistance Happens
1.
Lots of germs.
A few are drug resistant.
2.
Antibiotics kill bacteria causing the illness, as well as good bacteria protecting the body from infection.
3.
The drug-resistant bacteria are now allowed to grow and take over.
4.
Some bacteria give their drug-resistance to other bacteria, causing more problems.


TIEDEMANN


Temperature changes around the world (1901-2018)
AMERICAS
EUROPE
AFRICA
ASIA AND MIDDLE EAST
PACIFIC
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
-1.5
-1
-0.5
0
0.5
1
1.5

Climate change and antibiotic resistance: a deadly combination

Jason P. Burnham

Heat and antibiotic resistance

Temperature is intimately linked with bacterial processes and infections.[6] Horizontal gene transfer, a major mechanism for the acquisition of

Pollution and antibiotic resistance

More and more intense precipitation will lead to increased runoff and inevitably higher levels of pollution in our water. Pollutants are known to induce expression of antibiotic-resistance genes and bacterial mutagenesis.[31] Increased agricul-

Disasters and infections

As the climate warms, the capacity of the atmosphere to hold water increases exponentially, meaning storms will be more severe and come with more precipitation. More precipitation leads to flooding, flood-related infections, population displacement, refugees, and overcrowding.

World Health Organization

We must fight one of the world's biggest health threats: climate change

We know that worse is to come. Without bold and urgent action, climate change will displace around 216 million people by 2050, the World Bank estimates. Climate change is endangering lives and livelihoods as global food systems struggle to feed a growing world and water sources are compromised. And climate change is triggering a surge in infectious diseases like dengue and cholera which endanger millions.

..exacerbate healt inequity

Le epidemie da patogeni a trasmissione respiratoria

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What are VRIs ?

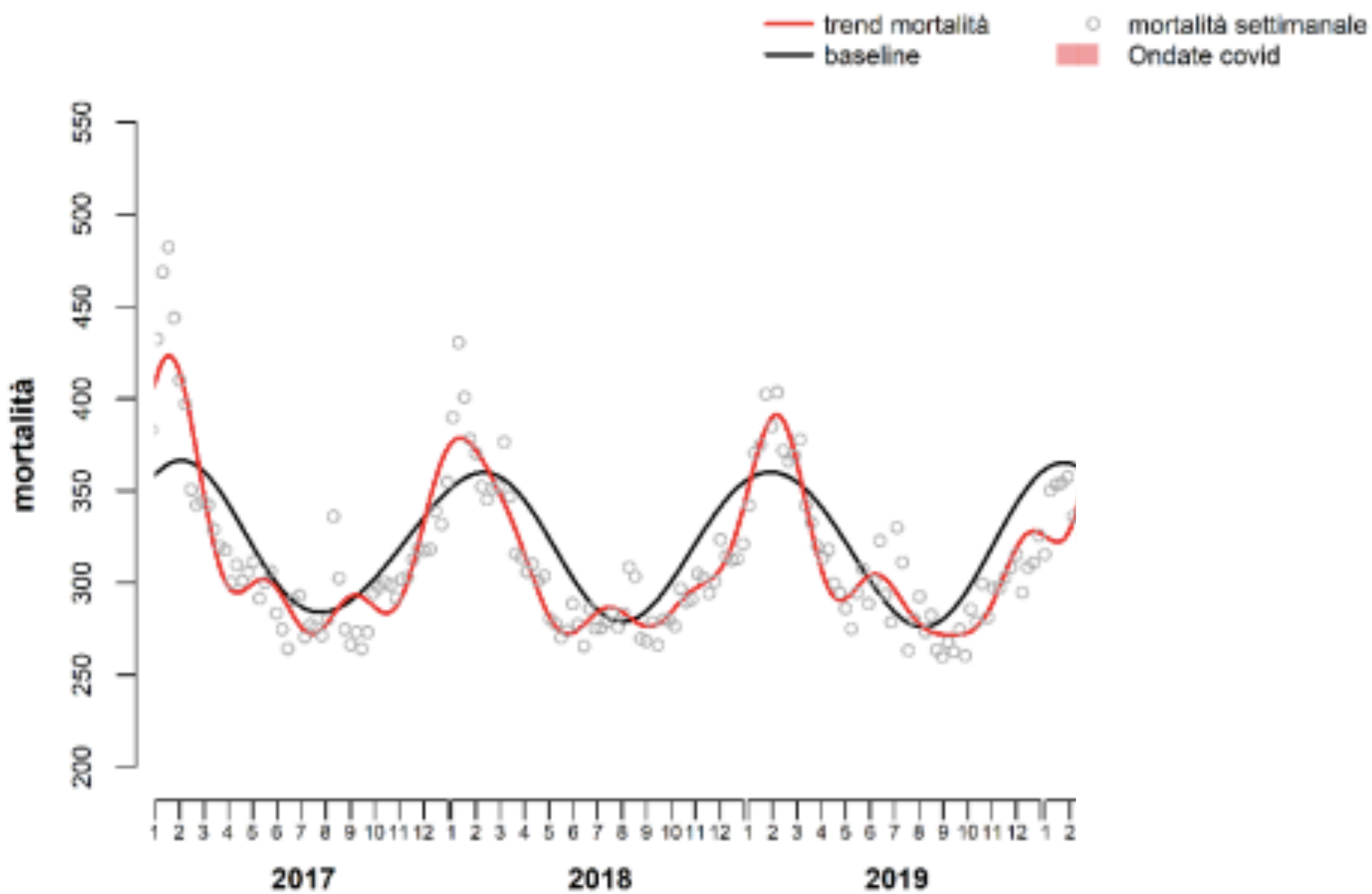
(Viral Respiratory Infections)

Respiratory virus	Family	Structure and genome	Subtypes	Primary routes of transmission	Seasonal patterns
Influenza virus[15]	*Orthomyxoviridae*	Enveloped ss – RNA viruses	A, B, C	Droplets and aerosols, contact	Winter peaks in temperate regions
Respiratory syncytial virus (RSV)[10]	*Paramyxoviridae*	Enveloped ss – RNA viruses	A, B	Direct and indirect contact, droplets, and aerosols	Winter and early spring peaks in temperate regions
Human Metapneumovirus (HMPV)[14]	*Paramyxoviridae*	Enveloped ss – RNA viruses	A, B	Droplets and contact	Late winter and spring peaks in temperate regions
Parainfluenza viruses (PIV)[14]	*Paramyxoviridae*	Enveloped ss – RNA viruses	1, 2, 3, 4	Droplets and contact	PIV-1 and PIV-2 peak in the fall and winter in temperate regions, PIV-3 peaks in warm seasons, PIV-4 sporadically all-year
Human coronavirus (HCoV)[13,16]	*Coronaviridae*	Enveloped ss + RNA viruses	OC43, 229E, NL63, HKU1[a]	Droplet spray and/or aerosol, contact	Winter peaks in most temperate regions
Rhinoviruses (RV)[17]	*Picornaviridae*	Enveloped ss + RNA viruses	Species A, B, and C, with >100 serotypes	Contact, droplet spray, and/or aerosol	All-year, with peaks in the autumn and spring in temperate regions
Human bocavirus (HBoV)[15]	*Parvoviridae*	Non-enveloped ss + DNA viruses	1, 2, 3	Contact, droplet spray, and/or aerosol	All-year, with a possible peak during the summer
Adenoviruses (ADV)[13,18]	*Adenoviridae*	Non-enveloped dsDNA viruses	53	Contact, possibly droplet spray and/or aerosol	All-year
Enterovirus (EV)[14]	*Picornaviridae*	Non-enveloped ss + RNA viruses	D68	Contact	Summer and autumn

[a]Other human coronaviruses include MERS-CoV, SARS-CoV and SARS-CoV-2.

***Table* 1: Characteristics of etiology and seasonality of viral respiratory infections (VRIs).**

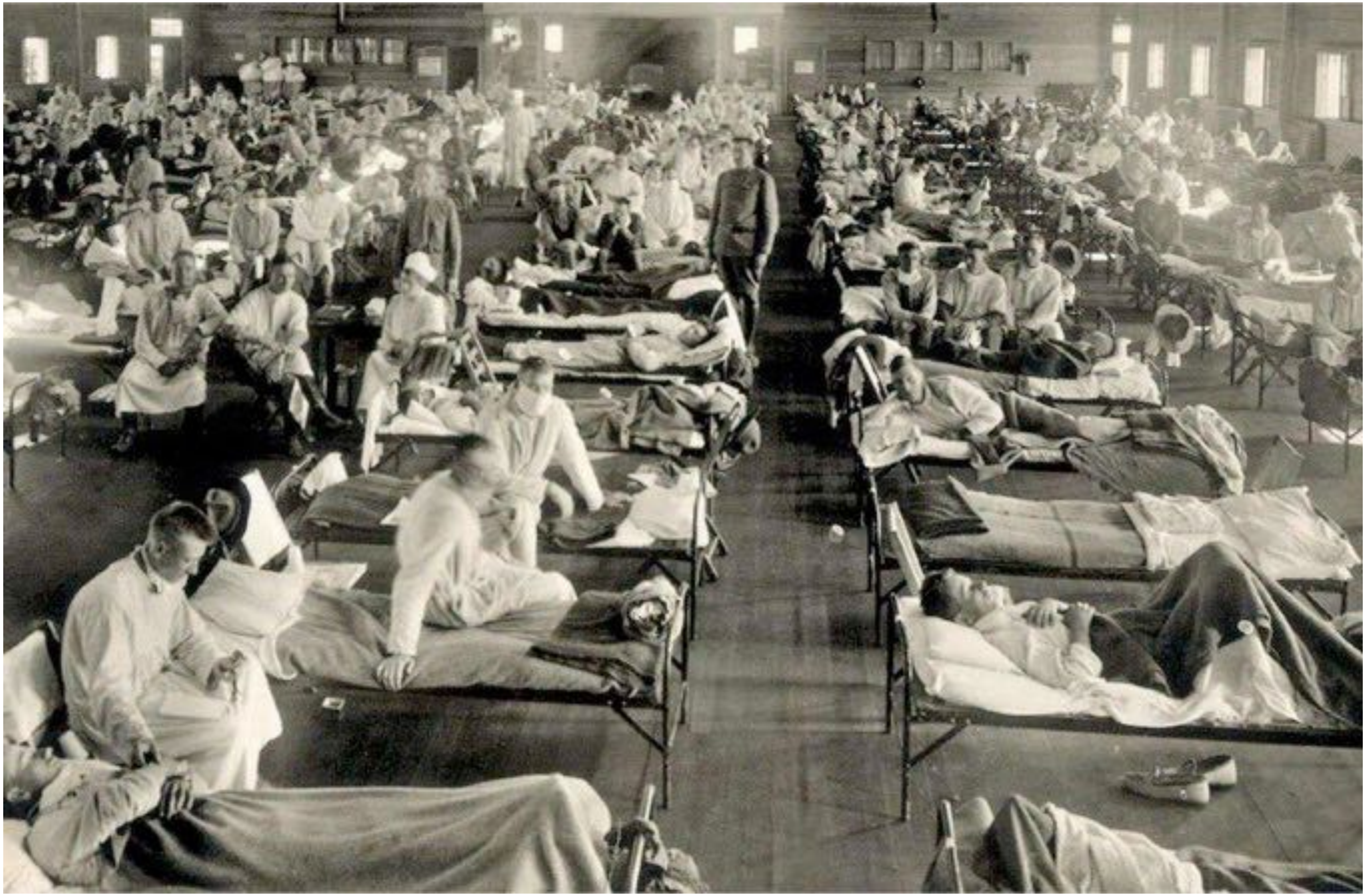
Figura 3. Andamento stagionale della mortalità totale per settimana nelle città italiane. Periodo gennaio 2017 – 24 maggio 2022.

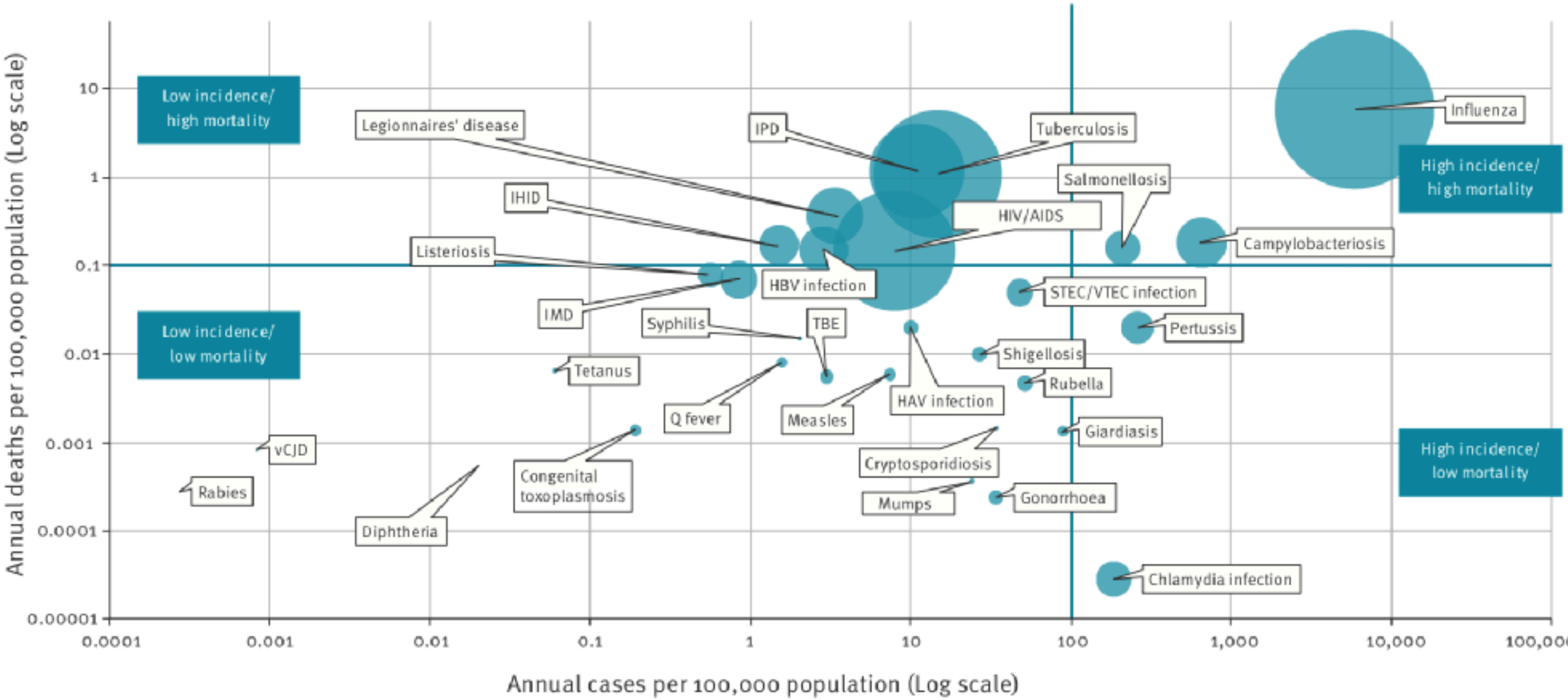


<u>Dati di 39 Comuni</u>: Aosta, Trento, Bolzano, Torino, Milano, Brescia, Verona, Venezia, Padova, Genova; Reggio Emilia, Modena, Bologna, Forlì, Rimini, Firenze, Prato, Livorno, Ancona, Perugia, Viterbo, Civitavecchia, Roma, Rieti, Frosinone, Latina, Napoli, Campobasso, Potenza, Foggia, Bari, Taranto, Catanzaro, Reggio Calabria, Palermo, Messina, Catania, Siracusa, Cagliari

**in questo report è stata esclusa Messina a causa di un mancato invio dei dati*

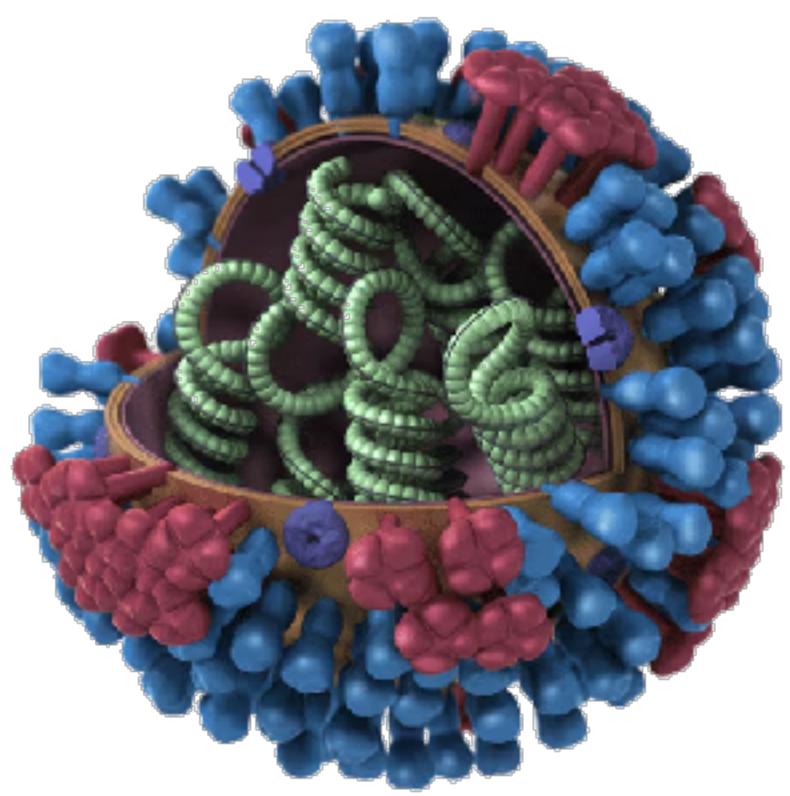
Ogni anno si succedono 6-8 settimane in cui incrementano gli accessi in PS, i ricoveri, il consumo di antibiotici inappropriato, la mortalità e la trasmissione intraospedaliera di influenza



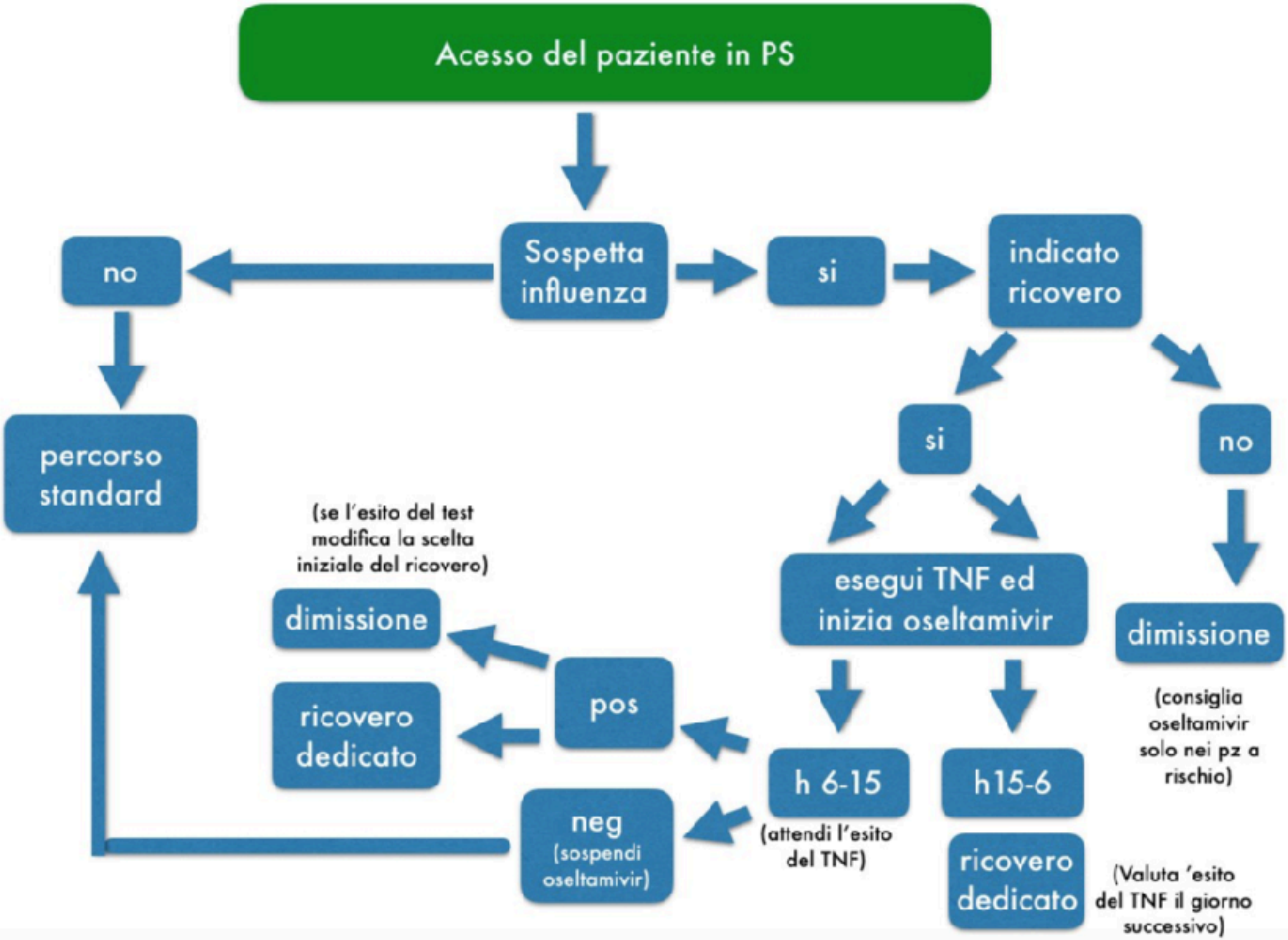


Il diametro della bolla riflette il numero di DALY per 100.000 abitanti all'anno.

SERVIZIO SANITARIO REGIONALE EMILIA-ROMAGNA Azienda Unità Sanitaria Locale della Romagna SPIAR **Programma per la gestione del rischio infettivo ed uso responsabile degli antibiotici AUSL Romagna**	**ISTRUZIONE OPERATIVA PER L'INDIVIDUAZIONE PRECOCE E GESTIONE DEL PAZIENTE CON SOSPETTA INFLUENZA DURANTE L'EPIDEMIA STAGIONALE**	Rev. 00 del 31.10.19 **DOC 3** Pagina 1 di 6

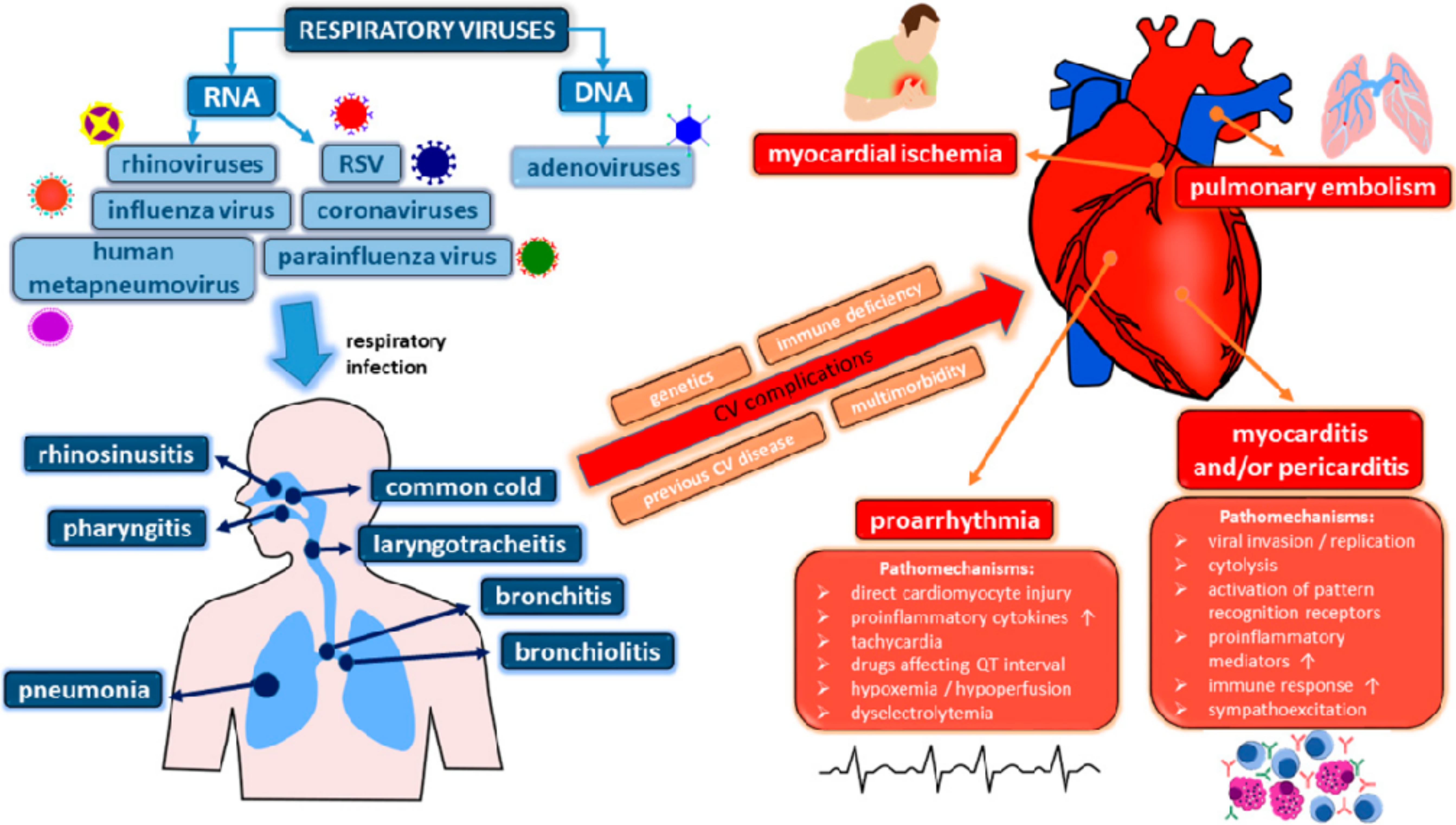


Algoritmo riassuntivo



Tamponi influenza-VRS, AUSL Romagna

	Positivi	Negativi	Totali
2014-15	14 (23,3%)	46	60
2015-16	6 (6,3%)	97	103
2016-17	**161 (25%)**	**475**	**636**
2017-18	**398 (25,4%)**	**1132**	**1530**
2018-19	**1009 (25,1%)**	**3031**	**4040**



RESPIRATORY VIRUSES
RNA
DNA
rhinoviruses
RSV
adenoviruses
influenza virus
coronaviruses
human metapneumovirus
parainfluenza virus
respiratory infection
rhinosinusitis
common cold
pharyngitis
laryngotracheitis
bronchitis
bronchiolitis
pneumonia
genetics
immune deficiency
CV complications
multimorbidity
previous CV disease
myocardial ischemia
pulmonary embolism
myocarditis and/or pericarditis
proarrhythmia
Pathomechanisms:
direct cardiomyocyte injury
proinflammatory cytokines ↑
tachycardia
drugs affecting QT interval
hypoxemia / hypoperfusion
dyselectrolytemia
Pathomechanisms:
viral invasion / replication
cytolysis
activation of pattern recognition receptors
proinflammatory mediators ↑
immune response ↑
sympathoexcitation

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Acute Myocardial Infarction after Laboratory-Confirmed Influenza Infection

Table 2. Incidence Ratios for Acute Myocardial Infarction after Laboratory-Confirmed Influenza Infection.*

Variable	Incidence Ratio (95% CI)
Primary analysis: risk interval, days 1–7	6.05 (3.86–9.50)
Days 1–3	6.30 (3.25–12.22)
Days 4–7	5.78 (3.17–10.53)
Days 8–14	0.60 (0.15–2.41)
Days 15–28	0.75 (0.31–1.81)

Journal of the American Heart Association

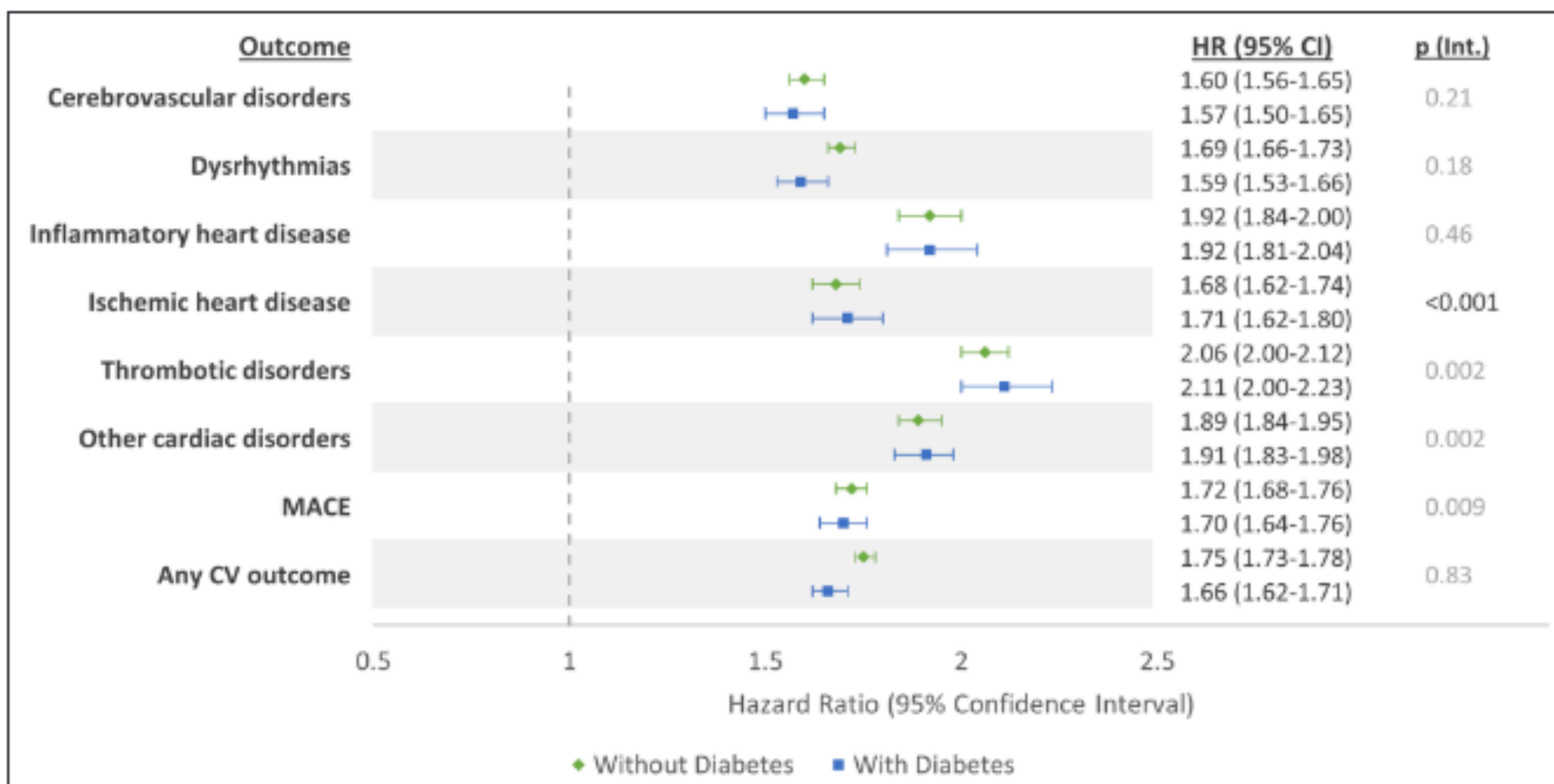
Volume 12, Issue 13, 4 July 2023

https://doi.org/10.1161/JAHA.123.029696

American Heart Association.

ORIGINAL RESEARCH

Risk of Cardiovascular Disease After COVID-19 Diagnosis Among Adults With and Without Diabetes



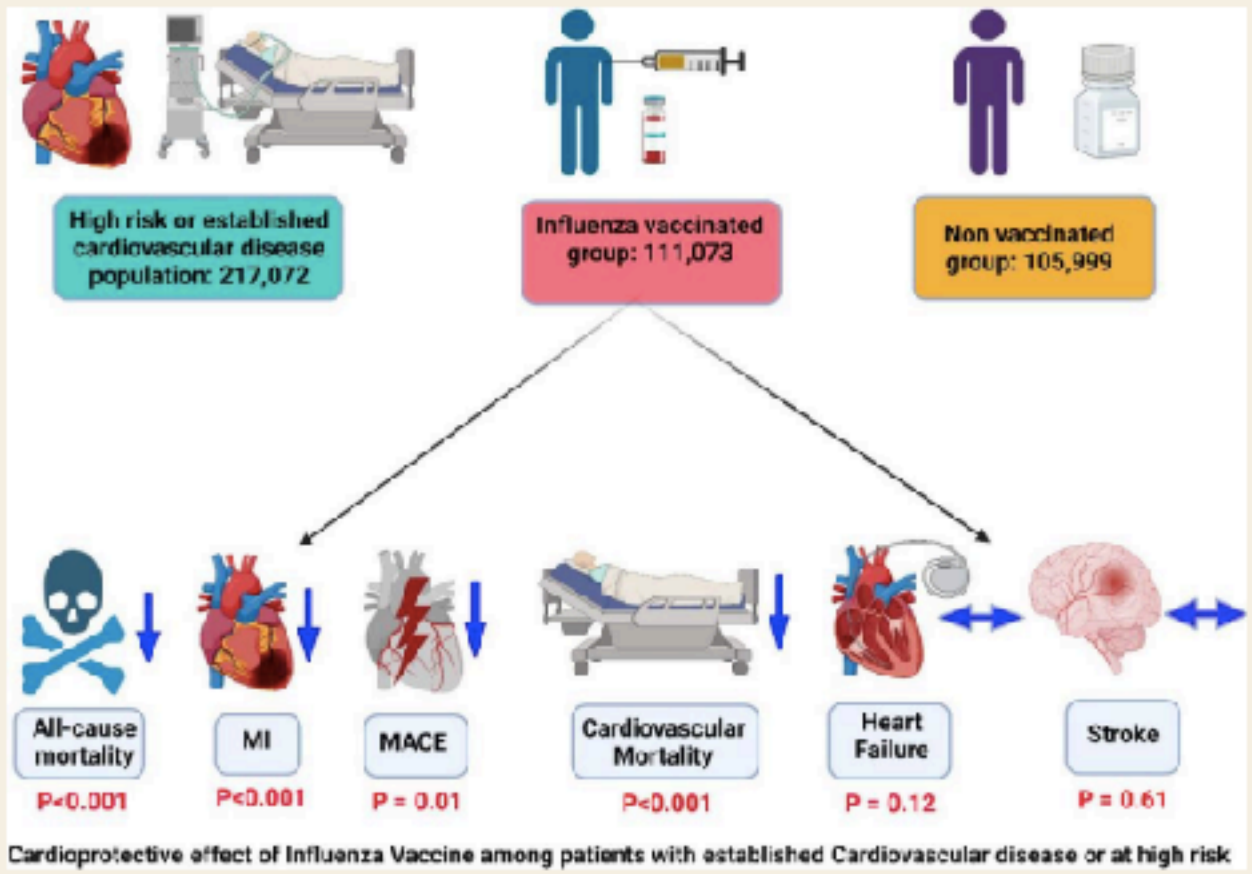
ESC European Society of Cardiology
European Journal of Preventive Cardiology (2022) 29, 1881–1892
https://doi.org/10.1093/eurjpc/zwac152

FULL RESEARCH PAPER
Primary care

Cardioprotective effects of influenza vaccination among patients with established cardiovascular disease or at high cardiovascular risk: a systematic review and meta-analysis

Vikash Jaiswal [1], Song Peng Ang[2], Sadia Yaqoob[3], Angela Ishak[1,4], Jia Ee Chia[5], Yusra Minahil Nasir[6], Zauraiz Anjum[7], M. Chadi Alraies [8], Akash Jaiswal[9], and Monodeep Biswas[10]*

Graphical Abstract



scientific reports

Check for updates

OPEN

Influenza vaccination and major cardiovascular risk: a systematic review and meta-analysis of clinical trials studies

Fatemeh Omidi[1], Moein Zangiabadian[2,3], Amir Hashem Shahidi Bonjar[4], Mohammad Javad Nasiri[2]✉ & Tala Sarmastzadeh[2]✉

Studies involving more than 9,000 patients reported a 26% decreased risk of heart attacks in people who received a flu vaccine and a 33% reduction in cardiovascular deaths.

SPIAR

PNRR Action Plan
M6C2 2.2b ICA C

Evento formativo

“Seasonal Influenza Preparedness"

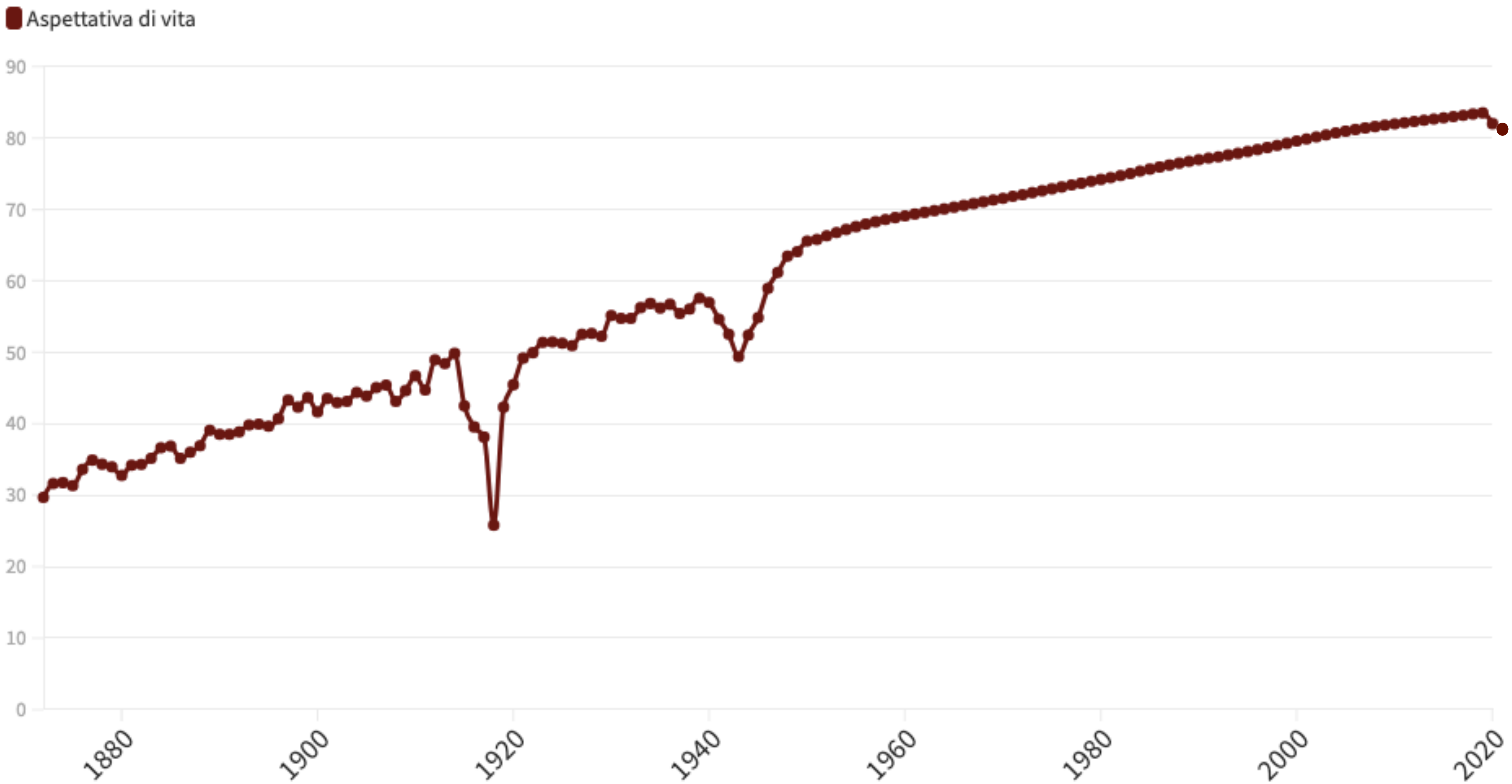
Venerdì 24/10/2024
dalle 15:00 alle 17:00

Centro Servizi di Pievesestina
EDIFICIO B Sala A
Codice corso WHR 45433

PROGRAMMA:

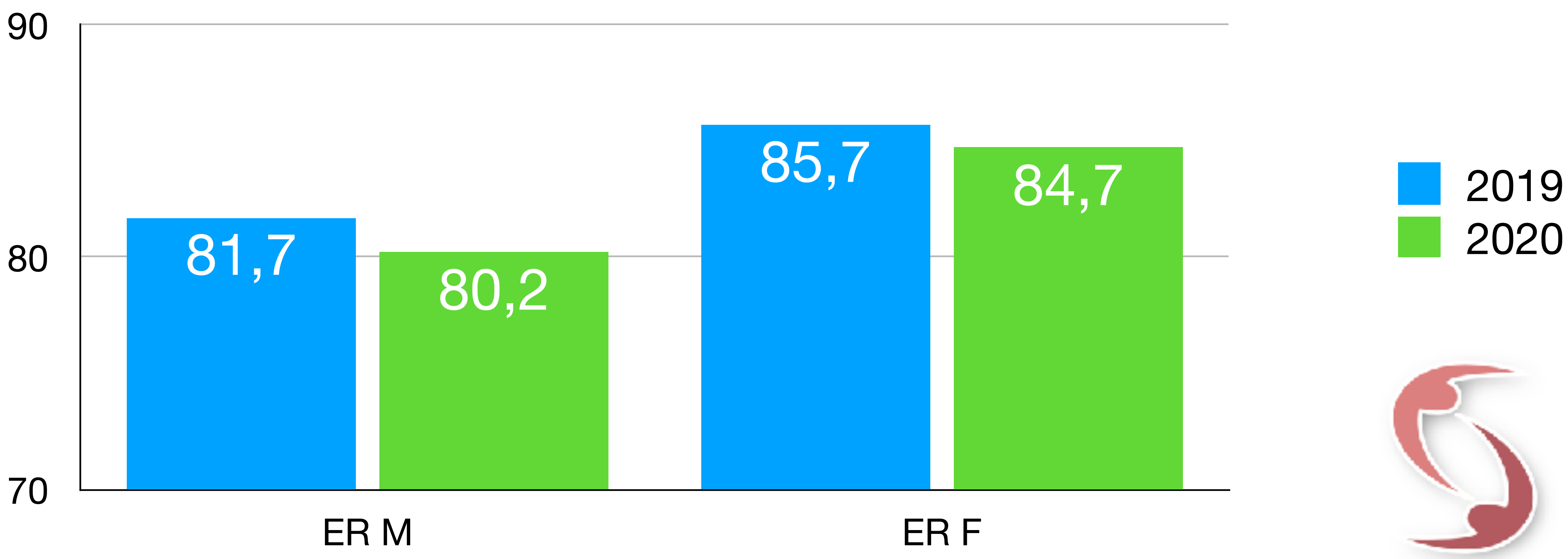
ore 15: introduzione (Carlo Biagetti)
ore 15,15: Virus respiratori e cambiamento climatico (Carlo Biagetti)
ore 15,30: prevenzione dell'influenza (Chiara Reali)
ore 15,45: epidemiologia e diagnosi microbiologica dell'influenza (Giorgio Dirani)
ore 16: valutazione del rischio infettivo e buone pratiche di infection control (Sabrina Alvisi)
ore 16,15: gestione clinica (Kety Luzi)
ore 16,30: influenza in terapia intensiva (Emanuele Russo)

L'aspettativa di vita in Italia dal 1872 al 2020

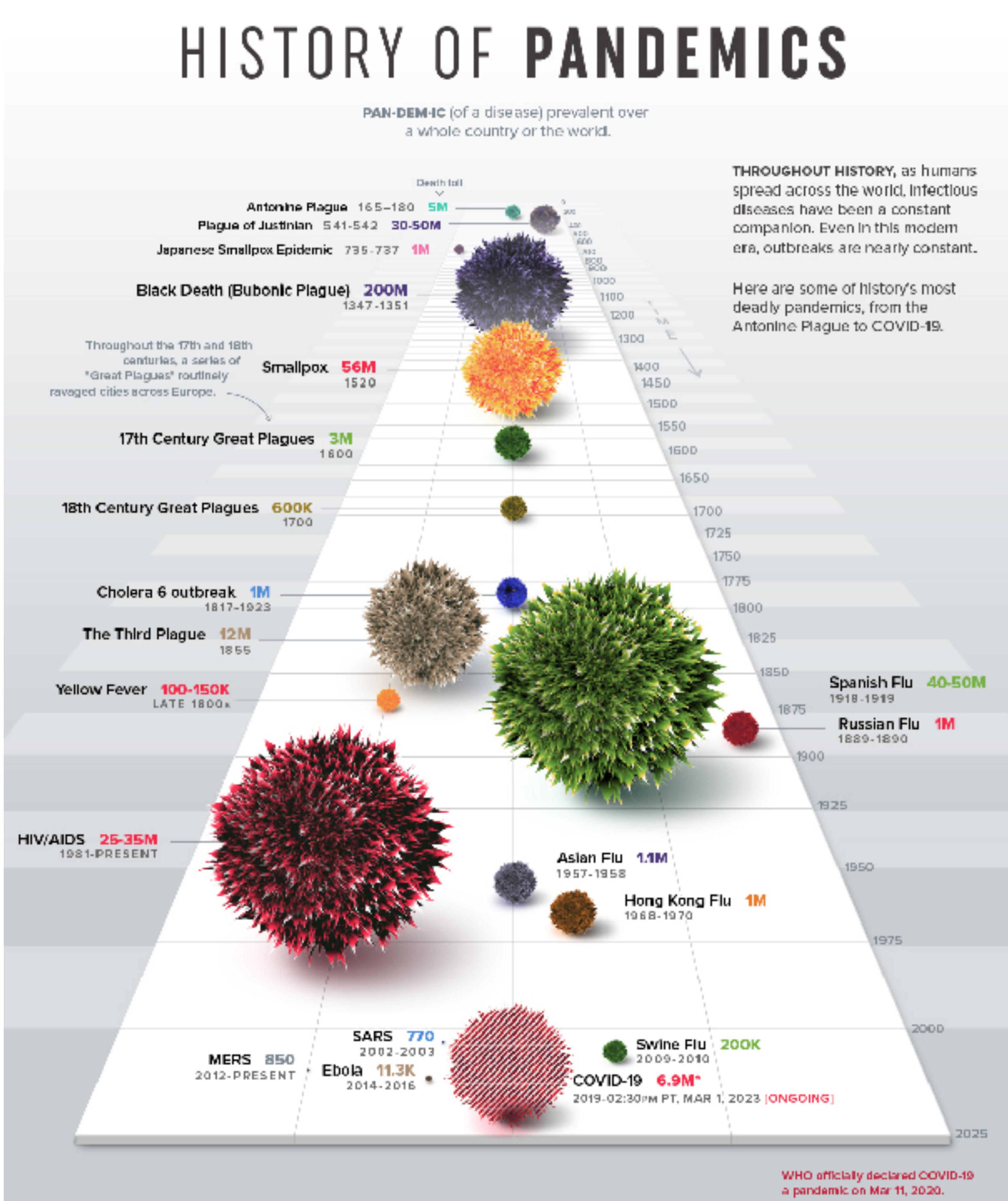


Organizzazione sanitaria e profilo demografico dell'Emilia Romagna

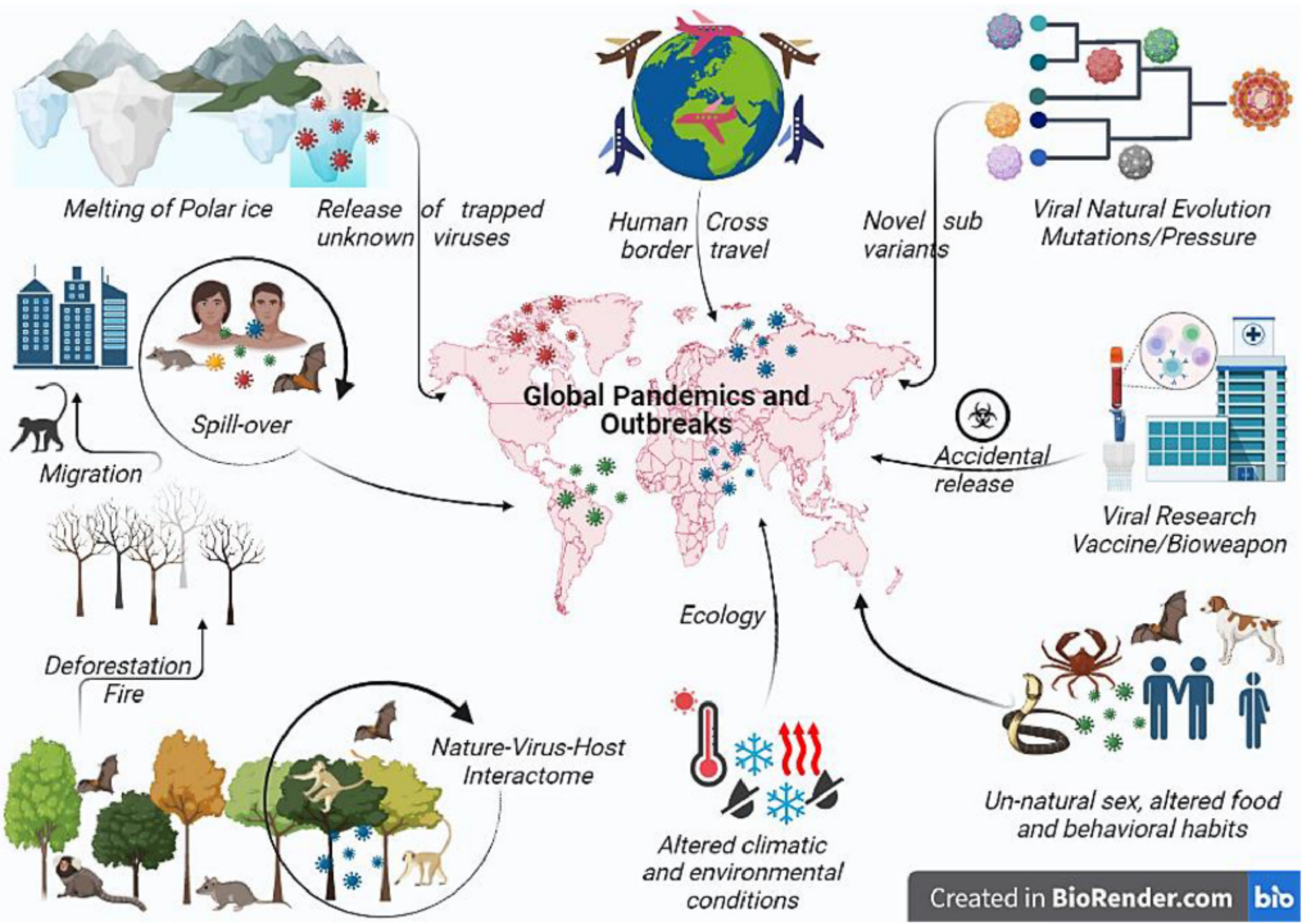
L'epidemia da COVID-19 ha determinato nel 2020 un forte calo della speranza di vita, comportando un azzeramento dei guadagni che si erano registrati nei precedenti 10 anni



SPIAR
Sicurezza nella cura



2003 SARS
2009 H1N1
2012 MERS
2019 COVID


Melting of Polar ice
Release of trapped unknown viruses
Human border Cross travel
Novel sub variants
Viral Natural Evolution Mutations/Pressure
Spill-over
Migration
Global Pandemics and Outbreaks
Accidental release
Viral Research Vaccine/Bioweapon
Ecology
Deforestation Fire
Nature-Virus-Host Interactome
Altered climatic and environmental conditions
Un-natural sex, altered food and behavioral habits
Created in BioRender.com

nature

NEWS | 20 September 2024

COVID pandemic started in Wuhan market animals after all, suggests latest study

The finding comes from a reanalysis of genomic data.

The most likely hosts include raccoon dogs and masked palm civet (*Paguma larvata*), which also might be susceptible to the virus. Other possible hosts include hoary bamboo rats (*Rhizomys pruinosus*), Amur hedgehog (*Erinaceus amurensis*) and the Malayan porcupine (*Hystrix brachyura),* but it is unclear whether these animals can catch SARS-CoV-2 and spread the infection. The team say the Reeves's muntjac (*Muntiacus reevesi*) and the Himalayan marmot (*Marmota himalayana*) could also be carriers, but are less likely than the other species.

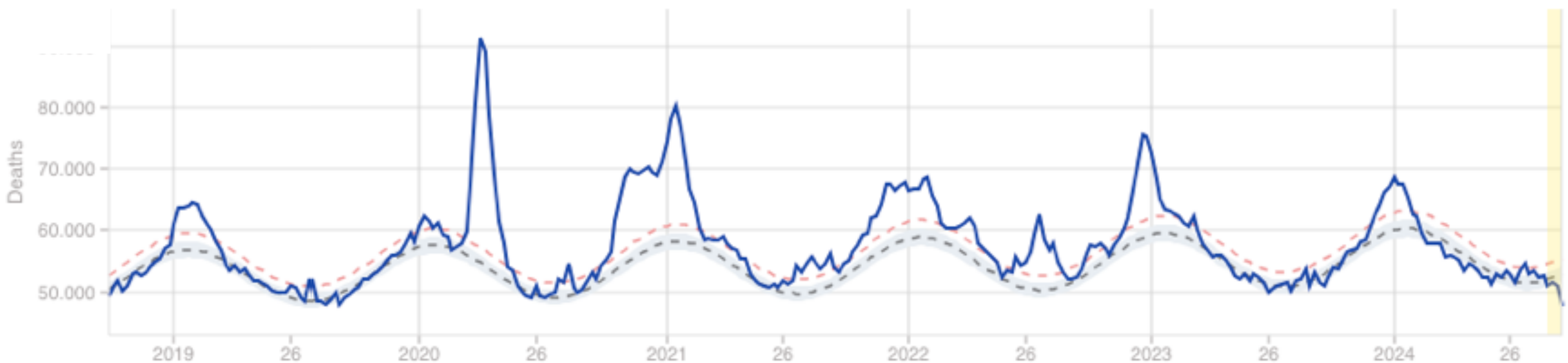
racoon dogs - cane procione

EUROMOMO

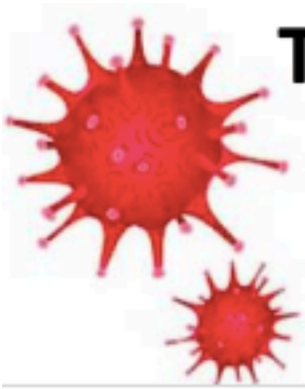
Graphs and maps

Last updated on week 38, 2024 Print

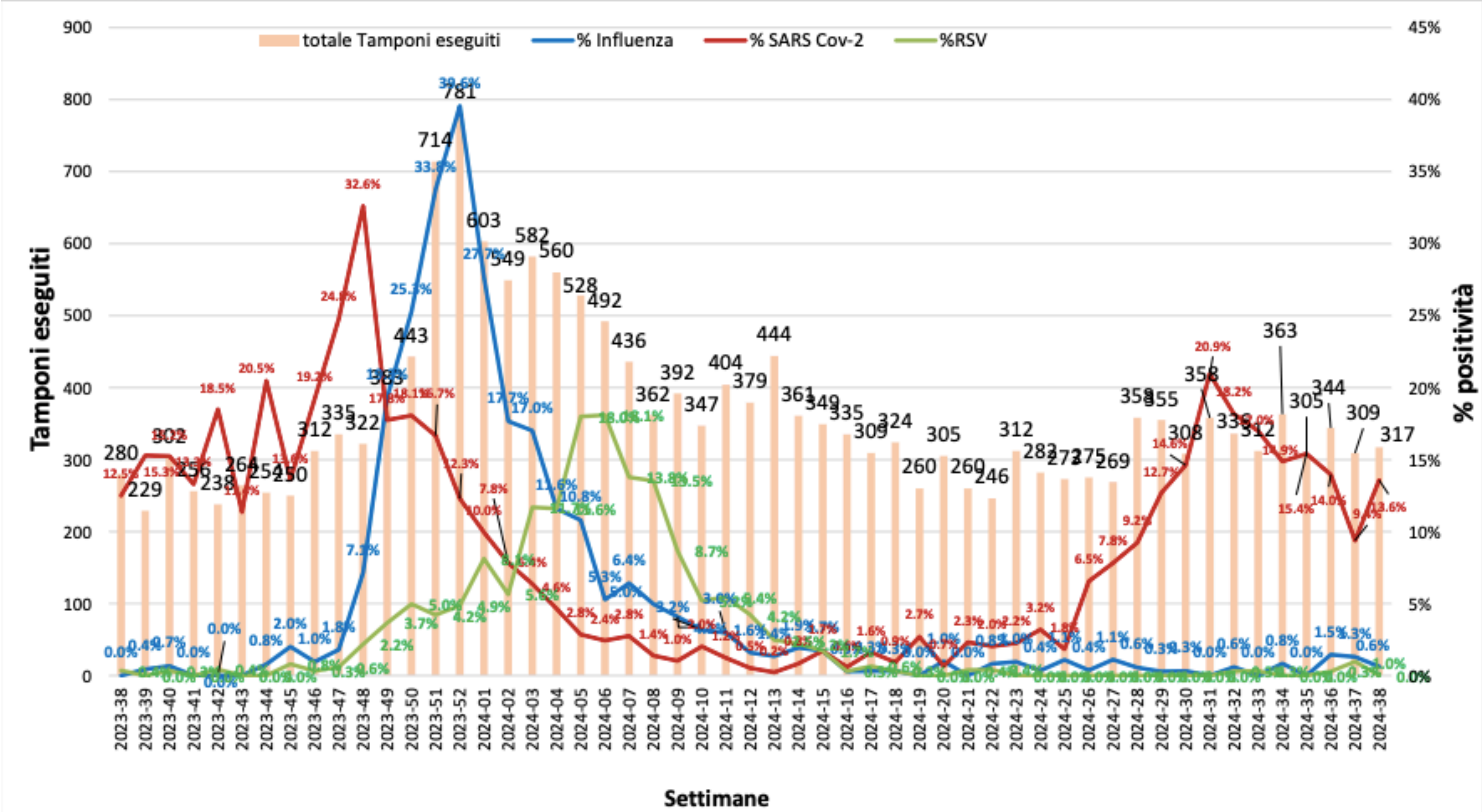
Europe



Italy



Tamponi eseguiti in urgenza nei Pronto Soccorso e reparti ospedalieri della Romagna a pazienti con sintomi/segni correlabili a possibile caso di Influenza/Covid-19/RSV



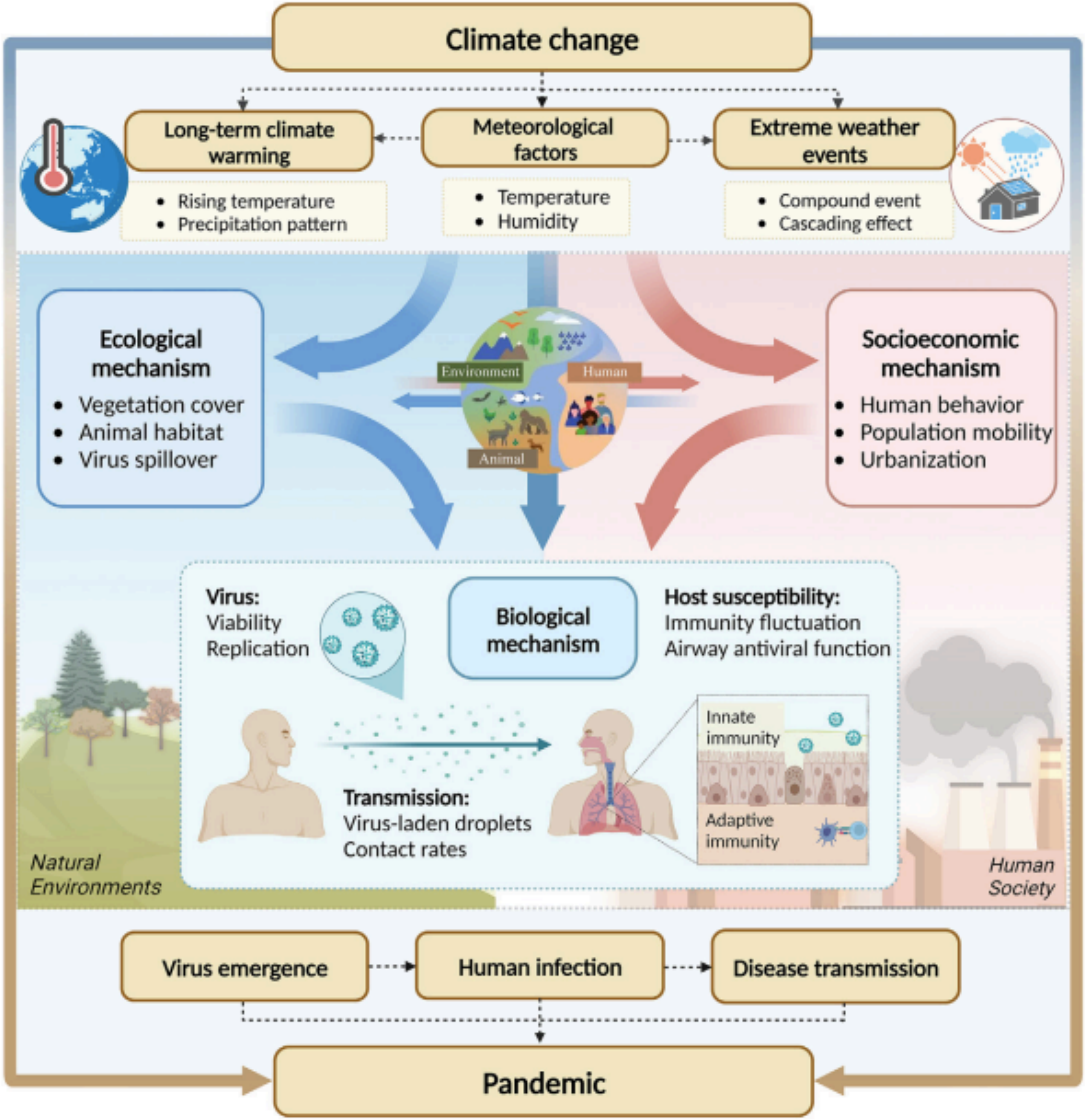
Fonte: Azienda Usl della Romagna

Review

Viral respiratory infections in a rapidly changing climate: the need to prepare for the next pandemic

Yucong He,[a,b] William J. Liu,[c] Na Jia,[d] Sol Richardson,[a] and Cunrui Huang[a,b,*]

[a]Vanke School of Public Health, Tsinghua University, Beijing 100084, China
[b]Institute of Healthy China, Tsinghua University, Beijing 100084, China
[c]NHC Key Laboratory of Biosafety, National Institute for Viral Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing 102206, China
[d]State Key Laboratory of Pathogen and Biosecurity, Beijing Institute of Microbiology and Epidemiology, Beijing 100071, PR China



Climate change
Long-term climate warming
Meteorological factors
Extreme weather events
Rising temperature
Precipitation pattern
Temperature
Humidity
Compound event
Cascading effect
Ecological mechanism
Vegetation cover
Animal habitat
Virus spillover
Environment
Human
Animal
Socioeconomic mechanism
Human behavior
Population mobility
Urbanization
Virus:
Viability
Replication
Biological mechanism
Host susceptibility:
Immunity fluctuation
Airway antiviral function
Innate immunity
Adaptive immunity
Transmission:
Virus-laden droplets
Contact rates
Natural Environments
Human Society
Virus emergence
Human infection
Disease transmission
Pandemic

1. Meterological fluctation
2. Extreme weather
3. Long term global warming

1. Meterological fluctation
2. Extreme weather
3. Long term global warming

In general, the transmission of respiratory viruses can be mostly categorized as occurring through three major routes:

- direct and/or indirect contact with contaminated surfaces or objects (fomites)
- short-range droplet-borne transmission
- long-range aerosol transmission.

Important determinants of the likelihood that droplet-borne viruses reach previously uninfected individuals are droplet sedimentation and evaporation, which are **largely influenced by climatic and other environmental conditions.**

nature

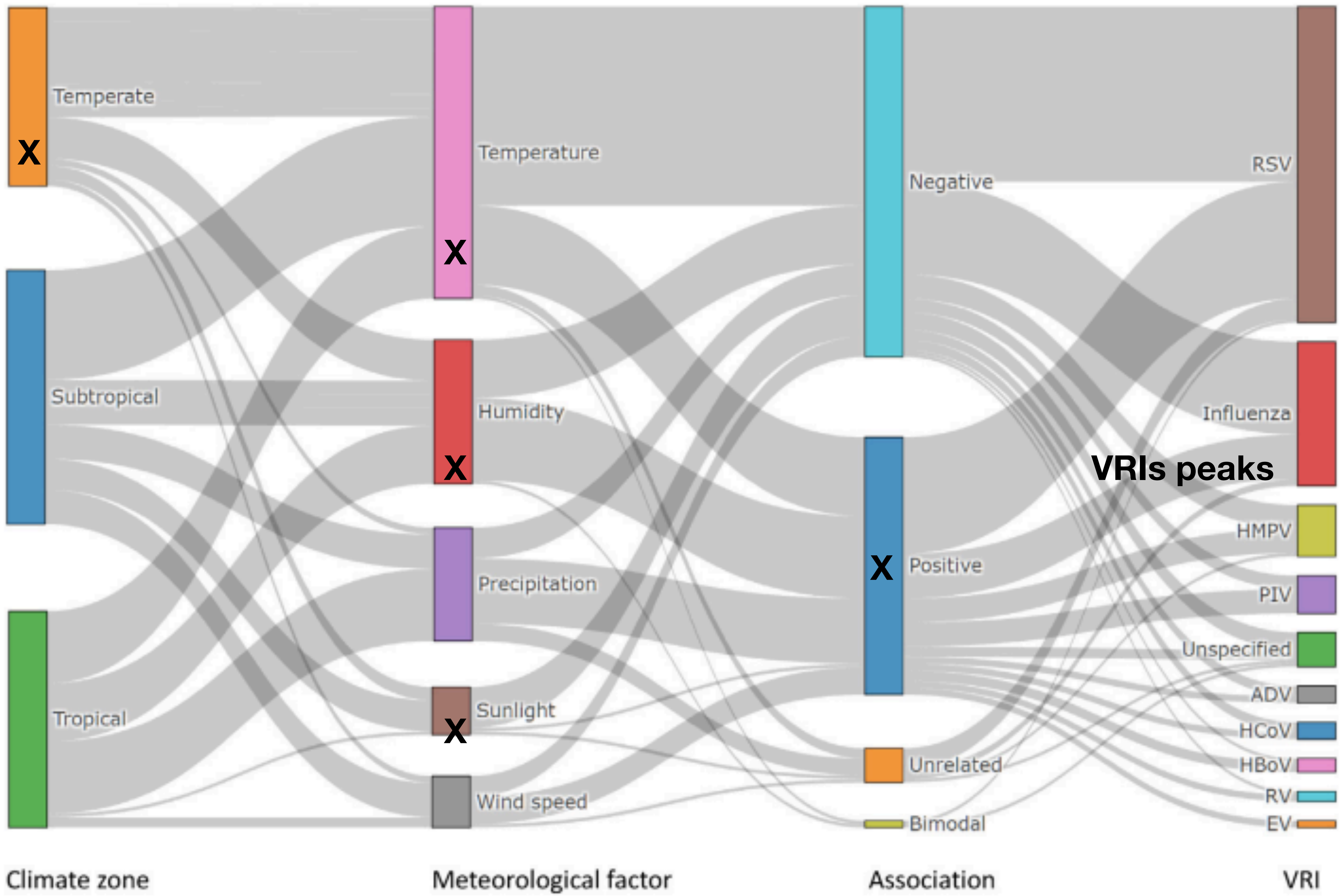
NEWS | 24 April 2024

WHO redefines airborne transmission: what does that mean for future pandemics?

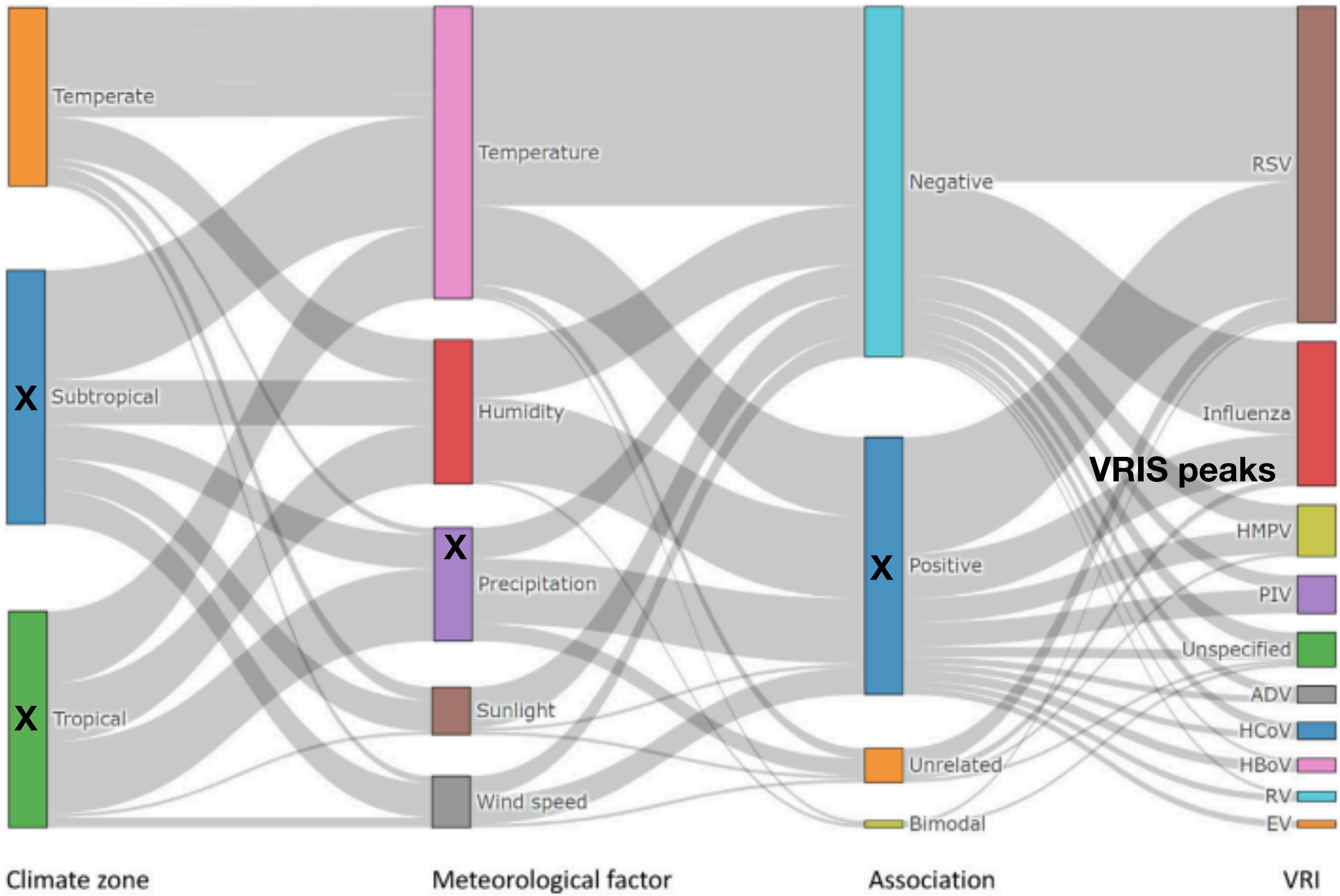
The World Health Organization was criticized for being too slow to classify COVID-19 as airborne. Will the new terminology help next time?

Infectious respiratory particles (IRPs) exist on a **continuous spectrum of sizes**, and **no single cut off points should be applied** to distinguish smaller from larger particles, this allows to move away from the dichotomy of previous terms known as 'aerosols' (generally smaller particles) and 'droplets' (generally larger particles).

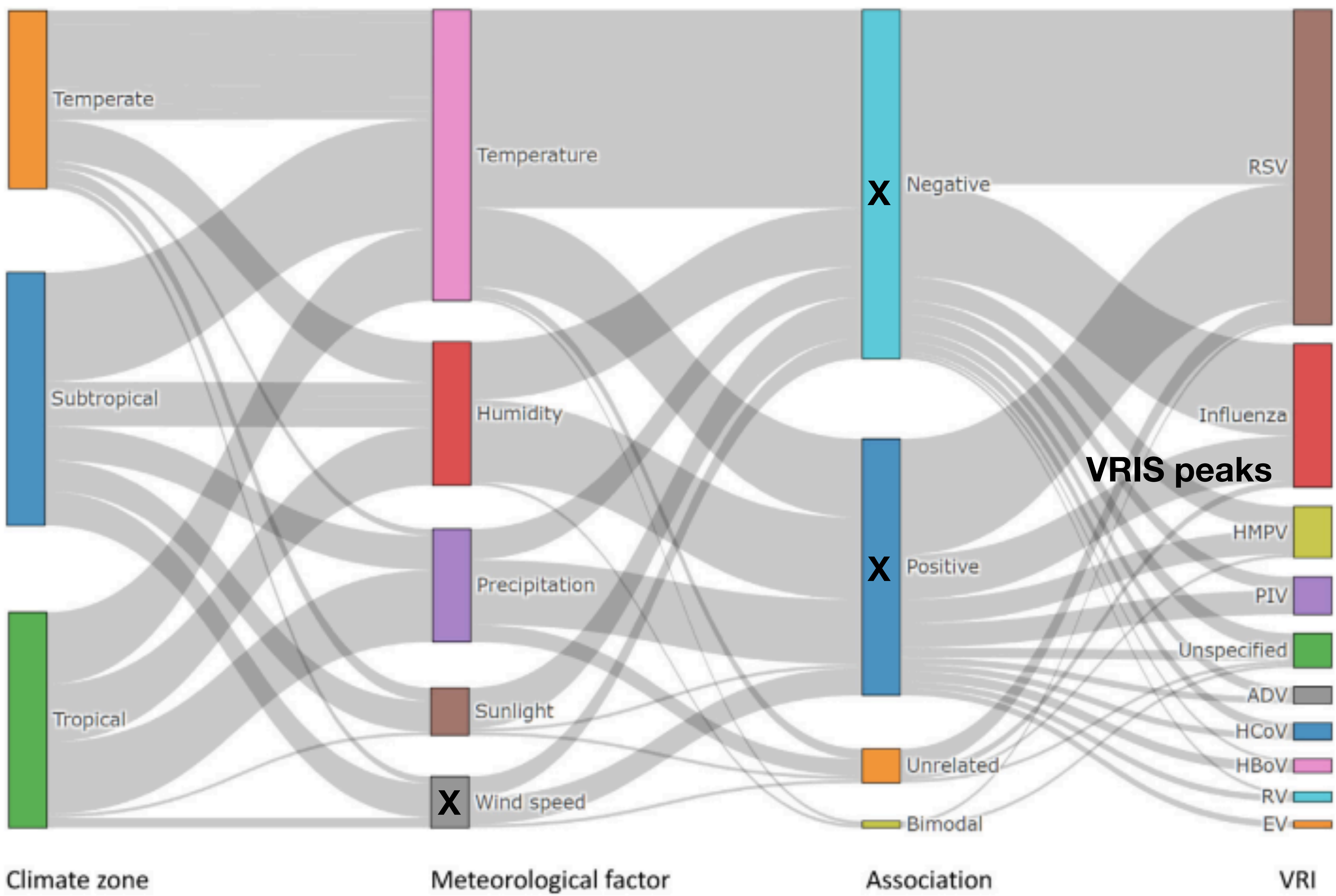
Many environmental factors influence the way IRPs travel through air, such as ambient air temperature, velocity, humidity, sunlight (ultraviolet radiation), airflow distribution within a space, and many other factors, and whether they retain viability and infectivity upon reaching other individuals.


Temperate
Subtropical
Tropical
Temperature
Humidity
Precipitation
Sunlight
Wind speed
Negative
Positive
Unrelated
Bimodal
RSV
Influenza
VRIs peaks
HMPV
PIV
Unspecified
ADV
HCoV
HBoV
RV
EV
Climate zone
Meteorological factor
Association
VRI

- Earlier laboratory studies have revealed that **low temperature** and **low humidity** enhance viral viability and transmission, especially influenza, and can **compromise host airway antiviral defense**
- Seasonal epidemics of VRIs are not only shaped by single meteorological factors but likely **the composition of multiple meteorological conditions.**
- **Indoor climate**: studies show that individuals living in homes with **indoor heaters that elevate indoor RH levels** have lower rates of infections due to decreased virus viability
- Virus transmission is more prevalent in indoor environments that are well-air-conditioned but have **poor ventilation.** The indoor climate and ventilation rates, regulated by outdoor weather conditions, are suggested to play a vital role in moderating the seasonal patterns of VRIs



Temperate
X
Subtropical
X
Tropical
Temperature
Humidity
X
Precipitation
Sunlight
Wind speed
Negative
X
Positive
Unrelated
Bimodal
RSV
Influenza
VRIS peaks
HMPV
PIV
Unspecified
ADV
HCoV
HBoV
RV
EV
Climate zone
Meteorological factor
Association
VRI

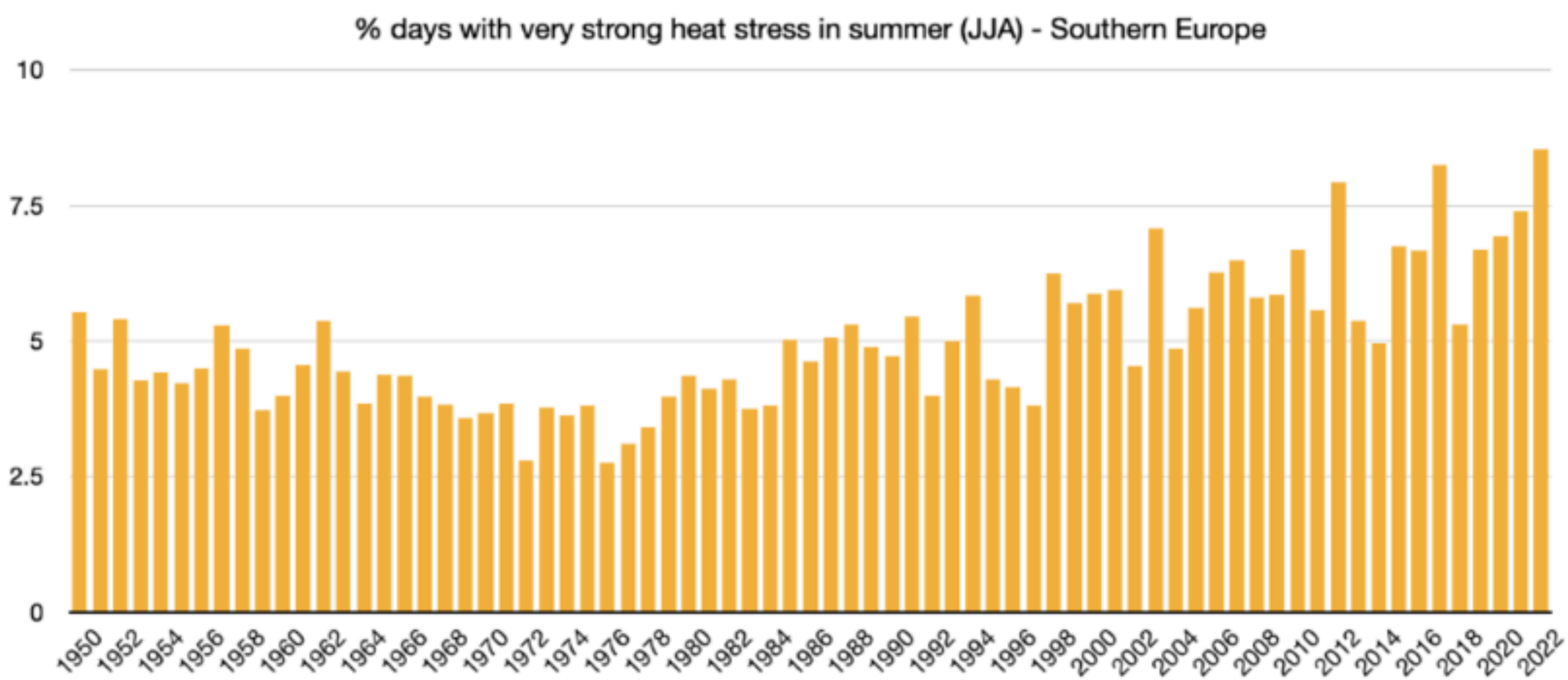

Temperate
Subtropical
Tropical
Temperature
Humidity
Precipitation
Sunlight
X
Wind speed
X
Negative
X
Positive
Unrelated
Bimodal
RSV
Influenza
VRIS peaks
HMPV
PIV
Unspecified
ADV
HCoV
HBoV
RV
EV
Climate zone
Meteorological factor
Association
VRI

1 Meterological fluctatation

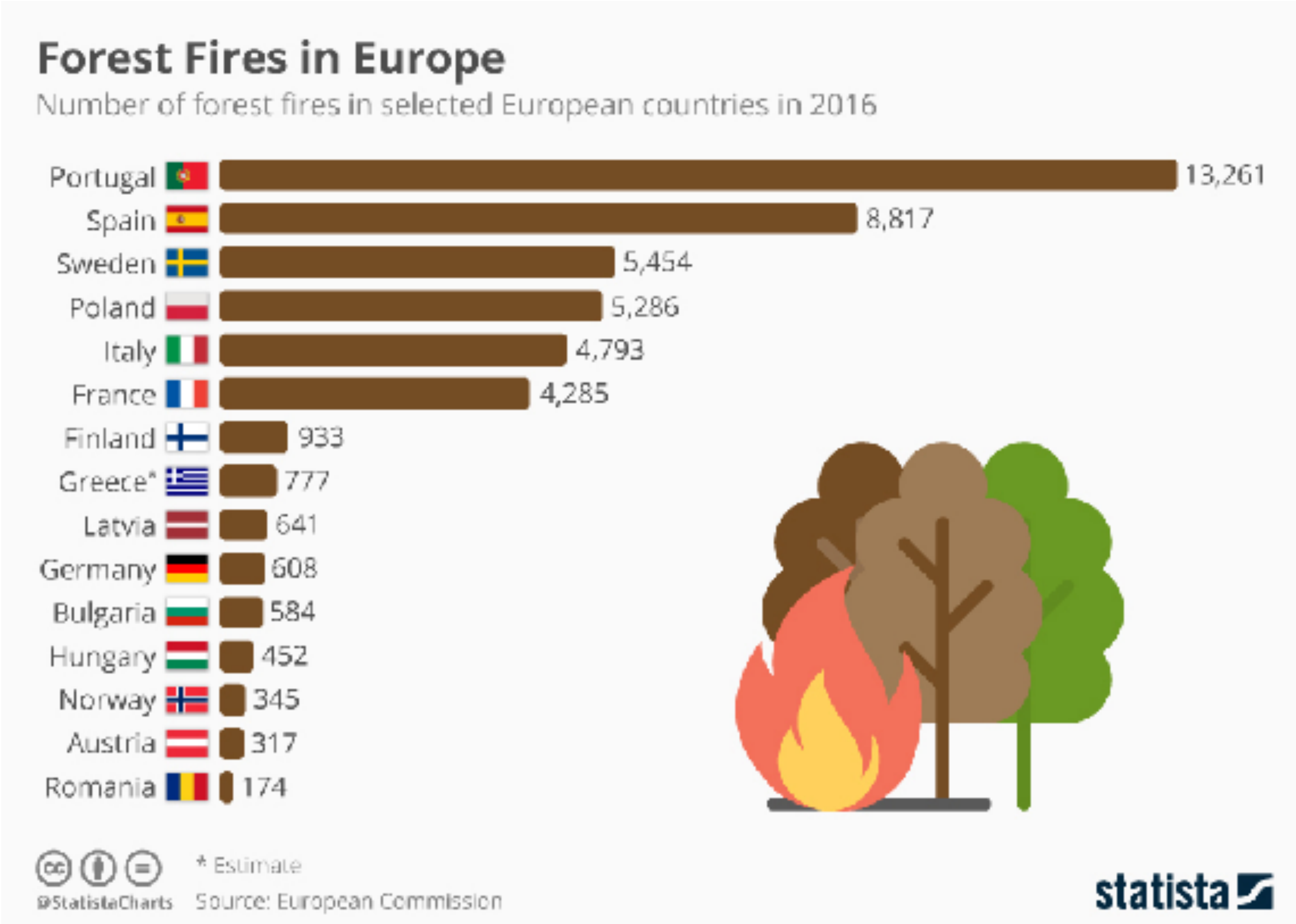
2 Extreme weather

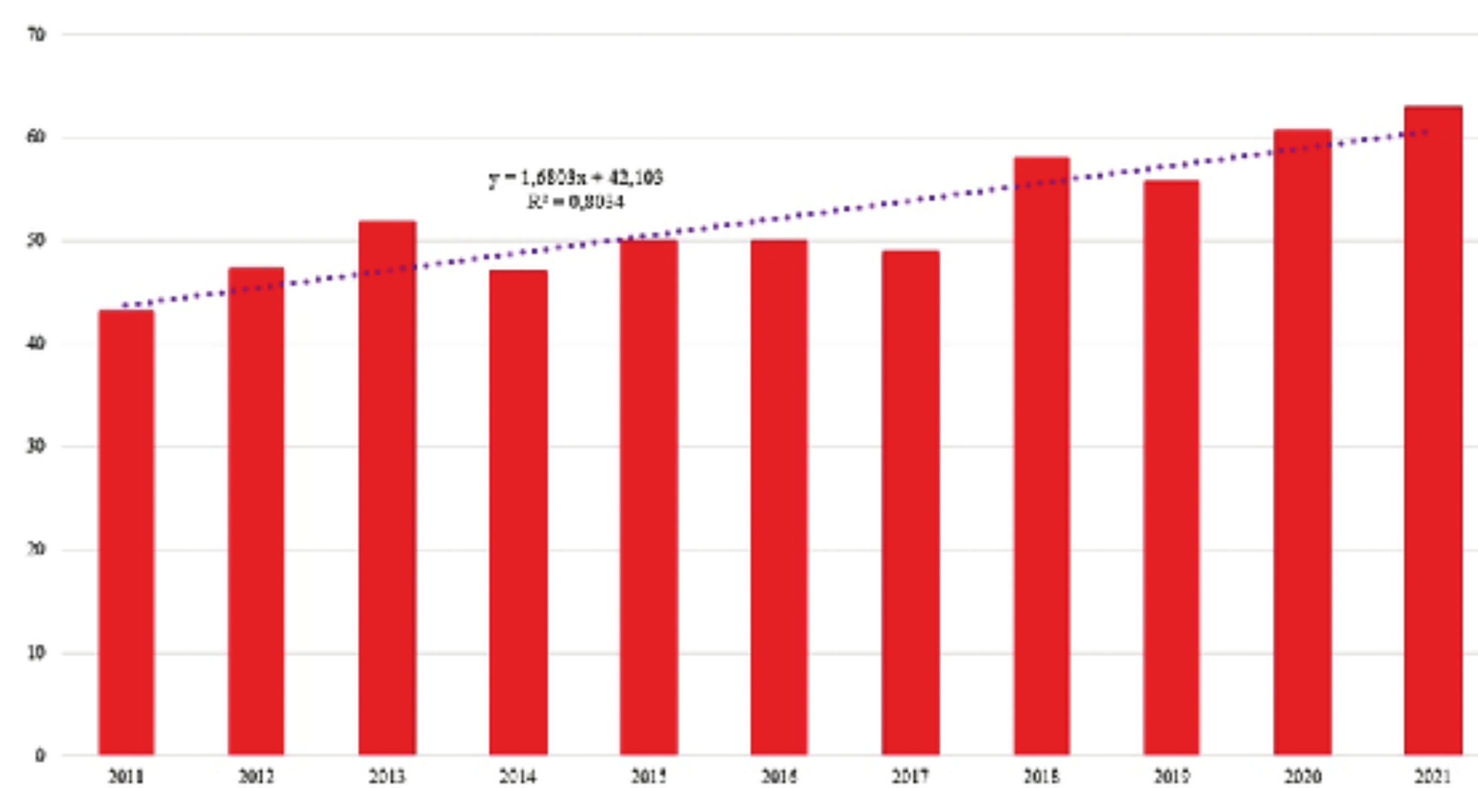
3 Long term global warming

The European heatwave of July 2023 in a longer-term context



Data Source: ERA5-HEAT, Credit: C3S/ECMWF


Forest Fires in Europe
Number of forest fires in selected European countries in 2016
Portugal 13,261
Spain 8,817
Sweden 5,454
Poland 5,286
Italy 4,793
France 4,285
Finland 933
Greece* 777
Latvia 641
Germany 608
Bulgaria 584
Hungary 452
Norway 345
Austria 317
Romania 174
* Estimate
Source: European Commission
@StatistaCharts
statista

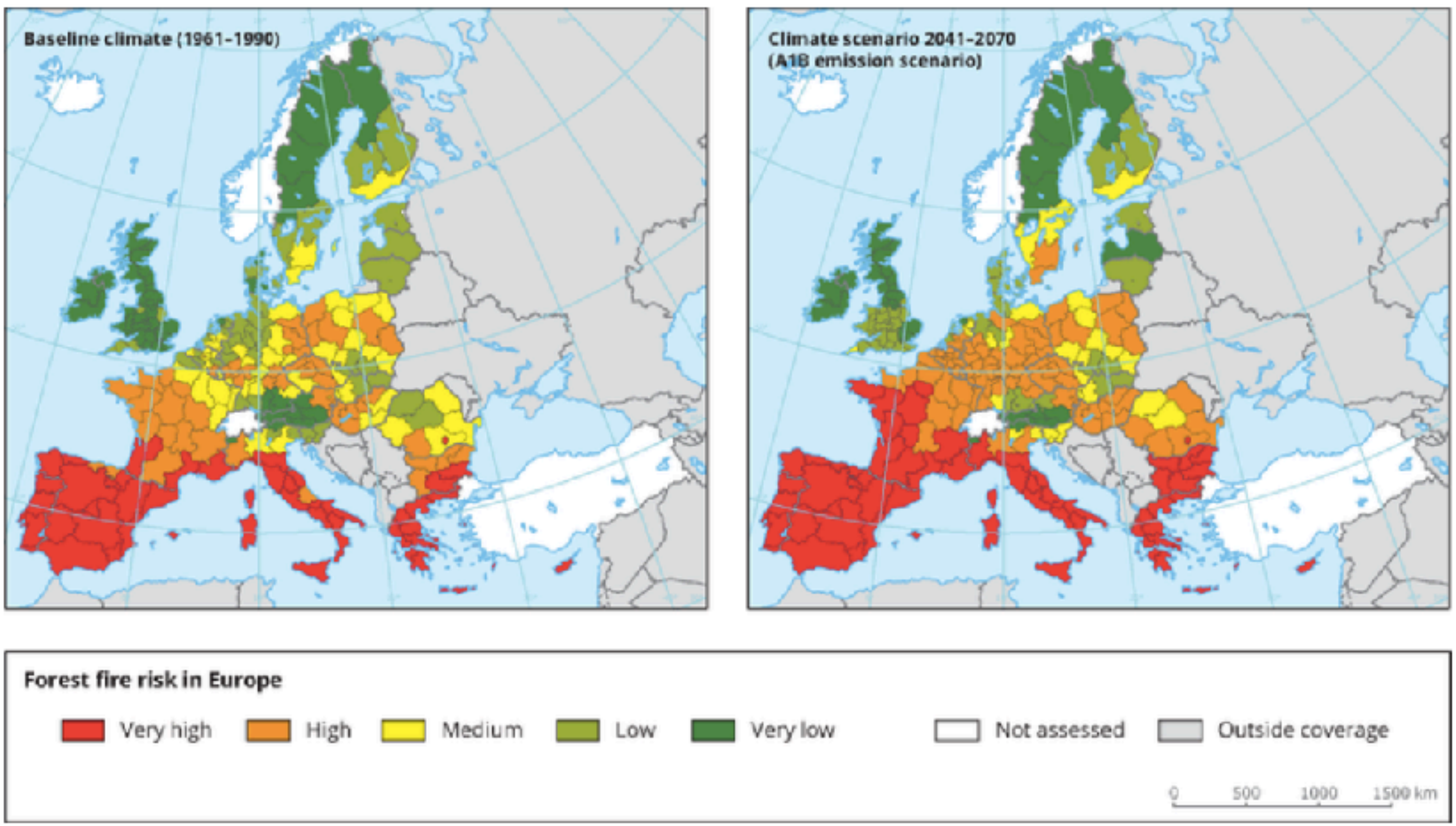

y = 1,6809x + 42,103
R² = 0,8034
70
60
50
40
30
20
10
0
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

European Environment Agency

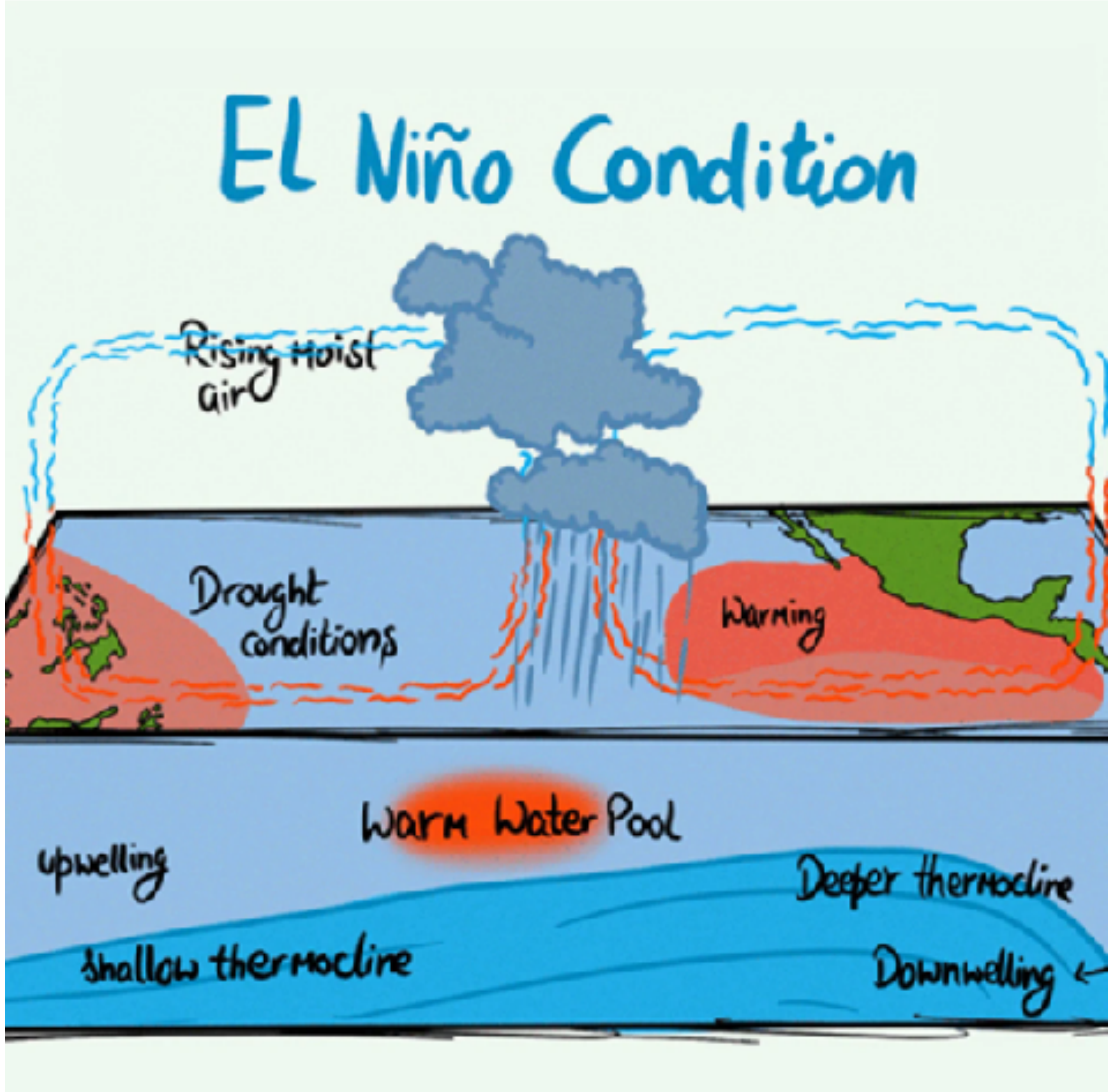
Topics Analysis and data

Projected Forest fire risk in Europe

Map (static) | Published 19 Jul 2017 | Modified 20 Sept 2024



- High-pressure atmospheric conditions, sunlight and low wind speeds during heatwaves contribute to **high levels of air pollution**. Heatwaves and droughts exacerbate the spread of wildfires, resulting in widespread **elevations in levels of particulate matter (PM)**, which can exacerbate damage to lung function and/or pre-existing respiratory illnesses like **COPD and asthma**
- A time-stratified case-crossover study in China showed that **the risk of acute upper respiratory infections increased by 30% during heatwaves**
- Other studies reported exacerbation of pre-existing respiratory illnesses and **increased host susceptibility to VRIs** resulting from synergistic effects of compound exposures to aggravated **air pollution, heatwaves, wildfire, and droughts**


El Niño Condition
Rising moist air
Drought conditions
Warming
Warm Water Pool
upwelling
Deeper thermocline
Shallow thermocline
Downwelling

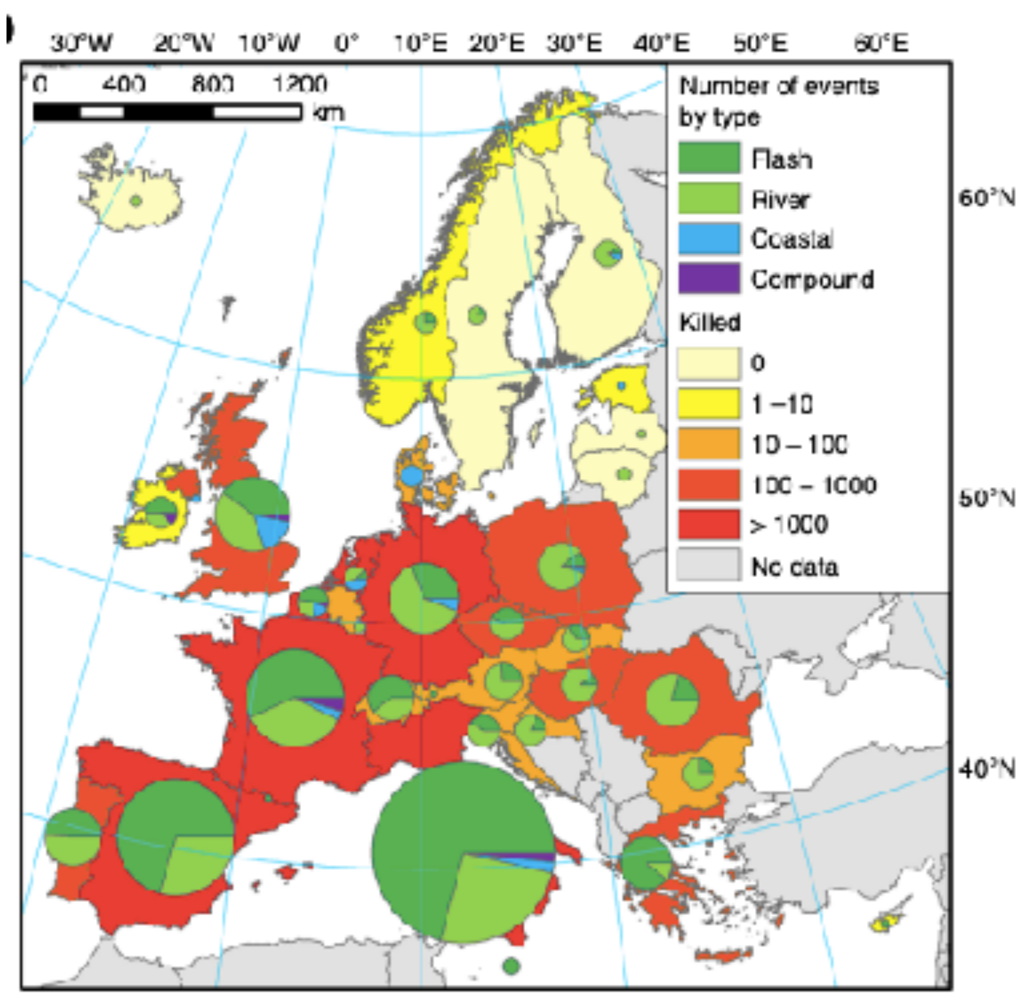
nature COMMUNICATIONS

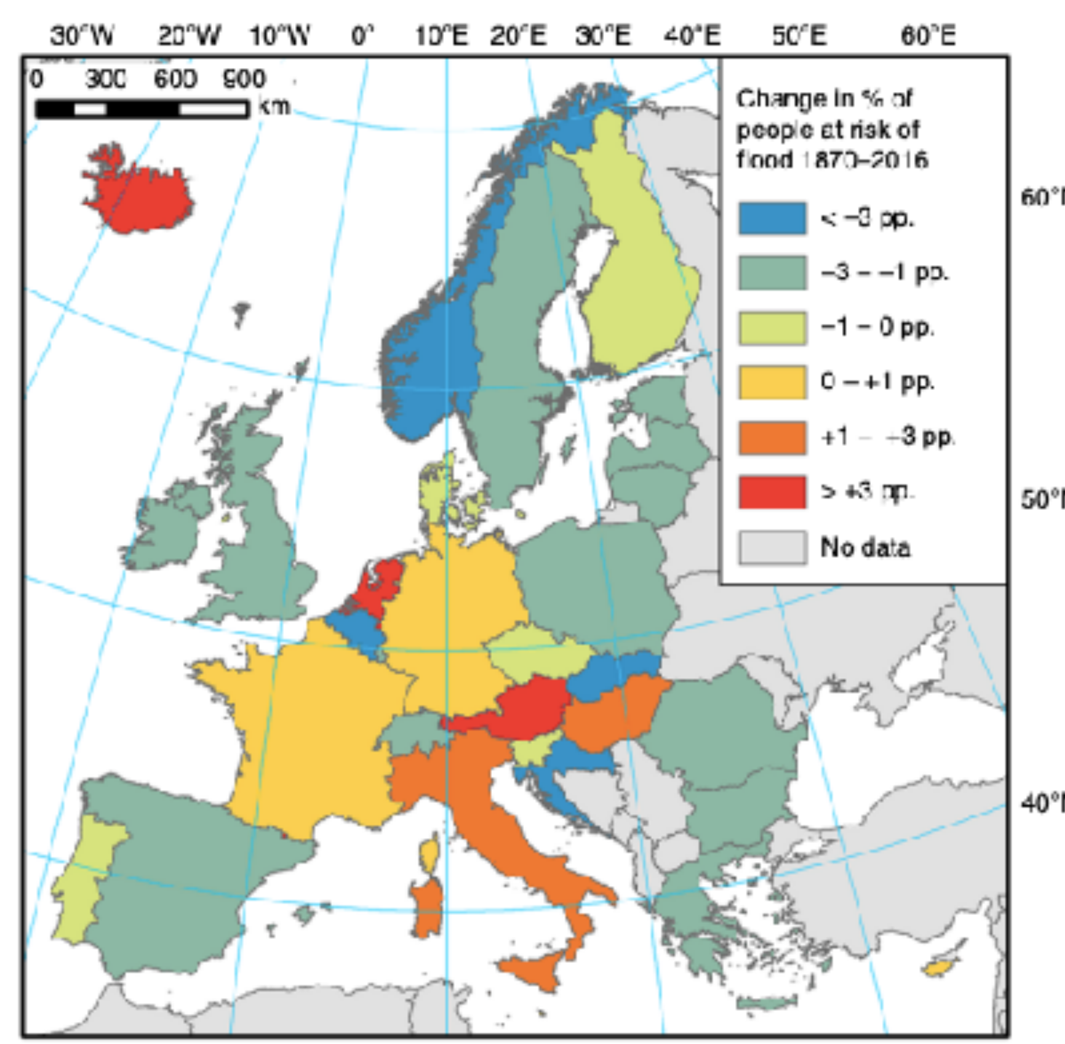
ARTICLE

DOI: 10.1038/s41467-018-04253-1 OPEN

Trends in flood losses in Europe over the past 150 years

Dominik Paprotny [1,2], Antonia Sebastian [1,3], Oswaldo Morales-Nápoles [1] & Sebastiaan N. Jonkman [1]





healthcare MDPI

Article

Syndromic Surveillance in Public Health Emergencies: A Systematic Analysis of Cases Related to Exposure to 2023 Floodwaters in Romagna, Italy

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BRIEF REPORT

Check for updates

Non-cholera *Vibrio* spp. invasive infections in the summer following May 2023 flood disaster in Romagna, Italy: a case series

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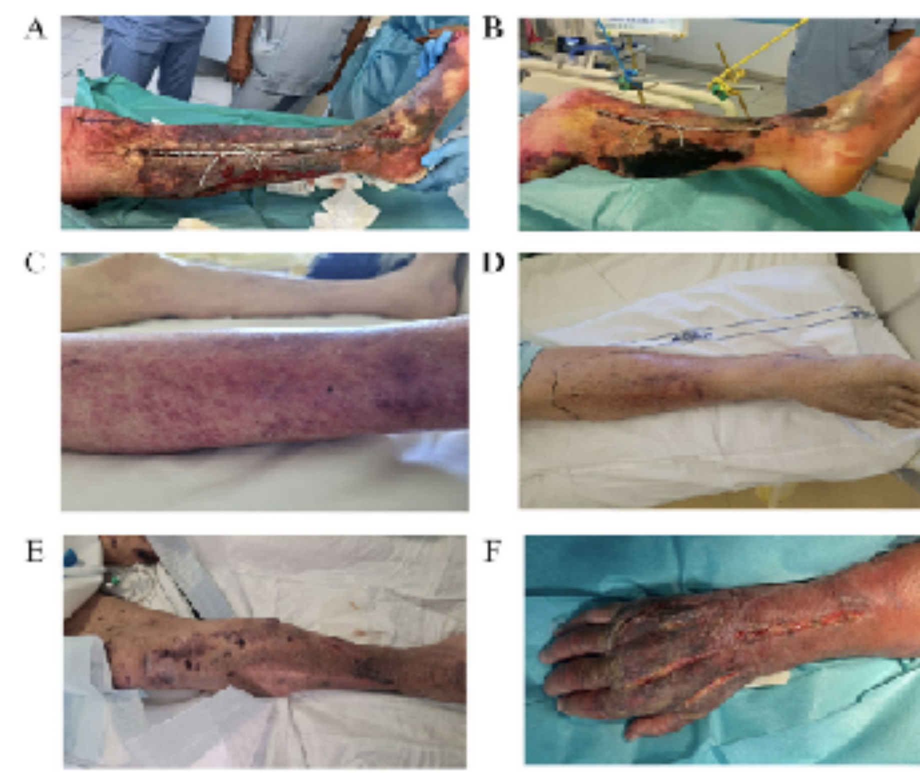
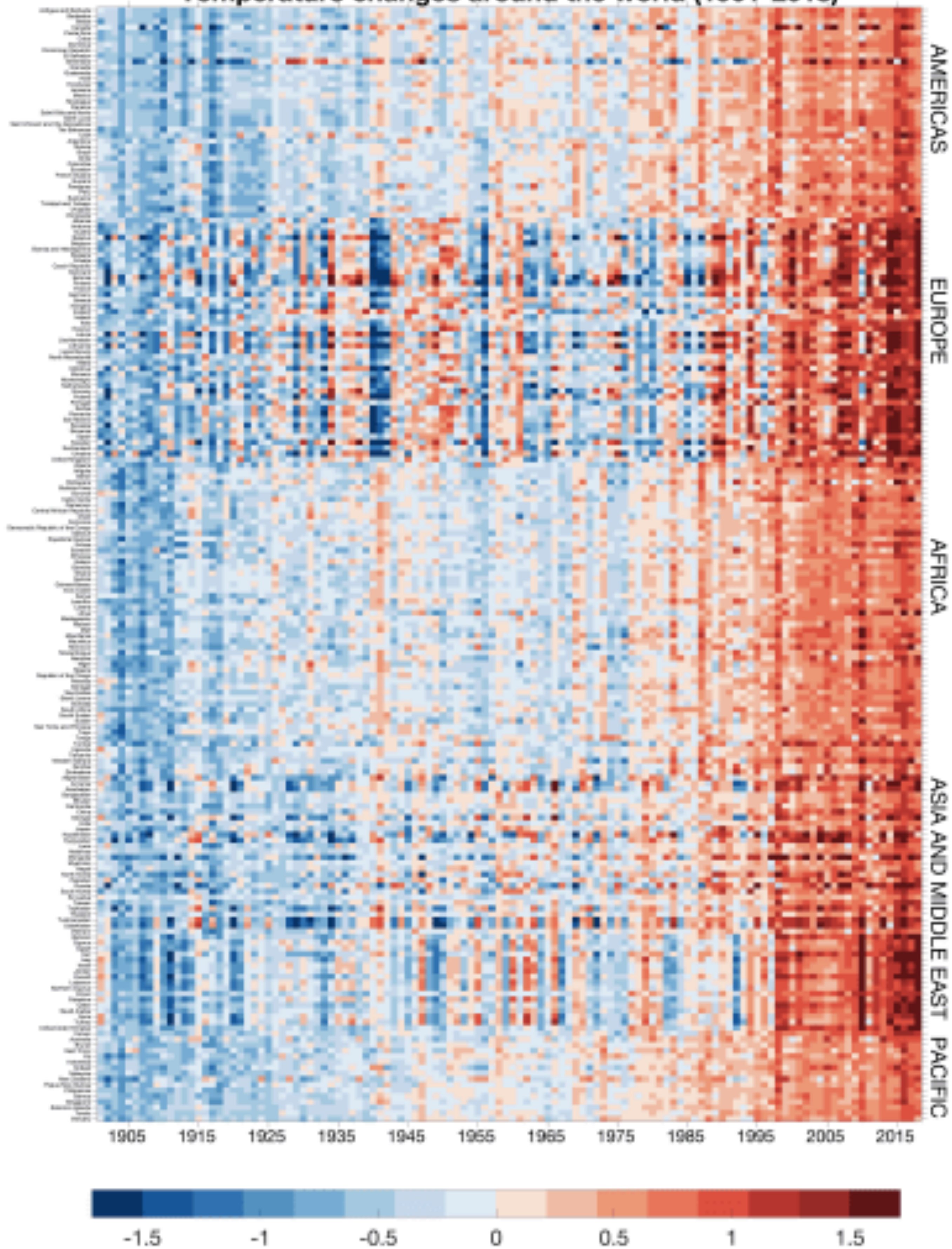


- These events may have cascading effects on **hydrological conditions, air quality, and health determinants**, modifying disease exposure, while increasing susceptibility and ultimately leading to **an increased risk of infections and outbreaks**
- In resource-limited tropical low- and middle-income countries (LMICs), which have been proven more vulnerable to the impacts of climate change, **heavy rainfalls are found to be more likely associated with VRI peaks.**
- A cross-sectional study reported that direct exposure to **floodwater increased the risk of influenza-like illnesses (OR = 2.75).**
- **Disruption of housing, health access, and emergency response infrastructure** due to flooding can compromise health system resilience and **increase both exposure and vulnerability to VRI risks**

1. Meterological fluctatation
2. Extreme weather
3. Long term global warming

Temperature changes around the world (1901-2018)



Shift in spatiotemporal dynamics of VRIs epidemics

- These include the changes in climate belts, alternations in vegetation coverage, melting of glacial permafrost, and loss of biodiversity.
- Recent epidemiological surveillance in temperate climates has revealed **a shift in the peak timing of RSV seasonal activity** towards warmer seasons over the past few decades, along with a shortened epidemic duration.
- Future RSV epidemics would have a northward shift in regional ranges as epidemic durations became **more persistent.**
- Densely populated areas would undergo the greatest rise in rapid intra-season temperature variability by the end of this century, **thereby increasing the risk of influenza morbidity by up to 50%**

Host susceptibility

- Prolonged exposure to extremely high temperatures (≥36 ◦C) in mice **impairs virus-specific CD8+ T cell responses and antibody production** following intranasal influenza virus infection.
- Heatwaves, along with wildfires, increase compound exposure to air pollution as well as allergens like pollens, which causes **airway irritation and respiratory tract inflammation.** This reduces airway responsiveness to harmful stimuli and weakened clearance, exacerbating the damage to lung function.

Agricultural adaptation

- Climate change has led to prolonged droughts, **desertification**, and l**and degradation,** which have had slow-onset but significant impacts on agriculture, especially in tropical regions in the developing world where soil quality is already poor. Increases in the frequency and severity of droughts exacerbate **food insecurity** in those areas currently vulnerable to undernutrition, i**ncreasing susceptibility to infectious diseases by compromising host immunity**

Human behavior

- **Crowding** in particular plays a key role in this regard.
- Outdoor climate can also affect human behavior, such as g**athering indoors during rainy days and using indoor heating on cold days or air conditioning on hot days.**
- This seems appropriate in explaining the different seasonal patterns of VRI epidemics for both cold temperate and hot subtropical or tropical regions, where such indoor crowding influenced by seasonal weather conditions facilitates human-to-human transmission
- Extreme weather events, including heavy rainfall and flooding, can disrupt housing, healthcare access, and emergency infrastructure, resulting in mass displacement and worsening living conditions

Emerging VRIs with pandemic potential

- Of all the viruses mentioned above, three families of RNA viruses associated with respiratory infections appear to frequently jump species boundaries, including **Orthomyxoviridae, Coronaviridae, and Paramyxoviridae** (corresponding to five types of virus: influenza virus, HCoV, RSV, PIV, HMPV)
- **Stage 1** involves the pathogen remaining in its natural reservoir. Large-scale ecological and societal changes can **alter the likelihood of cross-species transmission**, which can lead to progression into stage 2.
- **Stage 2** is characterized by localized emergence, where **spillovers** from natural reservoirs result in **human-to-human transmission.**
- **Stage 3** is marked by the acquisition of **sustained human-to-human transmission** with low or no human immunity. **Increased global connectivity** can aid the transition to stage 3, leading to actual pandemics.

Conclusion

- As suggested by both biological and epidemiological evidence, **temperature and humidity are the most significant meteorological drivers of VRI seasonality**.
- Due to climate change, **seasonal epidemics of VRIs may shift spatially and temporally**, with rising temperatures and abnormal rainfall patterns being contributing factors.
- **Extreme weather events** have the potential to exacerbate the risks of VRI transmission and increase outbreak risks
- The increasing concern of **spillover of emerging zoonotic pathogens** and the potential for pandemics is primarily a result of modifications in both natural and social environments as a result of climate change and human-animal environment interconnectedness.
- The contact patterns between humans and wildlife reservoirs have changed due to urbanization and **the intrusion of humans** into previously unoccupied regions.

Conclusion

- The COVID-19 pandemic may be a harbinger of an **upcoming new era**, defined by outbreaks of emerging and re-emerging diseases that spread quickly and internationally
- Therefore, adopting the **One Health approach**, which systematically considers the interconnected interaction between humans, animals, and the environment we share, as well as the interconnection of climate change, human health, environmental sanitation, and biodiversity as a whole, is instrumental for understanding the regional and global health threats associated with climate change
- This perspective **can enhance interdisciplinary collaboration** in strengthening surveillance and early warning of viral diseases to inform **preparation for future pandemics**


Healthy ecosystems
Healthy people
Healthy animals