Plenary Session II

Risk Assessment – weighing Risk in Policymaking

Twin Crises of Air Pollution and Anti Microbial Resistance

Risk assessment for Human Health

World Science Forum 2024
The Science and policy interface at
The time of global transformation
Budapest, Hungary
Nov 20-23, 2024

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Humanity's Challenges for the Next 50 Years

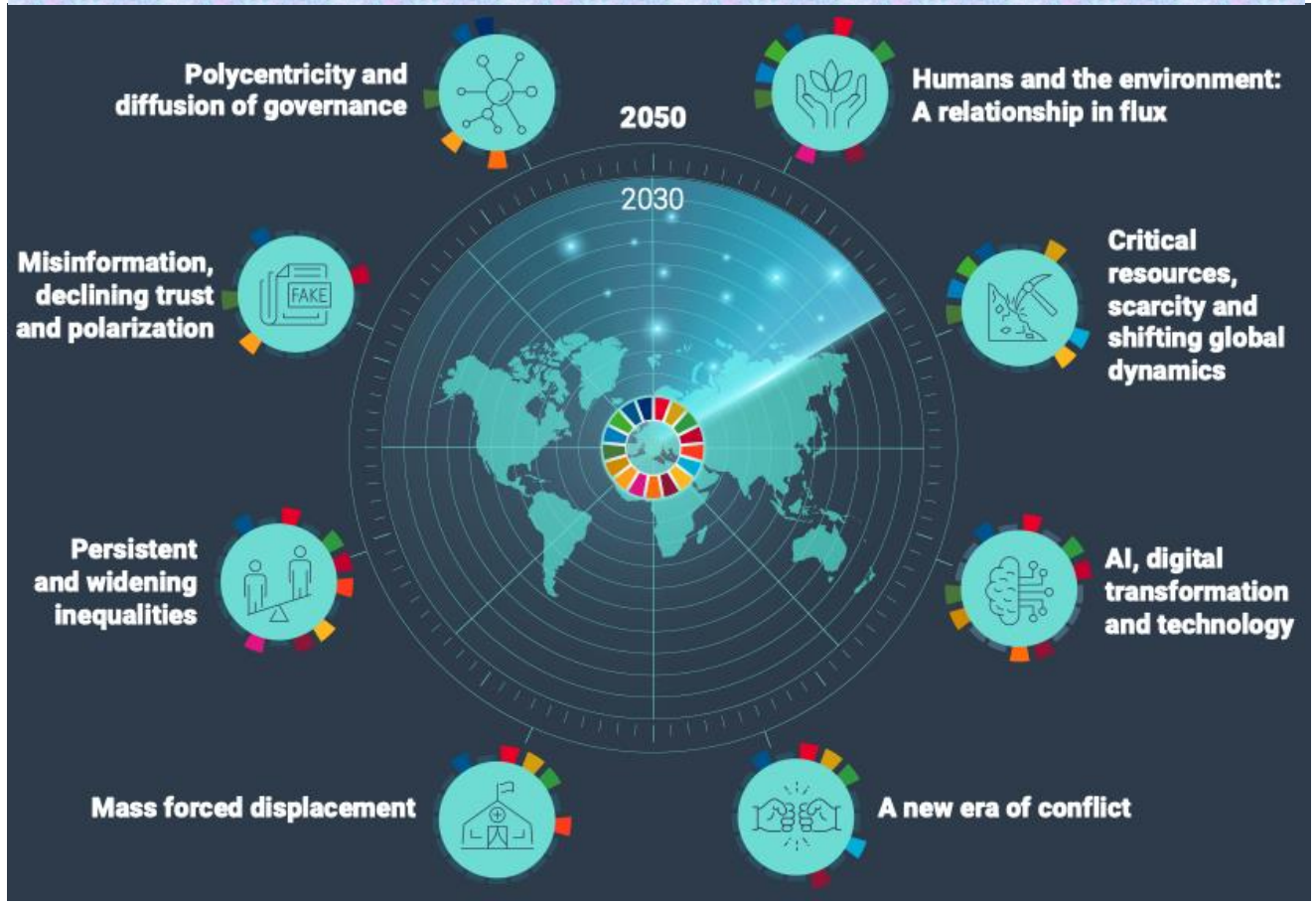
- CLEAN ENERGY
- WATER
- FOOD & NUTRITION SECURITY
- CLIMATE CHANGE
- Environmental Pollution
- POVERTY ALLEVIATION
- SCIENCE IN CONFLICT ZONES
- Antimicrobial Resistance
- EDUCATION FOR ALL
- POPULATION
- GLOBAL DATA SHARING

UN environment programme

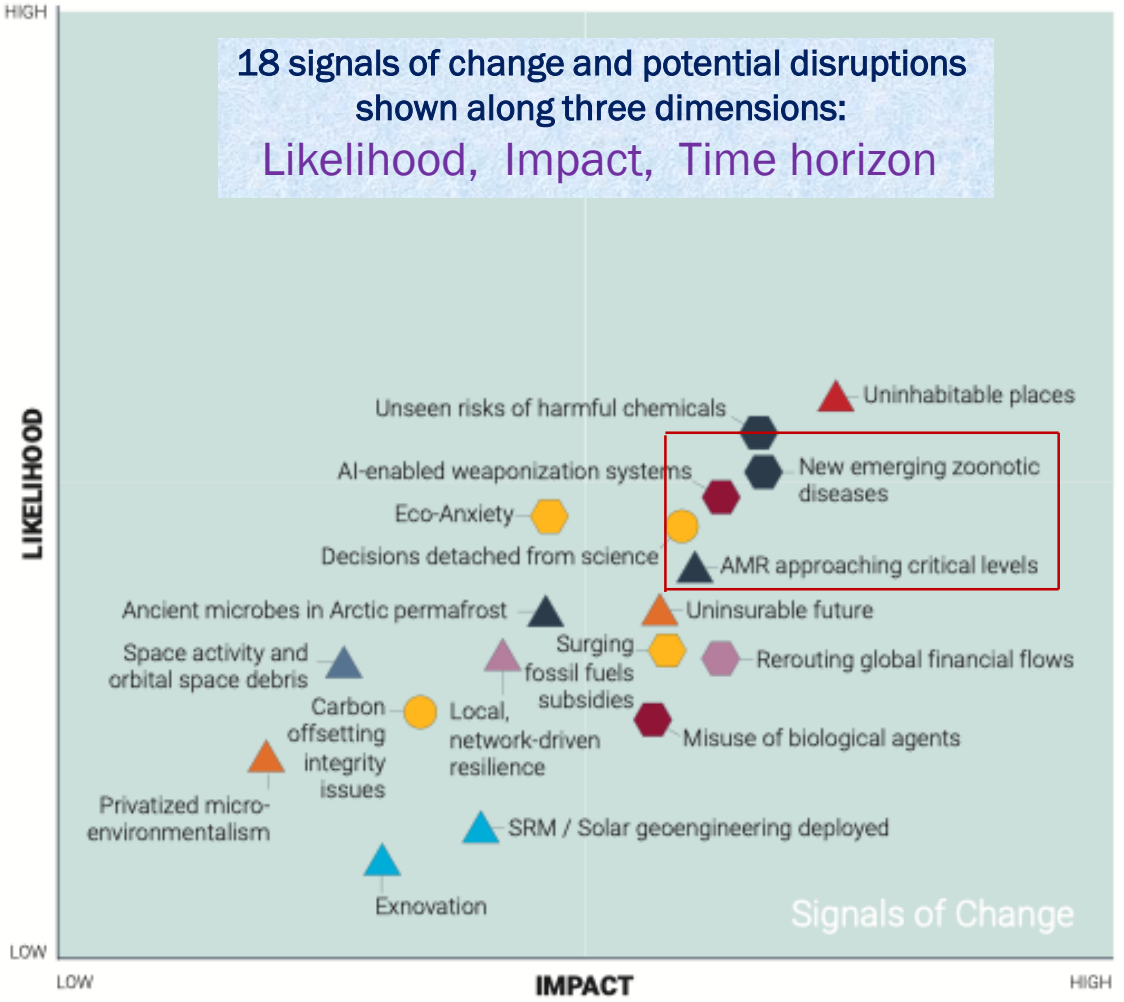
International Science Council
The global voice for science

2024 United Nations Environment Programme

8 critical global shifts or phenomena that emerged from the Foresight Process



18 signals of change and potential disruptions shown along three dimensions:
Likelihood, Impact, Time horizon



Critical Shifts:

- Humans and the environment: A relationship in flux
- Resources, scarcity and shifting dynamics of global security
- AI, digital transformation and technology – waves of change
- A new era of conflict
- Mass forced displacement
- Persistent and widening inequalities
- Misinformation, declining trust and polarization
- Polycentricity and diffusion of governance

Time Range:

2 - 3 years | 4 - 6 years | 7+ years

"AT THE CORE OF THIS CRISIS ARE THE HUMAN BEINGS"

Two intertwined Global challenges

Understanding how AMR evolved alongside CC could provide insights to policy and effective interventions

Urgently needed

Interdisciplinary research, political advocacy and Sustained global effort

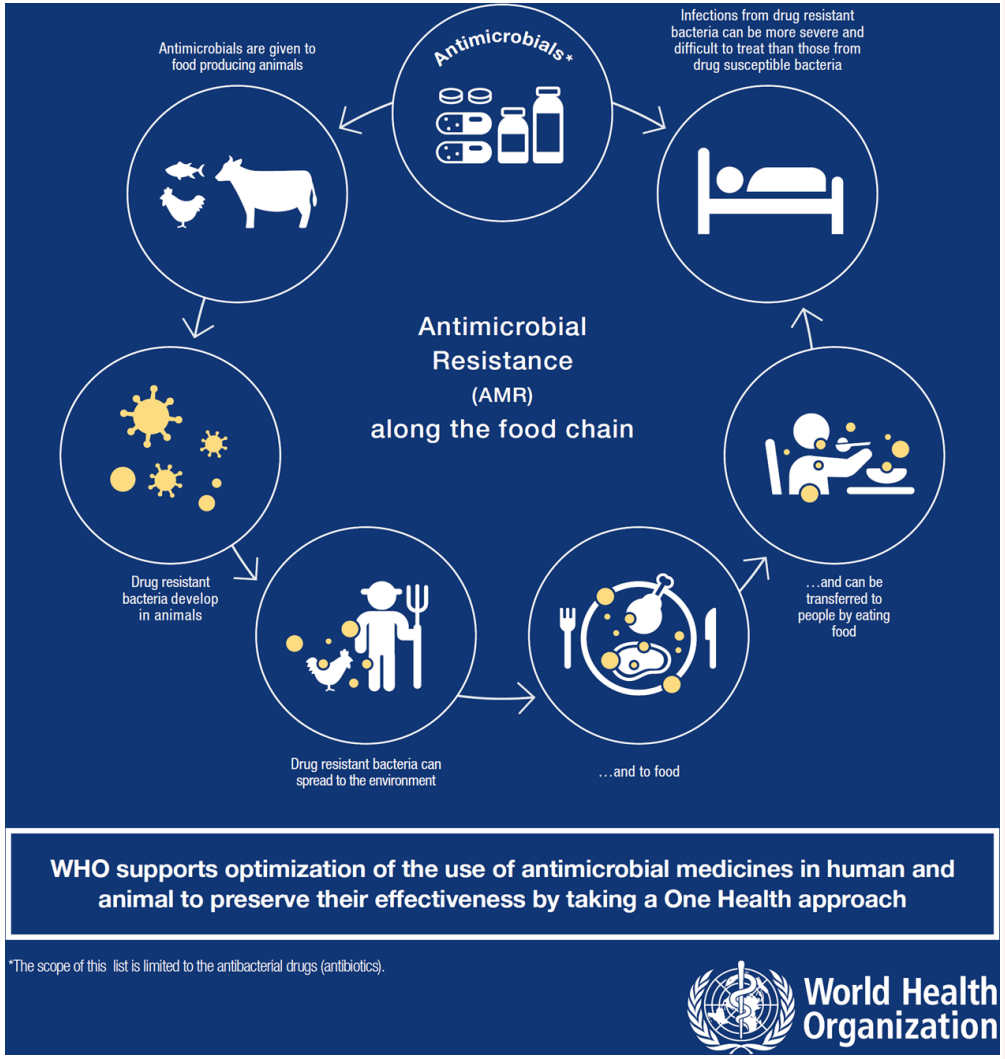
Growing Cancer Risk

- Air Pollution
- Antimicrobial Resistance (AMR)

Human health is determined by the interaction of our environment with the genome, epigenome and microbiome, all of which shape the transcriptomic, proteomic and metabolomic landscape of our cells and tissues

Anti-microbial resistance
(AMR)

- Refers to microorganisms such as bacteria, fungi, viruses, and parasites being able to resist the effects of antimicrobial drugs that were earlier effective in treating infections. **Due to this, the treatment and management of even common infections like pneumonia has become challenging.**
- Excessive use of anti-microbial drugs in both human and veterinary populations **(Human : Animal ratio, 30:70)**
- **WHO 2019 named AMR as one of the top 10 threats to global health, besides viral pandemics and climate change**
- **High burden of AMR in LMICs. There were an estimated 4.95 million deaths associated with bacterial AMR in 2019. 1.27 million were directly caused by AMR***
- **As per ICMR estimates, the mean total increment cost of treating any resistant infection is 40% higher than non-resistant organisms in Indian Govt hospitals.**
- **According to World Bank estimates, AMR could result in US$ 1 trillion additional healthcare costs by 2050, and US$ 1-3.4 trillion GDP** (gross domestic product) **losses by 2030**



*AMR collaborators Lancet 2022; 399: 629-55

AMR : ICMR Multicentric Study

- ✓ 21- Tertiary care hospital across the country, period; Jan1 – Dec 2023
- ✓ ~100,000 culture isolates analyzed for hospital acquired infections; 1,747 pathogens
- ✓ E. Coli was the most common, followed by *Klebsiella pneumoniae, pseudomonas aeruginosa, Acinetobacter baumannii, staphylococcus aureus*
- ✓ Study revealed that if 8/10 patients (81%) with drug-resistant *E. Coli* infection responded to Carbepenem (drug that effectively treated pneumonia and septicemia) in 2017, the figure has dropped to ~6/10 (66%) in 2022.
- ✓ And it is worse with the drug-resistant *Klebsiela pneumoniae*, in which the drop is alarming: 6/10 pts benefiting in 2017 to only 4/10 now in 2022.
- ✓ Globally, the resistance levels between 10% and 20% are considered to be alarming; nevertheless in some countries including India, there is widespread and uncontrolled use of antibiotics, such that even pts with >60% resistance levels are being prescribed antibiotics.
- ✓ Are we fast returning to pre-antibiotic days? A strong policy must be in place to curb this.

AMR Surveillance Network, ICMR 2023

Final Report

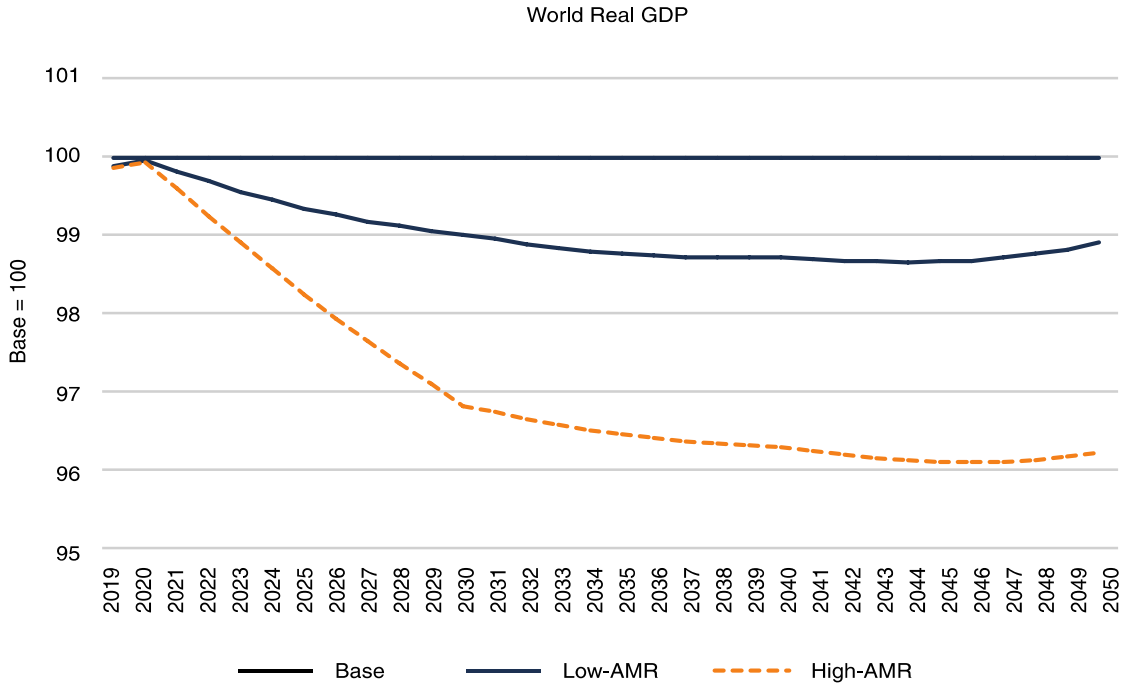
DRUG-RESISTANT INFECTIONS

A Threat to Our Economic Future

March 2017

WORLD BANK GROUP

FIGURE ES1. Substantial and Protracted Shortfalls in Global Economic Output



- Antimicrobial drugs are “miracle drugs” that saved hundreds of millions of lives since their wide use >70 yrs ago
- Loss of their drug effectiveness is increasing in both developing and developed countries
- If this trend continues unchecked, the world will confront a reality where many infectious diseases will have *‘no cure and no vaccine’*
- The economic damage could be colossal – may be as large as the global financial crises that started in 2008.

ANTIBIOTIC RESISTANCE COULD CAUSE 40 MILLION DEATHS BY 2050

Nature | Vol 633 | 26 September 2024

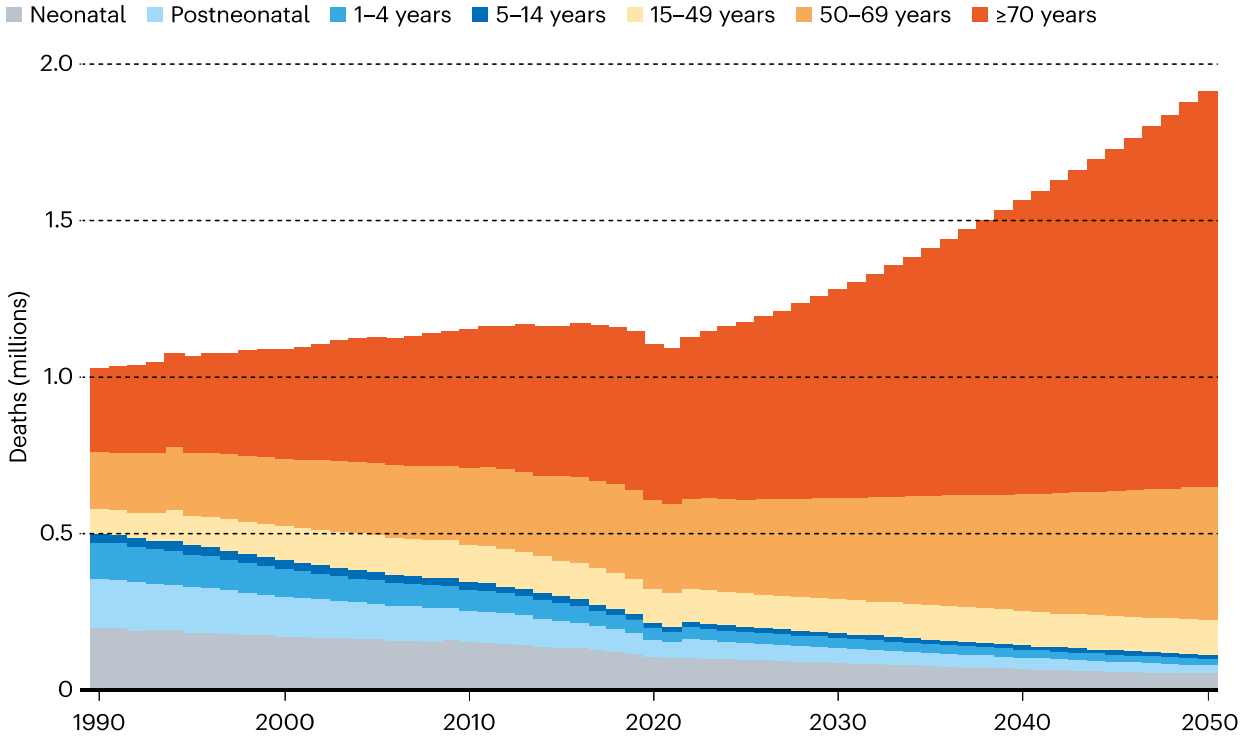
By the middle of the century, nearly two million people could die from drug-resistant infections each year.

By Miryam Naddaf

microbiologist at the University of Oxford, UK.

RESISTANCE CRISIS

By 2050, antimicrobial resistance could be responsible for 1.91 million deaths per year. Mortality is projected to rise by around 70% among people aged 70 and older, but will continue to fall in young children and babies.



Main Message

- Between 1990 and 2021, more than one million people died from drug resistant infections each year.
- AMR deaths among children below 5, declined by 50%, while among those aged 70 and above, it increased by more than 80%
- Top 6 pathogens causing >100,000 deaths: *S.aureus, Acinetobacter baumannii, E.coli, Klebsiella pneumoniae, S.pneumoniae and pseudomonas aeruginosa*

- **However**, by 2050, AMR could cause 1.91 million deaths each Year, and that a further 8.22 M people will die from illnesses associated with resistance.

- The death rate due to AMR will be higher than cancer

- Over 65% of AMR deaths in 2050 will be among those aged 70 years and above

- Regions with the highest predicted mortality rates are South Asia, Latin America and the Caribbean

(M. Naghavi *et al. Lancet* https://doi.org/nh9w; 2024).

INDIA: Risk Assessment and Policy Response

- AMR has emerged as a major public health crises in globally. The need is to **Expand** surveillance against drug resistant pathogens by including **Secondary care** centers and smaller hospitals
- India has established Antimicrobial Resistance Surveillance and Research Network **(AMRSN)** and strengthen stewardship programs in Tertiary care hospitals across the country
- Establishment of the **'National Institute of One Health'** at Nagpur and promote multi-institutional 'One Health' approach
- Post COVID-19 pandemic, Several **BSL-3** and **BSL-4** Labs and Genomic surveillance centers have been established across various states

Bio E3 Policy*

Biotechnology for **E**conomy, **E**nvironment and **E**mployment

Strategic/thematic Verticals

- Bio-based Chemical and Enzymes
- Functional Foods and Smart Proteins
- Precision Biotherapeutics
- Climate Resilience Agriculture
- Carbon Capture and its utilization
- Futuristic Marine
- Space Research

*announced by the Hon Prime Minister on Aug 24, 2024

‘Antibiotic resistance increases with air pollution’

HT
Aug 8, 2023

The increasing incidence of antibiotic resistance may be linked to rising air pollution according to the first such in-depth analysis published in The Lancet Planetary Health journal. By Rhythma Kaul

What did the study say?

The authors of the study said their analysis indicated to two major findings

1. Rising air pollution is potentially linked with a higher risk of antibiotic resistance
2. The relationship between the two has strengthened over time, with increases in air pollution levels coinciding with larger increases in antibiotic resistance in more recent years

480,000
premature deaths
were the result of rising antibiotic resistance due to air pollution in 2018

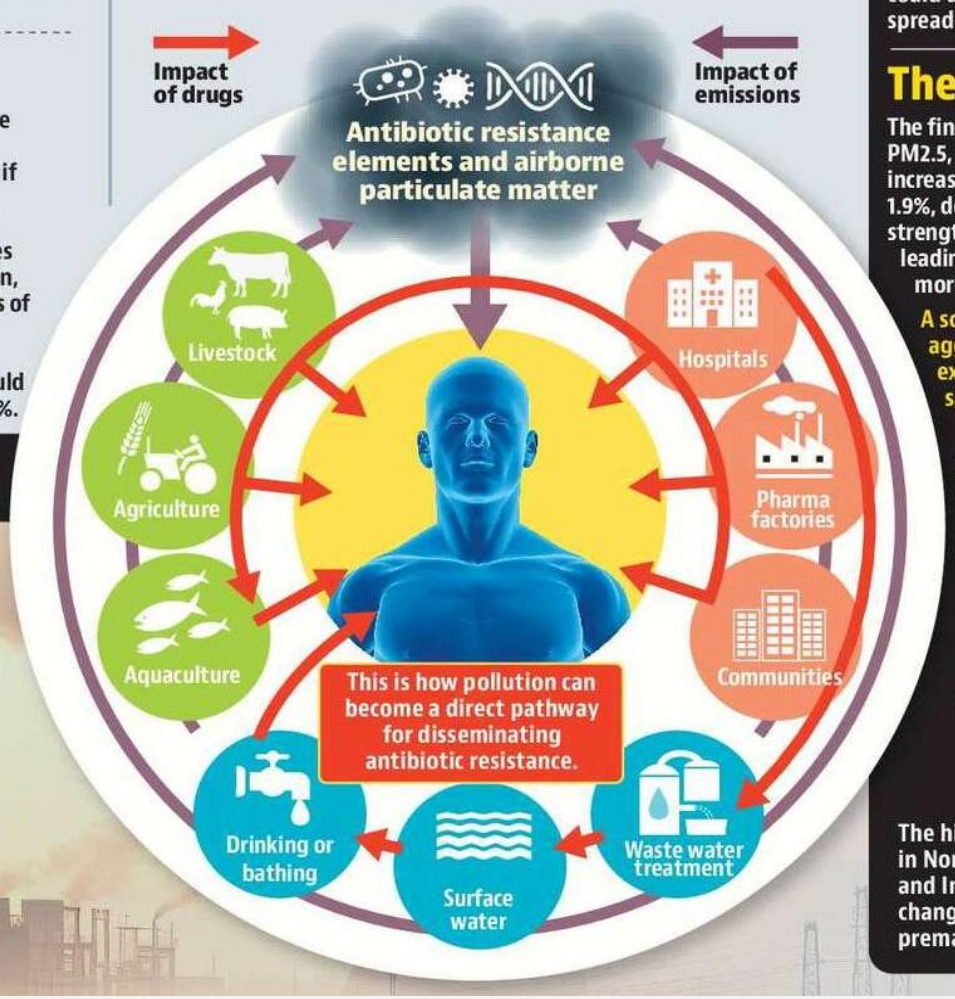
$395bn
additional economic costs incurred because of the phenomenon

The authors’ modelling of possible future scenarios indicates that if there were no changes to current policies on air pollution, by 2050, levels of antibiotic resistance worldwide could increase by 17%.

840,000 deaths every year are likely due to antibiotic resistance by 2050

How does this happen?

Humans are exposed to antibiotic-resistant bacteria and antibiotic-resistance genes via food, the environment (water, soil, and air), or contact with infectious sources, such as animals. For instance, antibiotic-resistant bacteria in hospitals can move to sewage-treatment facilities or ecosystems, and can also be emitted into the atmosphere and be inhaled by humans.



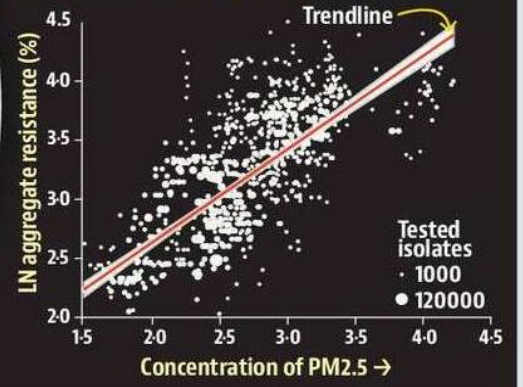
Why the findings are important

Until now, there was limited data on how much influence PM2.5 pollution has on antibiotic resistance. “Antibiotic resistance and air pollution are each in their own right among the greatest threats to global health. Until now, we didn’t have a clear picture of the possible links between the two, but this work suggests the benefits of controlling pollution could be two-fold: not only will it reduce the harmful effects of poor air, it could also play a major role in combatting the rise and spread of antibiotic-resistant bacteria,” researchers said.

The rising correlation

The findings indicate antibiotic resistance increases with PM2.5, with every 1% rise in air pollution linked with increases in antibiotic resistance of between 0.5% and 1.9%, depending on the pathogen. The association has strengthened over time, with changes in PM2.5 levels leading to larger increases in antibiotic resistance in more recent years, the authors point out.

A scatter plot of over 11.5 million samples showing aggregate resistance against PM2.5 concentration exhibits rising instances of resistant bacteria in samples taken from regions with high pollution.

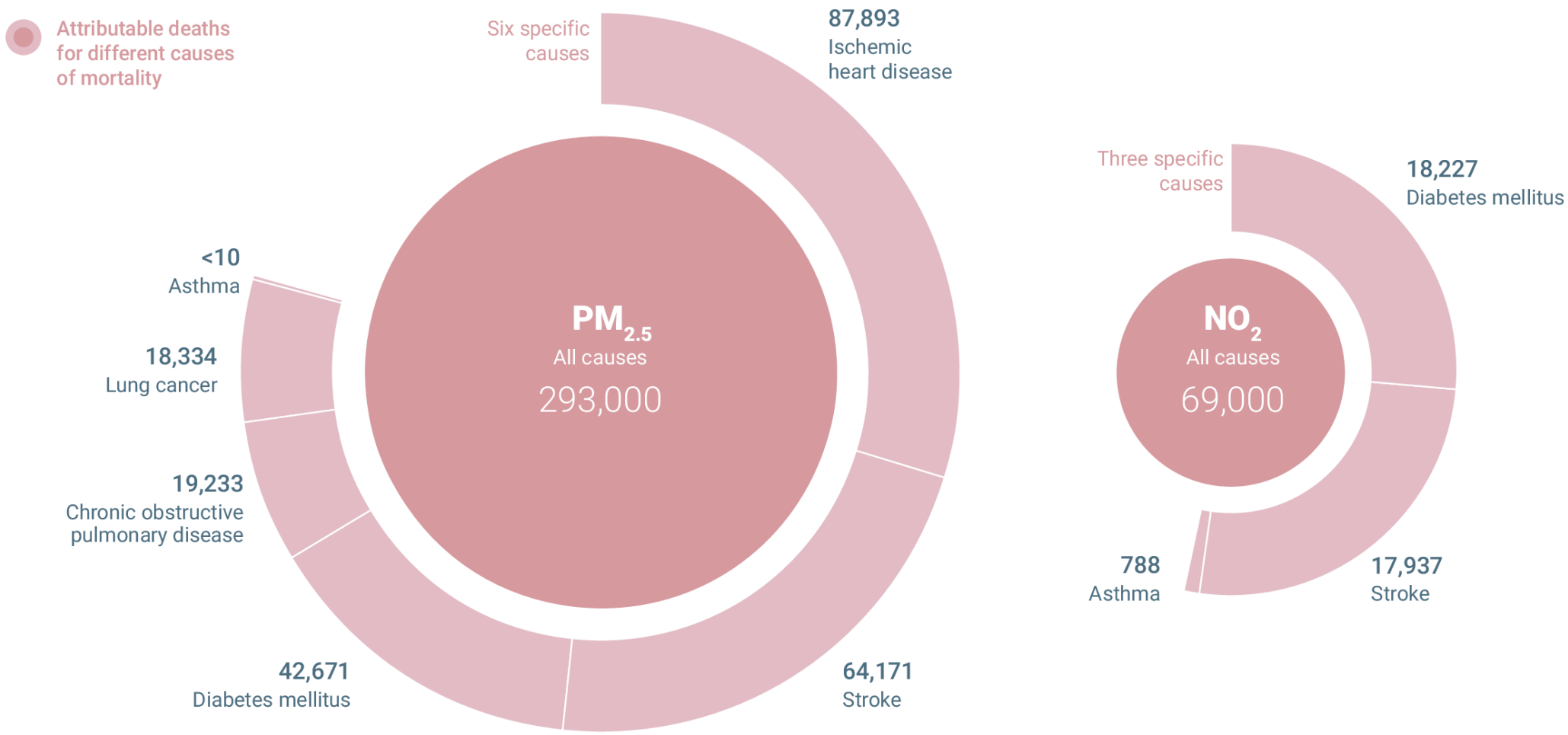


The highest levels of antibiotic resistance are found in North Africa, the Middle East and South Asia. China and India are believed to be the countries where changes in PM2.5 have the greatest impact on premature death toll from antibiotic resistance.

European Environment Agency

Harm to human health from air pollution in Europe:

Mortality due to exposure to PM2.5 and NO2, 2021



- **Greatest harm to human health is from Ischemic heart disease for PM2.5 and Diabetes mellitus for NO2**
- **The good thing is that between 2005 and 2021, the no. of deaths in EU attributable to air pollution fell by 41%**

Monday, September 11, 2023

High levels of particulate air pollution associated with increased breast cancer incidence

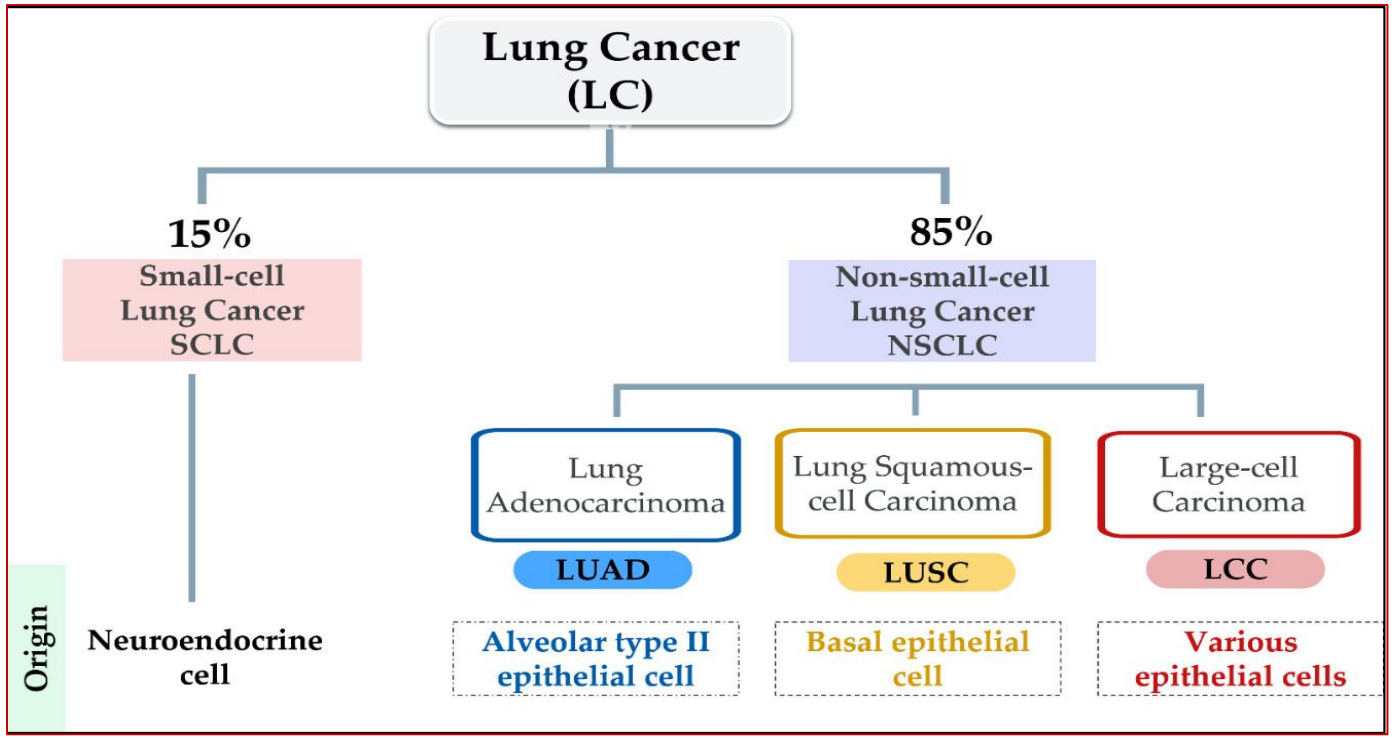
NIH researchers combined historical air quality data with breast cancer data from large U.S. study.

Published in J. Nat Cancer Inst, Sep 2023

- **The study used information from NIH-AARP Diet and Health study that enrolled half a million men and women between 1995-96 in six states.**
- **The women in the cohort were on an average 62 yrs of age, followed for approx. 20 years during which 15,870 breast cancer cases were identified.**

- **Largest increase in B.C. incidence in women living in areas with high PM2.5 near their homes**
- **In general there was an 8% increase in cancer incidence in such people.**
- **Researchers evaluated ER+ and ER- cases separately and found that high PM2.5 was associated with ER positivity, suggesting an underlying biologic pathway of endocrine disruption.**
- **Future work should explore the impact of various types of pollutants in PM2.5 and woman's risk of developing breast cancer including the staging.**

Air Pollution and Lung Cancer



- **Tumor origin of SCLC is poorly differentiated neuroendocrine cell. It is characterized by rapid metastasis, poor prognosis and poor response to therapy.**
- **NSCLC subtypes of cancers are derived from lung epithelia**
- **As per WHO classification: LUAD is the most frequent type, followed by LUSC.**

- Lung cancer is the most common cancer globally
- Besides cigarette smoking, EVPs are on the rise among younger people and non-smokers
- According to Cancer Genome Atlas, sequencing 178 LUSC confirmed the complexity of LC with a mean of 165 genomic rearrangements, 360 exonic mutations and 360 CNVs per tumor
- In smokers, numerous mutations were identified: KRAS, TP53, EGFR, BRAF, STK11 etc
- Adenocarcinoma is more likely to arise in women with a smoking history
- AMR could further impact cancer care, making infections in cancer pts harder to treat

INDIA

Why diabetes is in the air we breathe

G Ananthakrishnan • TNN

Updated 1 day ago

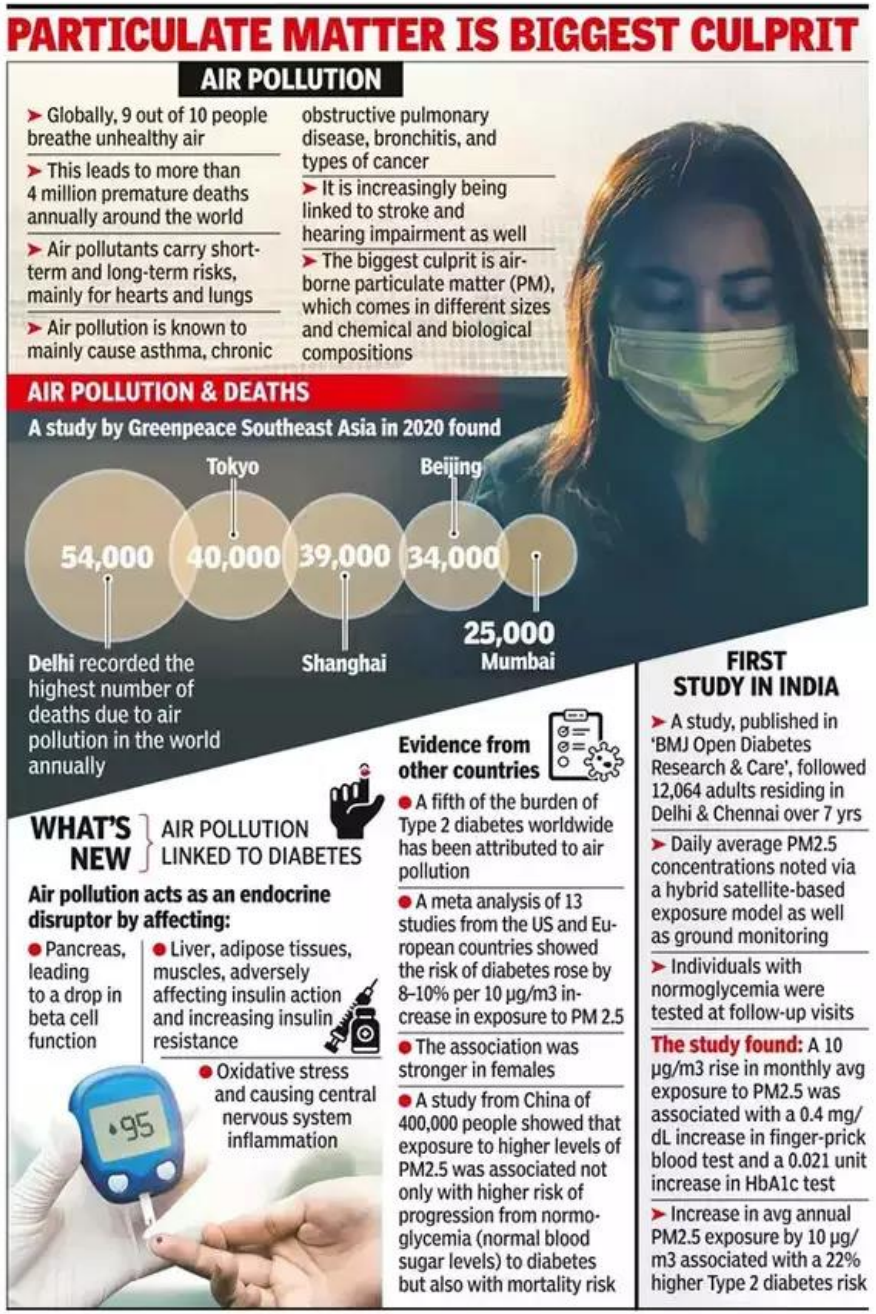
Particulate matter pollution could be triggering insulin resistance. Traffic jams are driving it to new levels. And pedestrians, the cleanest commuters of all, are the hardest hit

New research from Delhi and Chennai is adding to concerns that fine particulate matter air pollution spurred by bad urban planning and mobility policies is increasing the burden of diabetes and needs to be addressed as an urgent public health challenge.

Building on studies in other countries, Siddhartha Mandal, Joel D Schwartz and Viswanathan Mohan reported that there was a 23% higher risk of developing type 2 diabetes for a 10 micrograms per cubic metre change in long-term exposure to fine particulate matter (PM 2.5). It was associated with an increase in fasting blood glucose and HbA1c, a diabetes marker. Their findings were published in the journal *BMJ Open Diabetes Research and Care*.

Breathing polluted Air could increase T2D risk

Study reveals that PM 2.5 is an endocrine disrupter that affects insulin secretion and could also lead to insulin resistance



Mental Health Impacts of Climate Change Among Vulnerable Populations Globally: An Integrative Review

BRADLEY PATRICK WHITE
SUELLEN BREAKEY
MARGARET J. BROWN
JENNY RAND SMITH
AMANDA TARBET
PATRICE K. NICHOLAS
ANA M. VIAMONTE ROS

Annals of Global Health
2023

MGH Inst of Health, Boston

REVIEW

ubiquity press

104 published articles, selected out of 1828 manuscripts

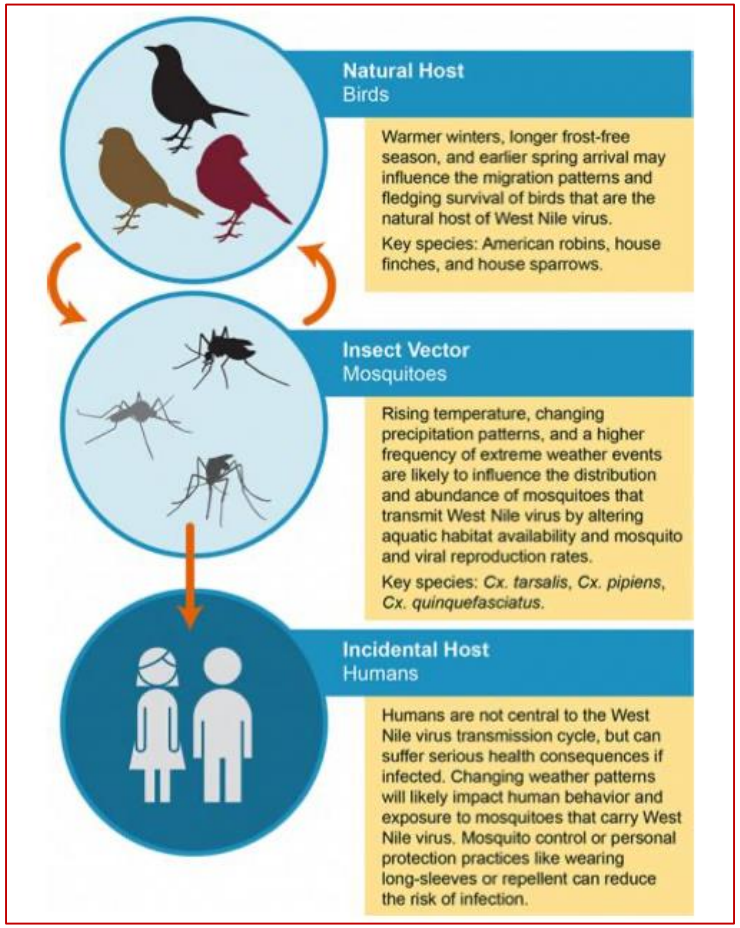
Most prevalent mental health issues:

- Solastalgia
- Suicidality
- Depression
- Anxiety/eco-anxiety
- PTSD
- Substance use
- Insomnia
- Bahavioral disturbance

The Era of Climate Change Medicine

Challenges to Health Care Systems

- **Heat related health impacts:** heat stroke, dehydration, cardiovascular, respiratory and cerebrovascular diseases.
- **Air Quality impacts:** increase in Ozone, changes in PM, changes in allergens and asthma triggers Impact on safe food and drinking water
- **Mental Health impacts** (depression, stress disorders)
- **Increase in zoonoses, food and Vector borne diseases**
- **Water related illnesses** (cholera and other diarrheal diseases)
- **Food Safety and Nutrition**
- **Vulnerable populations:** sensitivity, adaptive capacity



The Intergovernmental Panel on Climate Change's (IPCC)
6th Assessment Report concluded

"climate risks are appearing faster and will become more severe sooner than previously expected, and it will be harder to adapt with increased global heating".

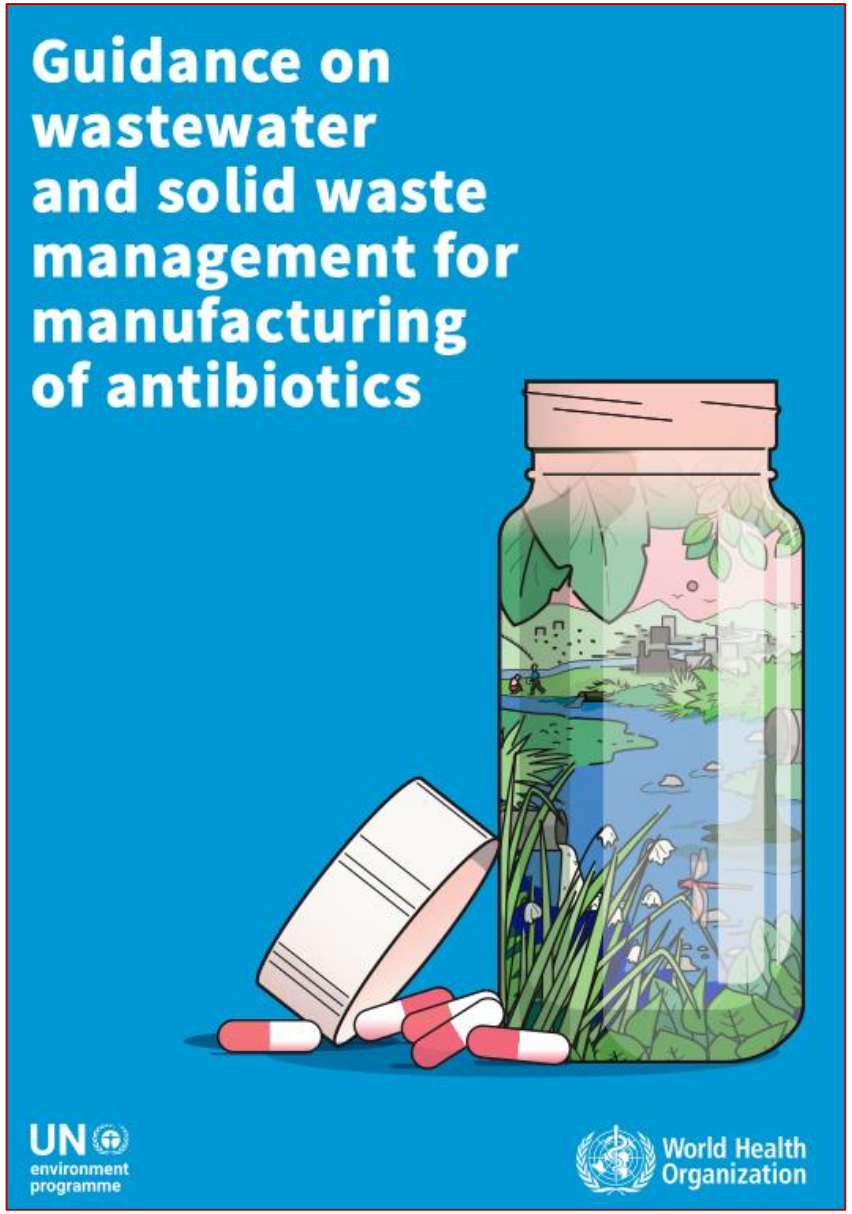
Climate sensitive infectious diseases
HIV/AIDS, Tuberculosis
Mosquito-borne diseases
(malaria, dengue, Yellow fever, Zika and others)

WHO publishes its first-ever guidance document on antibiotic pollution from manufacturing

Sep 3, 2024

- New guidance for wastewater and solid waste management for antibiotic manufacturing.
- Emergence and spread of AMR caused by antibiotic pollution could undermine the effectiveness of antibiotics globally
- Pharmaceutical waste from antibiotic manufacturing could facilitate global emergence of drug-resistant bacteria and threaten human health
- Consumers need to be informed on how to dispose of antibiotics when not being used, either because the course is finished or they expire

Critical role of climate change and environment in the development, transmission and spread of AMR needs to be understood



The range of threat that CC presents to Health is large, diverse and complex

Review article https://doi.org/10.1038/s41591-023-02438-w

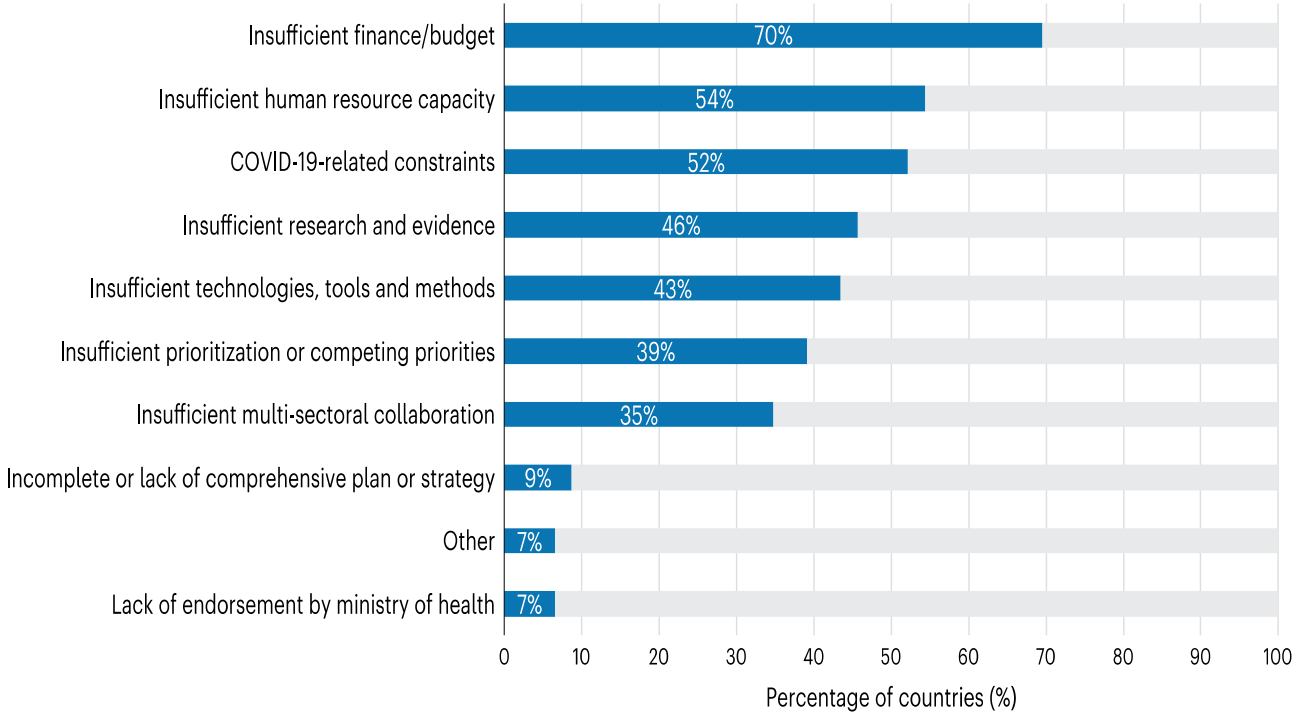


Fig. 3 | Main barriers to implementation of national health and climate change plans. Data from the WHO Climate and Health Country Survey[10]; 46 country respondents, multiple responses possible.

A goal driven approach is needed to

- Promote actions that both reduce carbon emissions and improve health
- Build better, more resilient and environmentally sustainable health systems
- Implement public health measures to protect from the range of climate risks to health and accelerate the health response to climate change

More importantly:
Science leaders and advocates must change the narrative, *'from the threat of climate crises to a healthy future through climate action'*

Emerging Therapies for Tackling AMR

Antimicrobial resistance: a concise update

Charlotte S Ho, Carlos T H Wong, Thet Tun Aung, Rajamani Lakshminarayanan, Jodhbir S Mehta, Saaeha Rauz, Alan McNally, Balint Kintses, Sharon J Peacock, Cesar de la Fuente-Nunez, Robert E W Hancock, Darren S J Ting

Review analysis by multiple authors (across several countries)

Lancet Microbe 2024

World Health Organization

2024
168 page Report

Estimating the Impact of Vaccines in reducing antimicrobial resistance and antibiotic use

Report focusses on 24 pathogens and 44 vaccines, and aims to quantify the potential of these vaccines to reduce AMR, its effects and antibiotic use

OPEN ACCESS

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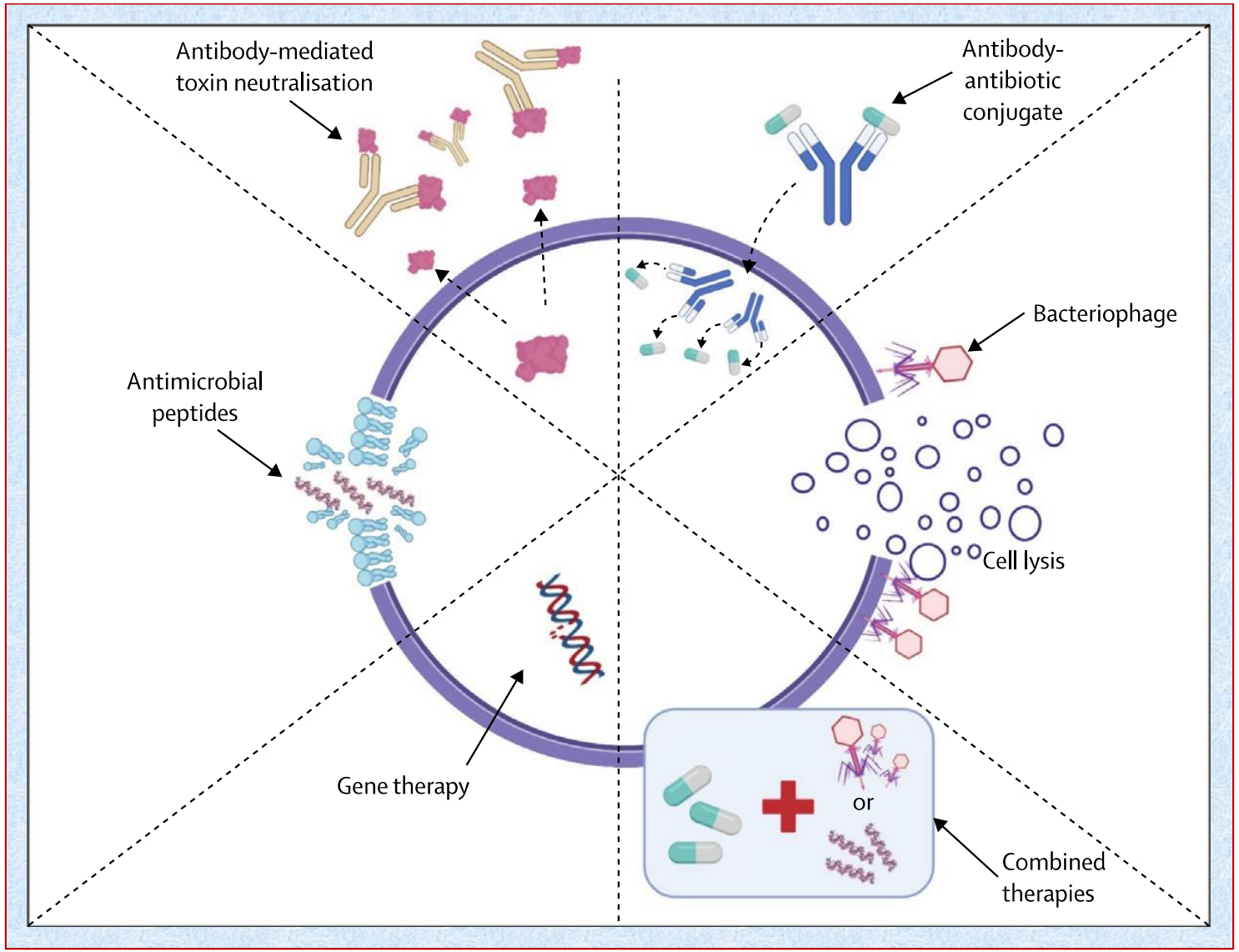
J. Pharm. Pharm. Sci 27:12721,
doi: 10.3389/jpps.2024.12721

Community pharmacists as antimicrobial resistance stewards: a narrative review on their contributions and challenges in low- and middle-income countries

Rosy Raju[1], Sunitha Chandrashekar Srinivas[2], Srikanth Malavalli Siddalingegowda[1]*, Raj Vaidya[3], Manjiri Gharat[4] and T. M. Pramod Kumar[1]

[1]JSS College of Pharmacy, JSS Academy of Higher Education and Research, Mysore, India, [2]Karuna Trust, Bangalore, India, [3]Hindu Pharmacy, Panaji, Goa, India, [4]Indian Pharmaceutical Association, Kolkata, India



Policy for Tackling Antimicrobial Resistance

❖ **Lancet recently published a series (Sep 2024) on AMR and estimated that 10% of global AMR can be averted with existing interventions such as improving water, sanitation and hygiene (WASH), controlling infection, conducting vaccination in LMICs and taking other preventive measures in health-care facilities**

- **First:** There is increased focus on AMR and CC in high income nations, while the **largest burden is in LMICs,** which have substantially poor capacity to manage life threatening drug-resistant infections

- **Second:** Most AMR initiatives are focused on hospitals and tertiary institutions, efforts to curb the widespread antimicrobial use at the primary care level is scarce. **More than 85% antibiotic use is in the community.**
- People seek care from a variety of poorly regulated health care providers – pharmacists, informal providers, traditional healers and others

Five Blind Spots

- **Third:** Big dispensers of antibiotics include pharmacies and informal providers who use antibiotics for empirical management of a wide range of conditions. People use them because of **low cost, established trust and easy accessibility**

- **Fourth:** Intense focus on curbing antibiotic abuse in humans, while it is **substantially higher in livestock animals** – multi-billion dollar meat industry.
- Need global data on the two intertwined challenges: CC & AMR

- **Fifth:** Current focus of AMR research is on developing new antibiotics, while neglecting the need for diagnostics.
- Need is to incorporate **POC tests into clinical decision-making** w/o compromising health outcomes

'Understanding how antimicrobial resistance evolved alongside climate change could provide insights to policy and effective Interventions'

'Urgently needed is interdisciplinary research, political advocacy and sustained global effort'