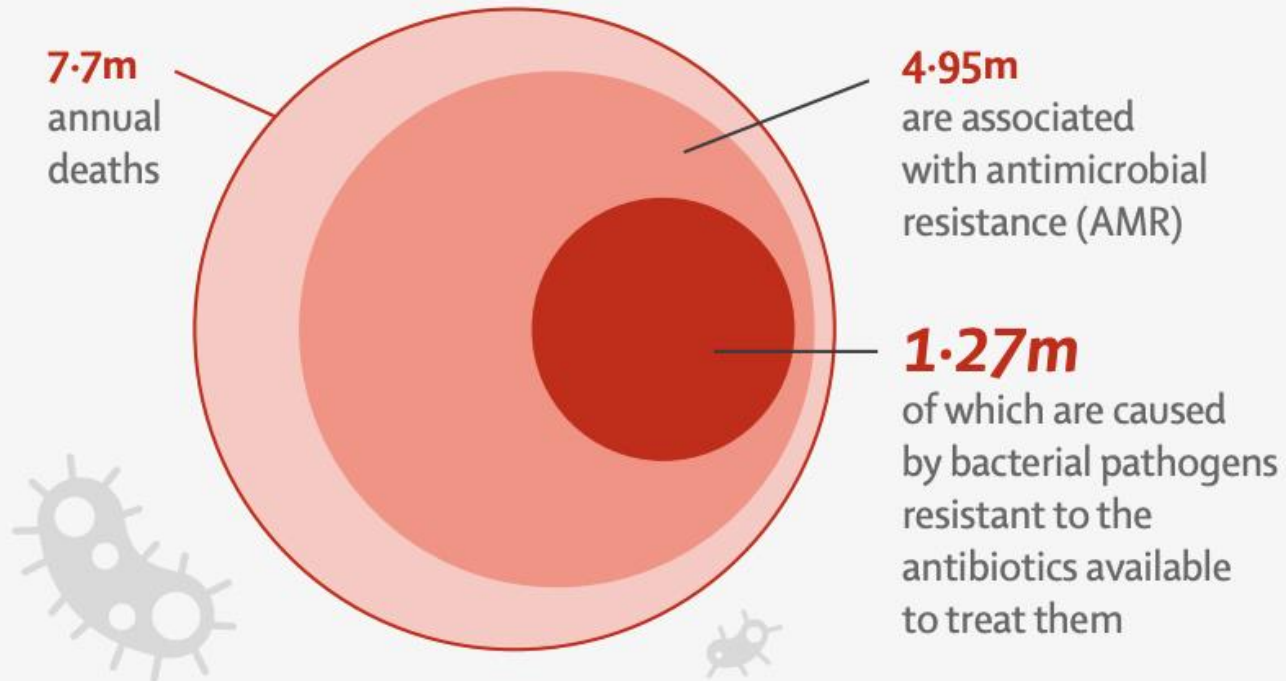# The overall impact of currently known AMR interventions

Joseph Lewnard, PhD
**University of California, Berkeley**

Antimicrobial resistance: an enormous, growing, and unevenly distributed threat to global health

Each year, an estimated 7·7 million deaths are associated with bacterial infections

7·7m
annual
deaths

4·95m
are associated
with antimicrobial
resistance (AMR)

1·27m
of which are caused
by bacterial pathogens
resistant to the
antibiotics available
to treat them

Rising AMR has been documented over the past two decades.
Projections from high-income countries predict resistance to third-line antibiotics—the last-resort drugs—could be 2·1 times higher in 2035 compared to 2005

2·1 times higher

2005

2035
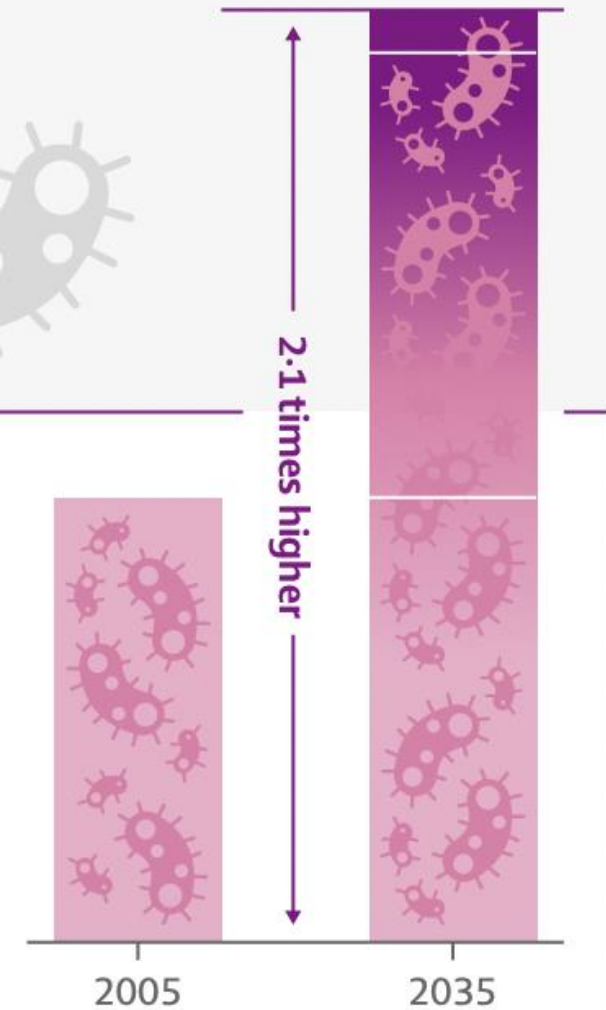
Improving access to effective antibiotics and addressing AMR are critical to achieving global goals for child survival and healthy aging

Existing interventions can have a significant impact in LMICs

Findings of the *Lancet* AMR Series indicate that reducing global AMR-associated deaths by 10% by the year 2030 is achievable with existing interventions. These findings provide robust evidence to guide countries in prioritising public health interventions, offering the greatest potential to mitigate AMR burden. For example:

Aligning IPC standards

–337 000 *deaths*

Aligning infection prevention and control (IPC) standards in LMIC healthcare settings with those of HICs could prevent up to 337 000 AMR-associated deaths annually

Access to WASH services

–247 800

Achieving universal access to water, sanitation, and hygiene (WASH) services could prevent up to 247 800 AMR-associated deaths annually

High-priority paediatric vaccines

–181 500

Achieving universal coverage of high-priority paediatric vaccines—such as those against rotavirus, pneumococci, and RSV—could prevent up to 181 500 AMR-associated deaths annually

LMICs=low-income and middle-income countries; HICs=high-income countries; Image credits: Tima Miroshnichenko; PICHA Stock; ER Productions Limited

THE LANCET
May, 2024   www.thelancet.com

Sustainable Access to Effective Antibiotics
An Executive Summary for *The Lancet's* Series

"Preserving antibiotic effectiveness, a global public good, requires political will, targets, accountability frameworks, and funding."

A Series by *The Lancet*

Burden of bacterial antimicrobial resistance in low-income and middle-income countries avertible by existing interventions: an evidence review and modelling analysis

Joseph A Lewnard, Esmita Charani, Alec Gleason, Li Yang Hsu, Wasif Ali Khan, Abhilasha Karkey, Clare I R Chandler, Tapfumanei Mashe, Ejaz Ahmed Khan, Andre N H Bulabula, Pilar Donado-Godoy, Ramanan Laxminarayan

Lancet 2024

Infection prevention in healthcare settings

A. Primary scenario

Reduction with 10% increase in HH compliance: 4.6% (3.0–6.2%)

Reduction with 10% increase in HH compliance: 9.7% (3.0–16.2%)

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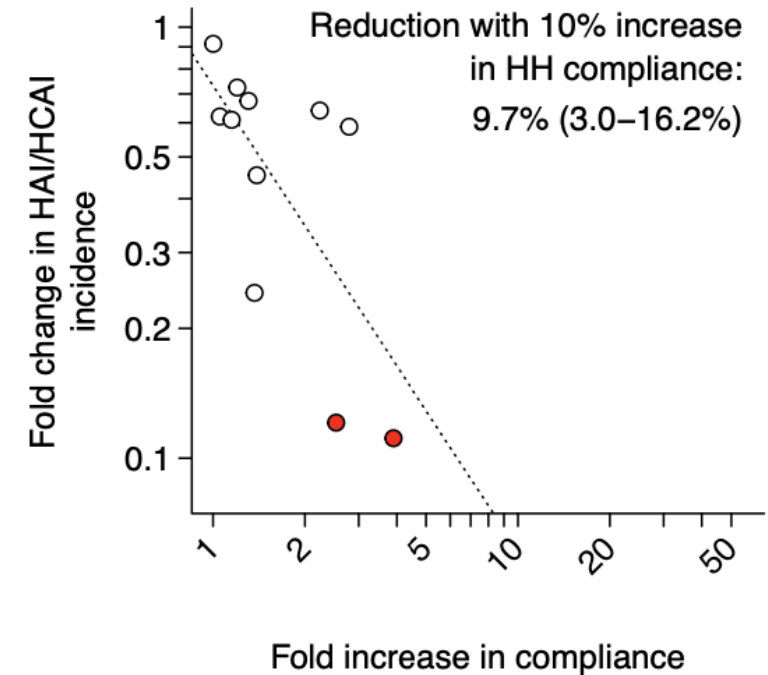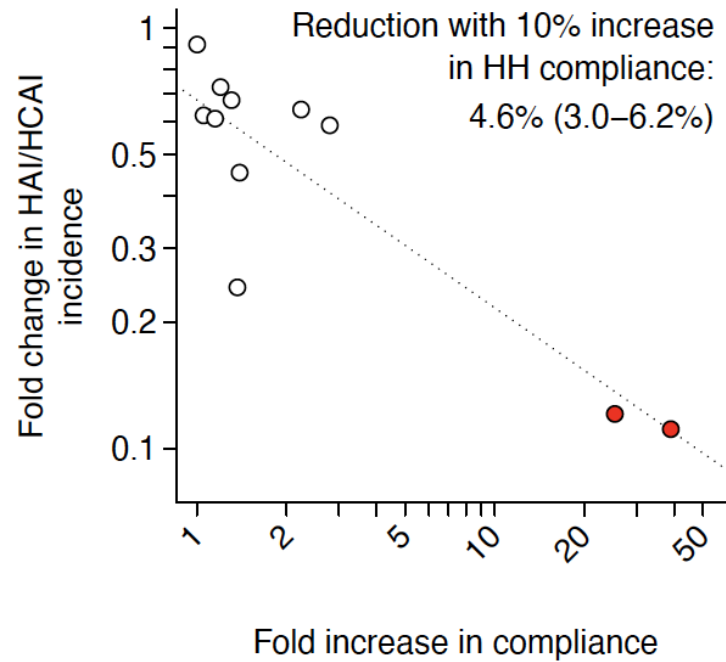
Infection prevention in healthcare settings
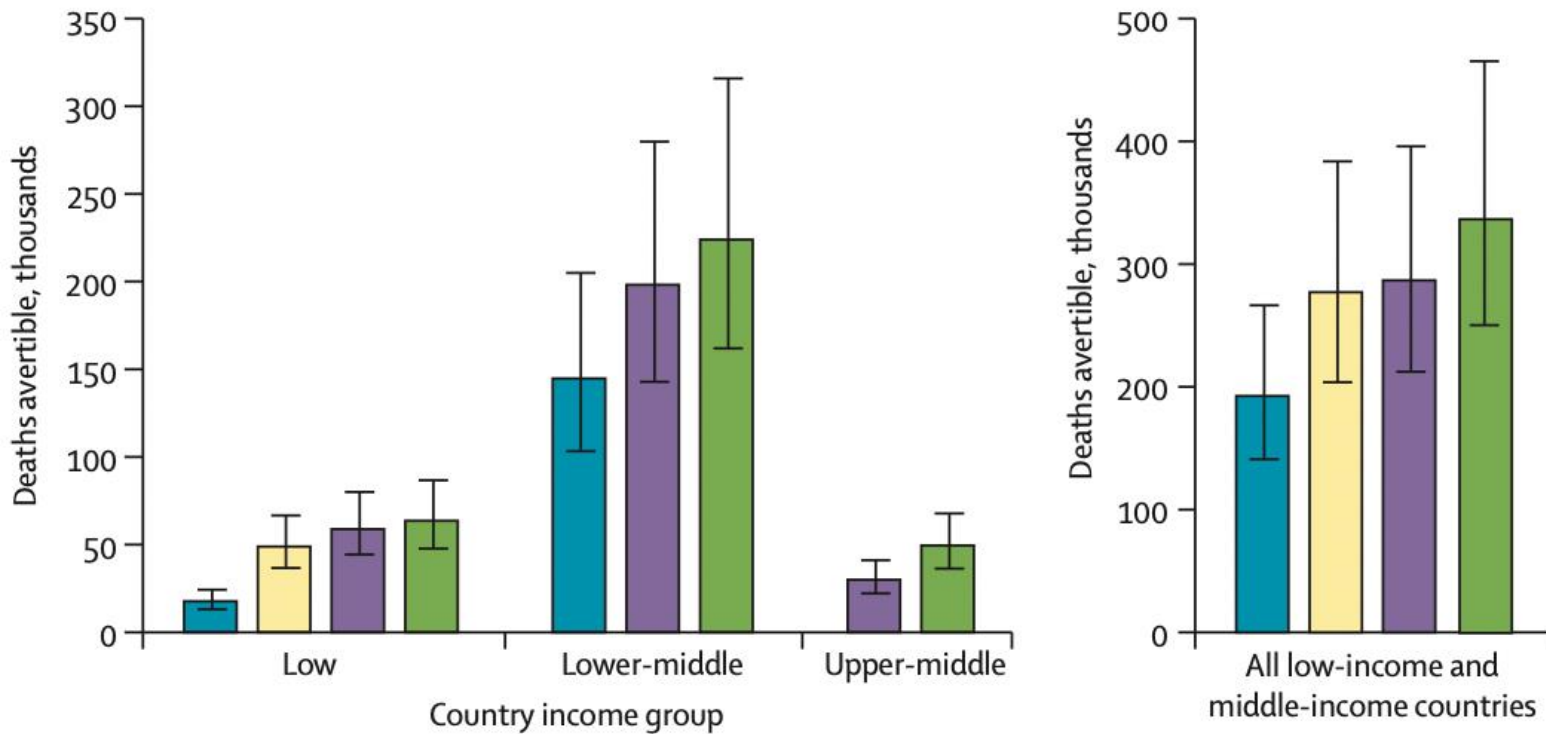
	Deaths, thousands (95% CI)	Proportion (95% CI)
Matching highest level across all countries		
Low income	63·6 (47·7–86·7)	11·5% (8·4–16·1)
Lower-middle income	224·0 (161·9–315·9)	9·1% (6·3–13·4)
Upper-middle income	49·5 (36·3–67·8)	3·8% (2·6–5·6)
All low-income and middle-income countries	337·0 (250·2–465·2)	7·8% (5·6–11·0)

Legend:
- Matching highest level within income group
- Matching highest level of next income group
- Matching highest level across low-income and middle-income countries
- Matching highest level across all countries
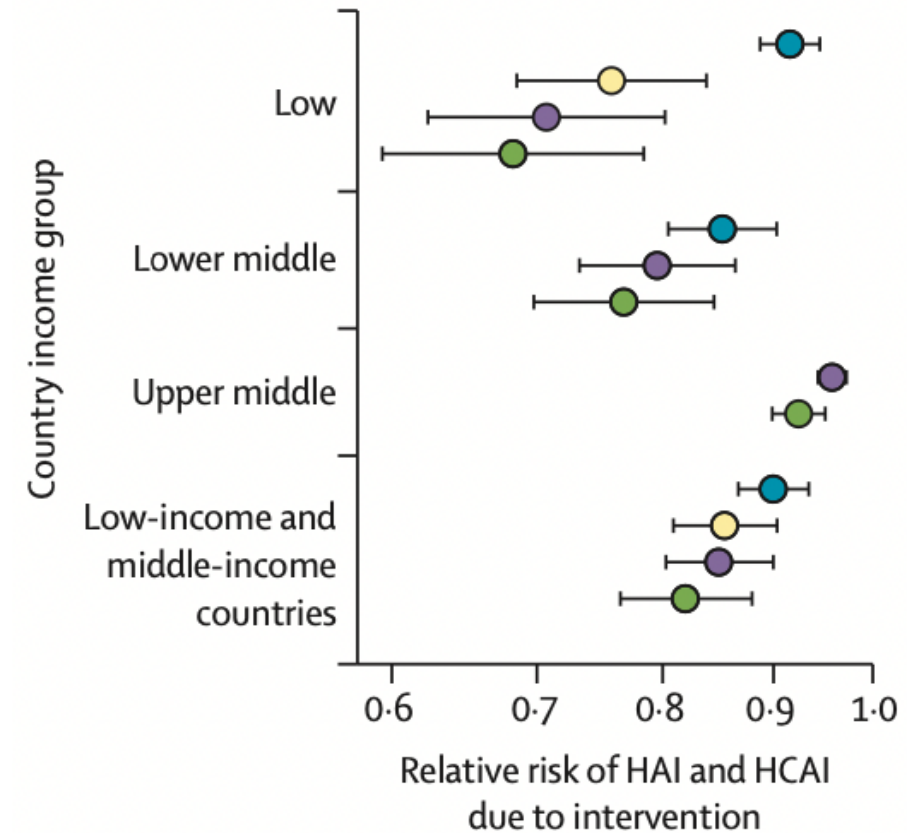
Water, sanitation, and hygiene in the community

Legend:
- Water and sanitation (diarrhoea deaths)
- All WASH (diarrhoea deaths)
- Handwashing (other deaths)
- All WASH (all deaths)
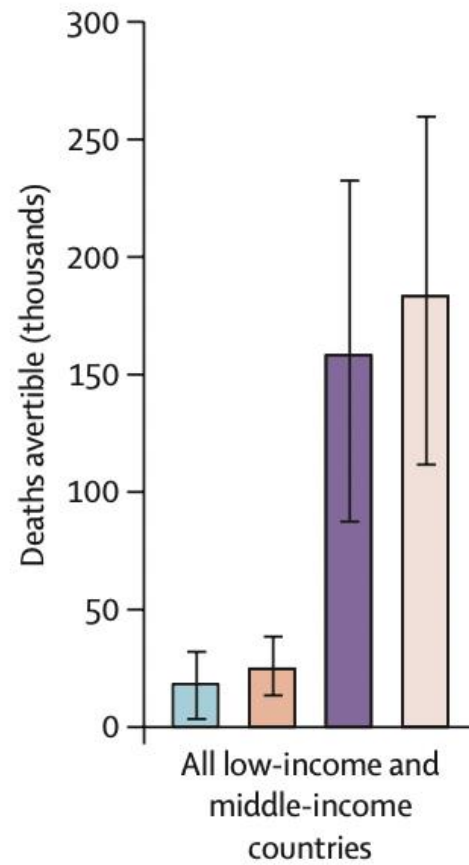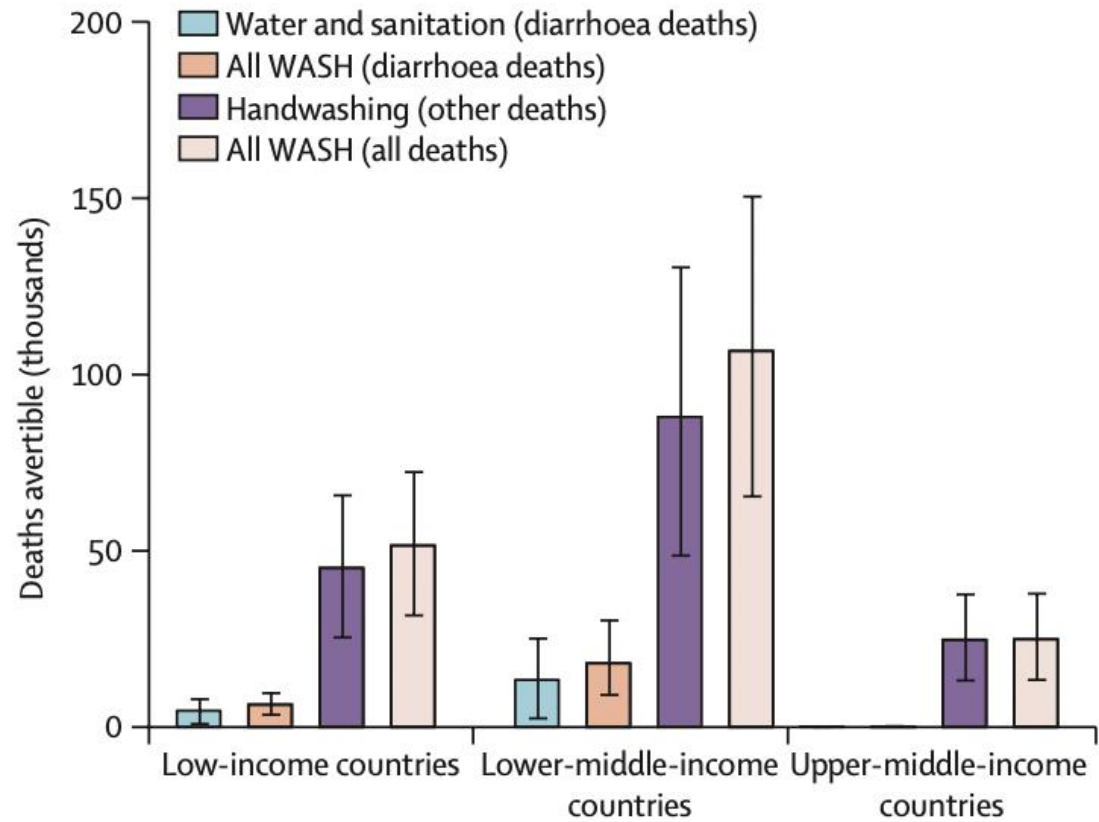
	Prevalence of WASH minimum risk exposure counterfactual in 2019*	Association between WASH counterfactual and outcome (against lowest level of exposure)
Diarrhoea		
Safely managed drinking water	37·9% (27·1–49·9)	0·48 (0·26–0·87), p=0·017[4]
Basic sanitation connected to sewer	29·7% (23·9–36·1)	0·53 (0·30–0·93), p=0·030[4]
Handwashing with soap after potential faecal contact	26·4% (23·4–29·6)	0·7 (0·64–0·76), p<0·0001[4]
Acute respiratory infections		
Handwashing with soap after potential faecal contact	26·4% (23·4–29·6)	0·83 (0·76–0·90), p<0·0001[7]

Data are prevalence (95% CI) or relative risk (95% CI), p value. WASH=drinking water, sanitation, and hygiene. *Aggregated across included countries.

Table 1: Counterfactual and outcome association for diarrhoea and acute respiratory infections

Deaths, thousands	
All low-income and middle-income countries	
Water/sanitation (diarrhoea)	18·3 (3·4–32·1)
All WASH (diarrhoea)	24·8 (13·5–38·5)
Handwashing (other)	158·2 (87·4–232·5)
All WASH (all)	183·3 (111·6–259·7)

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Wolf et al., *Lancet* 2023

Vaccines against bacterial pathogens

Low-income countries

- Pneumococcal conjugate (10/13 valent)
- Hib conjugate
- Typhoid conjugate
- GBS conjugate (6 valent)
- Total

Lower-middle-income countries

Upper-middle-income countries

All low-income and middle-income countries

	Deaths, 1000s (95% CI)	DALYs, 1000s (95% CI)	Total (95% CI)	<5 years (95% CI)
All low-income and middle-income countries				
PCV	29·4 (22·0–36·1)	2578 (1942–3179)	0·7% (0·5–0·9)	2·8% (2·1–3·5)
Hib	0·9 (0·5–1·2)	78 (47–107)	0·0% (0·0–0·0)	0·1% (0·1–0·1)
TCV	28·7 (20·0–40·1)	2146 (1454–3051)	0·7% (0·4–1·0)	2·7% (1·9–3·9)
GBS	37·0 (20·0–48·1)	3309 (1776–4297)	0·9% (0·5–1·2)	3·5% (1·9–4·7)
Total	95·4 (74·9–113·5)	8071 (6293–9580)	2·2% (1·7–2·7)	9·1% (7·0–11·1)

Mitigating AMR through reduced antibiotic use

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Annual drug consumption (relative to global mean)

A. *S. pneumoniae* and penicillins
B. *S. pneumoniae* and macrolides
C. *E. coli* and fluoroquinolones
D. *E. coli* and quinolones
E. *H. pylori* and macrolides
F. *H. pylori* and quinolones
G. *S. pyogenes* and macrolides

1. Primary input parameter
2. Lower bound input parameter
3. Upper bound input parameter
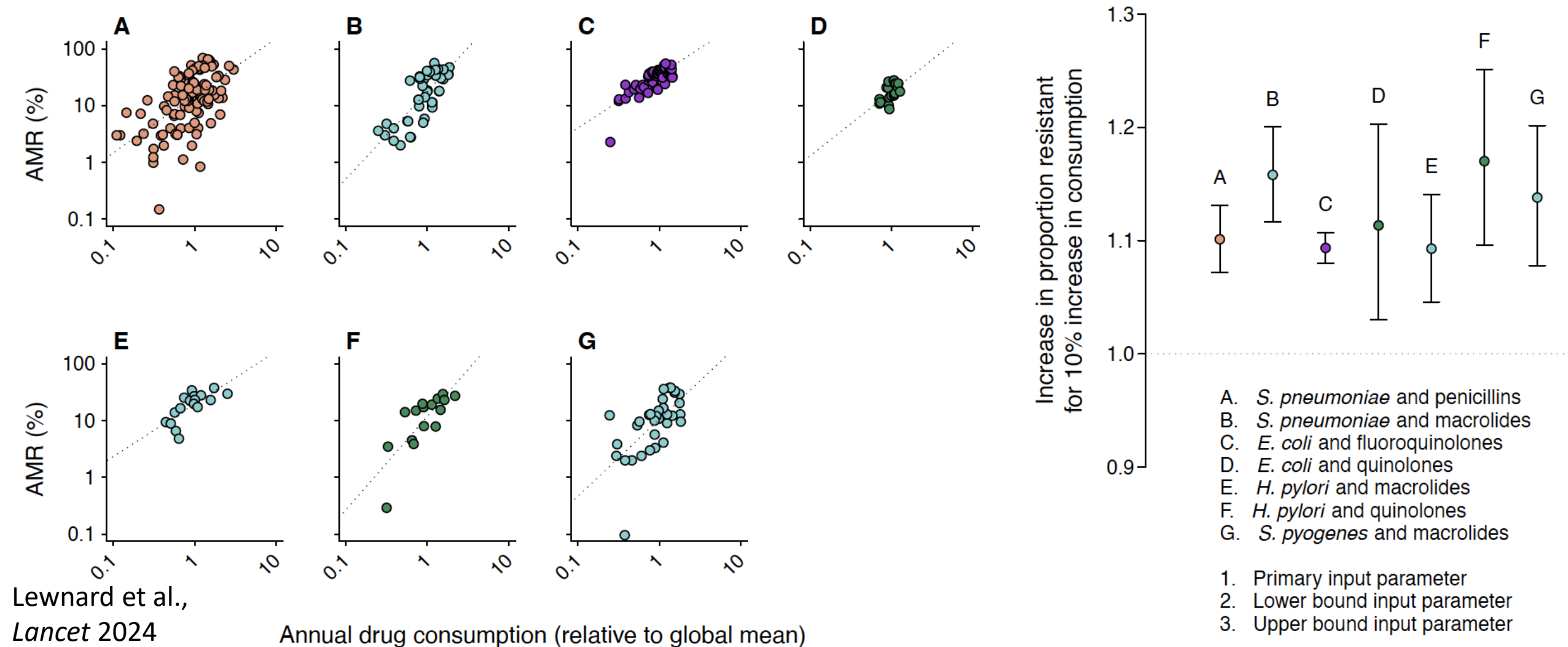
Total achievable effects (WASH and vaccines)

	DDD avertible by intervention			Deaths avertible by intervention	
	Total, millions (95% CI)	Proportion in children <5 years (95% CI)		Total, thousands (95% CI)	Proportion (95% CI)
WASH interventions					
Water and sanitation (diarrhoea)	562·6 (105·0–823·2)	5·2% (1·0–7·6)		47·7 (9·0–73·3)	1·1% (0·2–1·7)
All WASH (diarrhoea)	799·8 (478·8–985·3)	7·4% (4·4–9·1)		66·8 (39·3–89·1)	1·5% (0·9–2·1)
Handwashing (other)	451·7 (258·5–631·2)	4·2% (2·4–5·8)		181·7 (100·9–265·9)	4·2% (2·3–6·3)
All WASH (all)	1243·2 (875·2–1518·4)	11·5% (8·1–14·0)		247·8 (160·0–337·8)	5·7% (3·7–8·0)
Total vaccines achievable					
Pneumococcal conjugate	233·2 (0·0–479·8)	2·2% (0·0–4·4)		40·4 (30·6–49·9)	0·9% (0·7–1·2)
Hib conjugate	38·5 (10·4–66·9)	0·4% (0·1–0·6)		3·3 (2·4–4·2)	0·1% (0·1–0·1)
RSV	104·5 (7·0–195·0)	1·0% (0·1–1·8)		4·6 (2·7–6·4)	0·1% (0·1–0·2)
Seasonal influenza	1014·7 (803·3–1219·7)	9·4% (7·4–11·3)		54·6 (39·7–66·0)	1·3% (0·9–1·6)
Oral rotavirus	239·0 (81·8–377·1)	2·2% (0·8–3·5)		13·2 (9·1–17·2)	0·3% (0·2–0·4)
RTS,S	14·9 (7·9–19·8)	0·1% (0·1–0·2)		0·8 (0·6–1·0)	··
Typhoid conjugate	··	··		28·7 (20·0–40·1)	0·7% (0·4–1·0)
GBS conjugate	··	··		37·0 (20·0–48·1)	0·9% (0·5–1·2)
Total	1637·1 (1279·5–2004·8)	15·1% (11·8–18·5)		181·5 (153·4–206·8)	4·2% (3·4–5·1)

Lewnard et al., *Lancet* 2024

Ensuring progress on sustainable access to effective antibiotics at the 2024 UN General Assembly: a target-based approach

Marc Mendelson, Joseph A Lewnard, Mike Sharland, Aislinn Cook, Koen B Pouwels, Yewande Alimi, Mirfin Mpundu, Evelyn Wesangula, Jeffrey Scott Weese, John-Arne Røttingen, Ramanan Laxminarayan
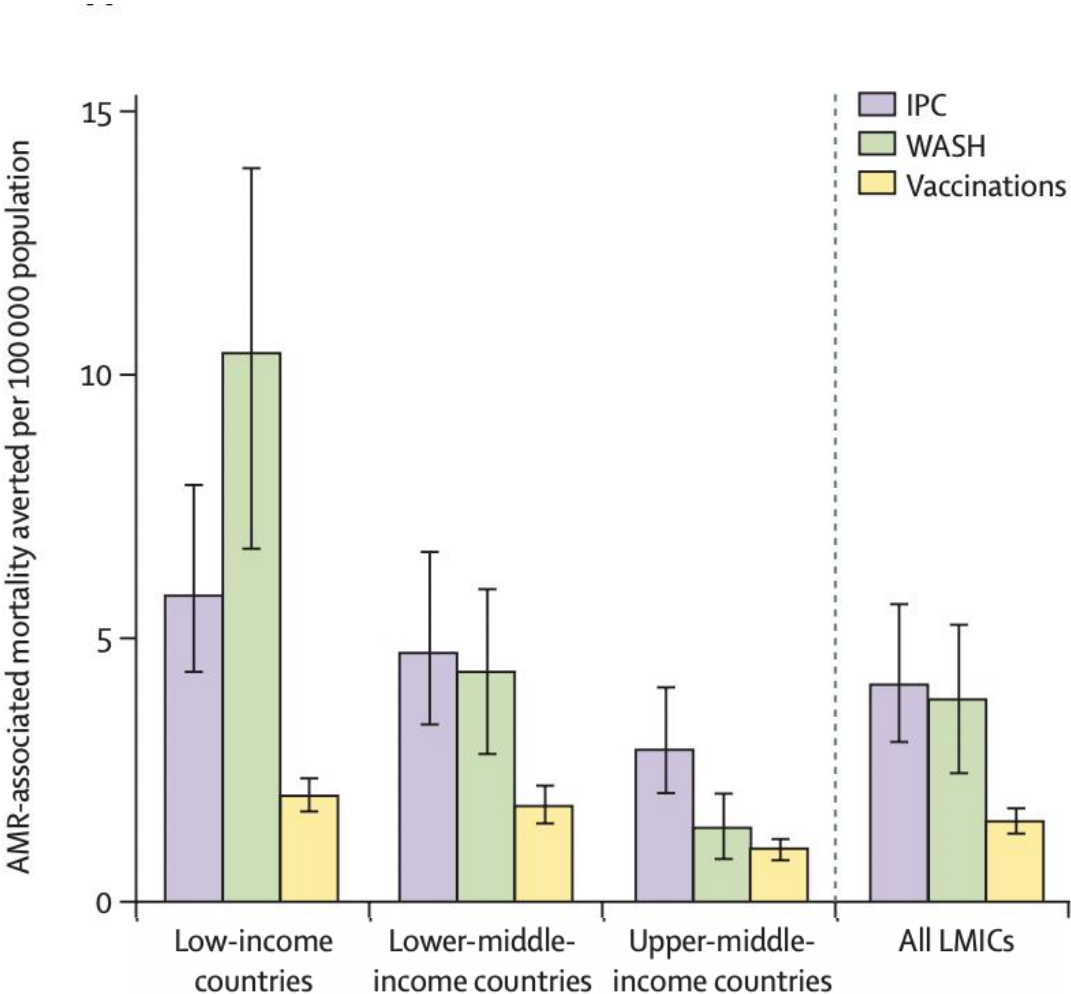
	Mortality averted (per 100 000 population)	Proportion of AMR mortality (%)	DALY losses averted (millions)
Increasing IPC compliance by 20%			
Low-income	5·8 (4·3–7·9)	7·0 (5·1–9·8)	2·9 (2·2–3·9)
Lower-middle-income	4·7 (3·3–6·6)	6·3 (4·3–9·3)	7·4 (5·4–10·3)
Upper-middle-income	2·9 (2·0–4·1)	5·5 (3·7–8·3)	1·9 (1·4–2·7)
All LMICs	4·1 (3·0–5·6)	6·2 (4·4–8·6)	11·7 (8·8–16·0)
Achieving universal WASH access			
Low-income	10·4 (6·7–13·9)	12·6 (7·8–17·4)	6·1 (4·1–8·2)
Lower-middle-income	4·3 (2·8–5·9)	5·8 (3·7–8·3)	8·9 (5·8–12·0)
Upper-middle-income	1·4 (0·8–2·0)	2·6 (1·4–4·1)	1·0 (0·6–1·4)
All LMICs	3·8 (2·4–5·2)	5·7 (3·5–7·9)	14·9 (9·8–20·1)
Achieving universal coverage of select paediatric vaccines			
Low-income	2·0 (1·7–2·3)	2·4 (1·9–3·0)	1·4 (1·2–1·6)
Lower-middle-income	1·8 (1·5–2·2)	2·4 (1·9–3·1)	4·9 (4·0–6·1)
Upper-middle-income	1·0 (0·8–1·2)	1·9 (1·4–2·5)	0·9 (0·8–1·1)
All LMICs	1·5 (1·3–1·8)	2·3 (1·9–2·7)	7·0 (5·9–8·3)
All interventions (combined impact)			
Low-income	18·3 (14·7–21·4)	22·1 (16·8–27·7)	10·5 (8·4–12·3)
Lower-middle-income	10·9 (9·2–12·7)	14·7 (11·4–18·6)	21·4 (18·1–24·8)
Upper-middle-income	5·3 (4·4–6·2)	10·1 (7·6–13·2)	3·9 (3·3–4·4)
All LMICs	9·5 (8·0–10·9)	14·2 (11·4–17·2)	33·8 (28·6–39·0)