Economic Effects of Environmental Exposure to AMR

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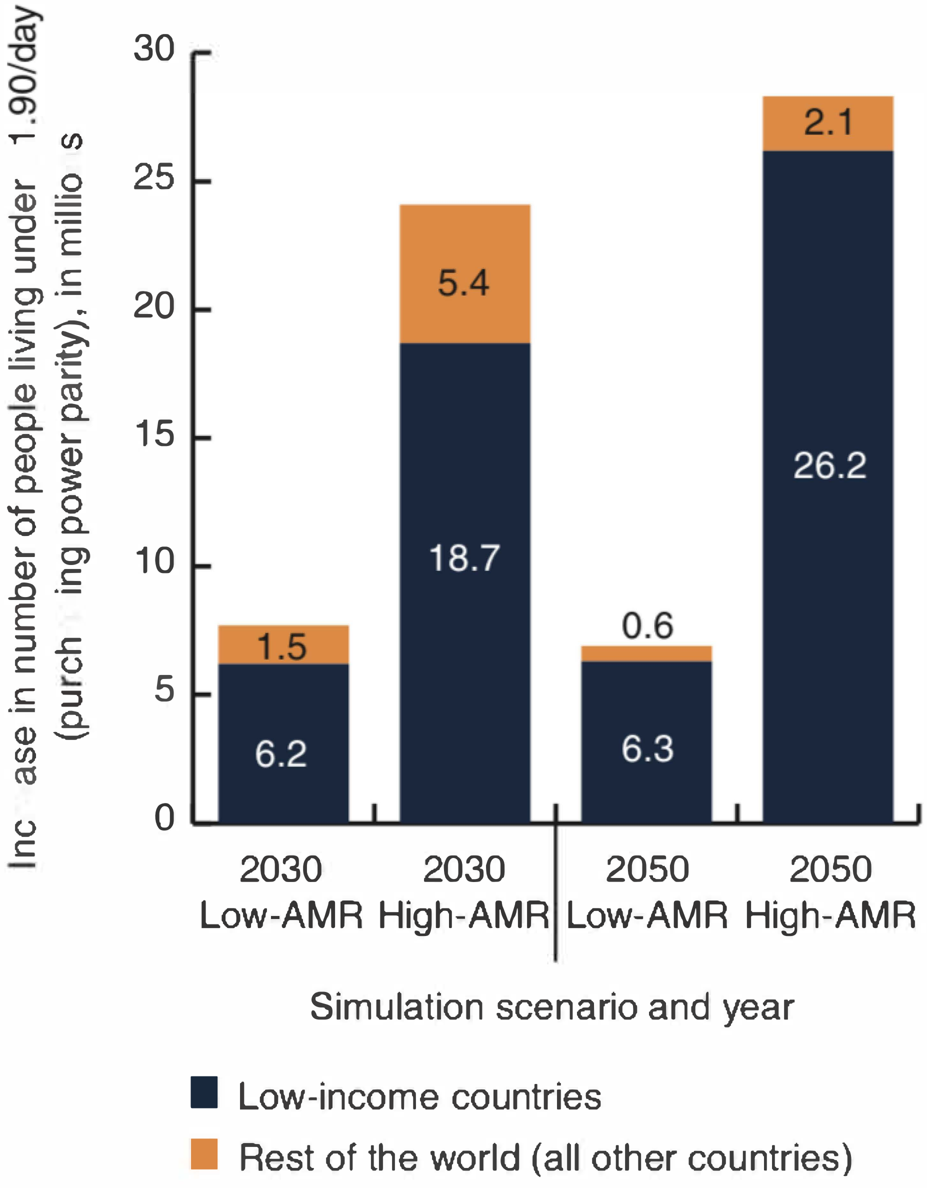
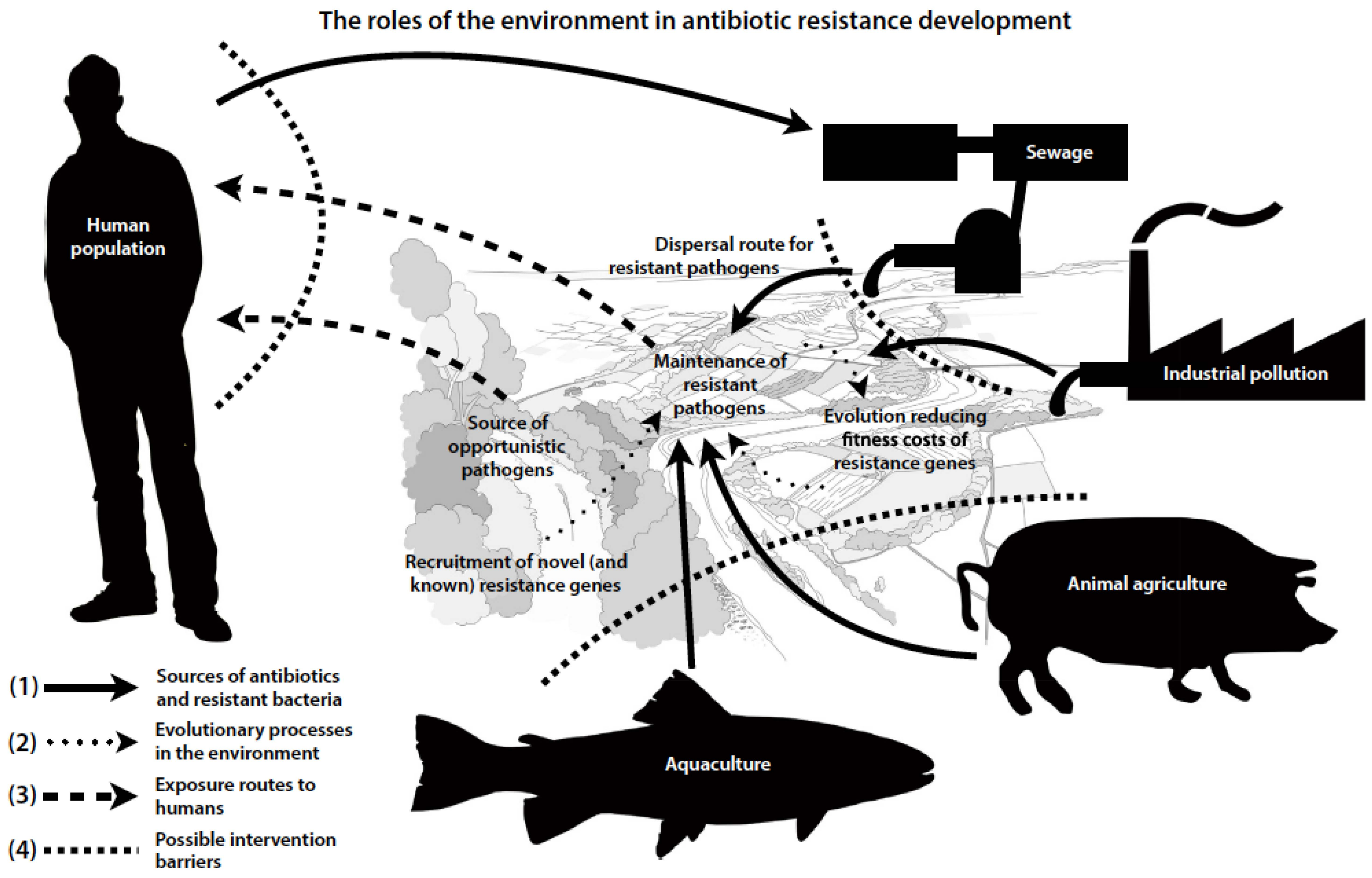
Additional people falling into extreme poverty: nearly 8 million by 2030 in the low-AMR case; more then 28 million by 2050 in the high-AMR case



Source: Simulation results and author's calculations.



The roles of the environment in antibiotic resistance development
Human population
Sewage
Industrial pollution
Dispersal route for resistant pathogens
Maintenance of resistant pathogens
Source of opportunistic pathogens
Evolution reducing fitness costs of resistance genes
Recruitment of novel (and known) resistance genes
Animal agriculture
Aquaculture
(1) Sources of antibiotics and resistant bacteria
(2) Evolutionary processes in the environment
(3) Exposure routes to humans
(4) Possible intervention barriers

Pathways of impact

- Via human health
  - Drug resistant infections
  - Long term effects of antibiotic exposure
- Via animal health

Benefit-cost of interventions – open questions

- Should we focus on measures primarily protecting the environment from exposure to selective agents, resistant bacteria and genes, or measures that protect humans from resistant bacteria and resistance determinants of environmental origin?
- Does it make economic sense to focus at the regional or national level or focus on certain regions of the world, even if distant?
- Should we prioritize investments in waste management in certain sectors, such as clinical or pharmaceutical facilities over others?
- How do investments in behavior change compare against investments in technological interventions?

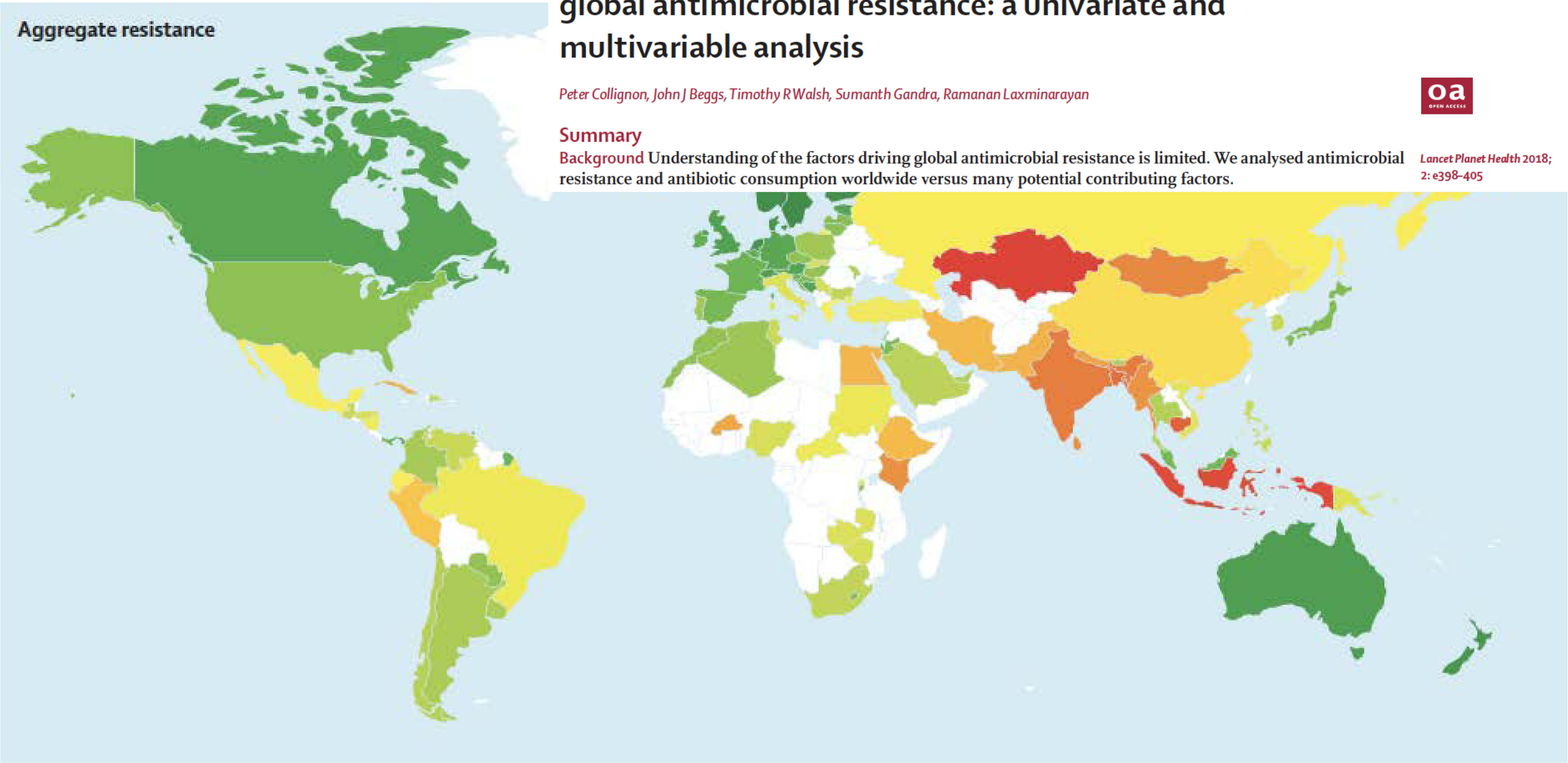
Anthropological and socioeconomic factors contributing to global antimicrobial resistance: a univariate and multivariable analysis

Peter Collignon, John J Beggs, Timothy R Walsh, Sumanth Gandra, Ramanan Laxminarayan

Lancet Planet Health 2018; 2: e398–405

Summary

Background Understanding of the factors driving global antimicrobial resistance is limited. We analysed antimicrobial resistance and antibiotic consumption worldwide versus many potential contributing factors.



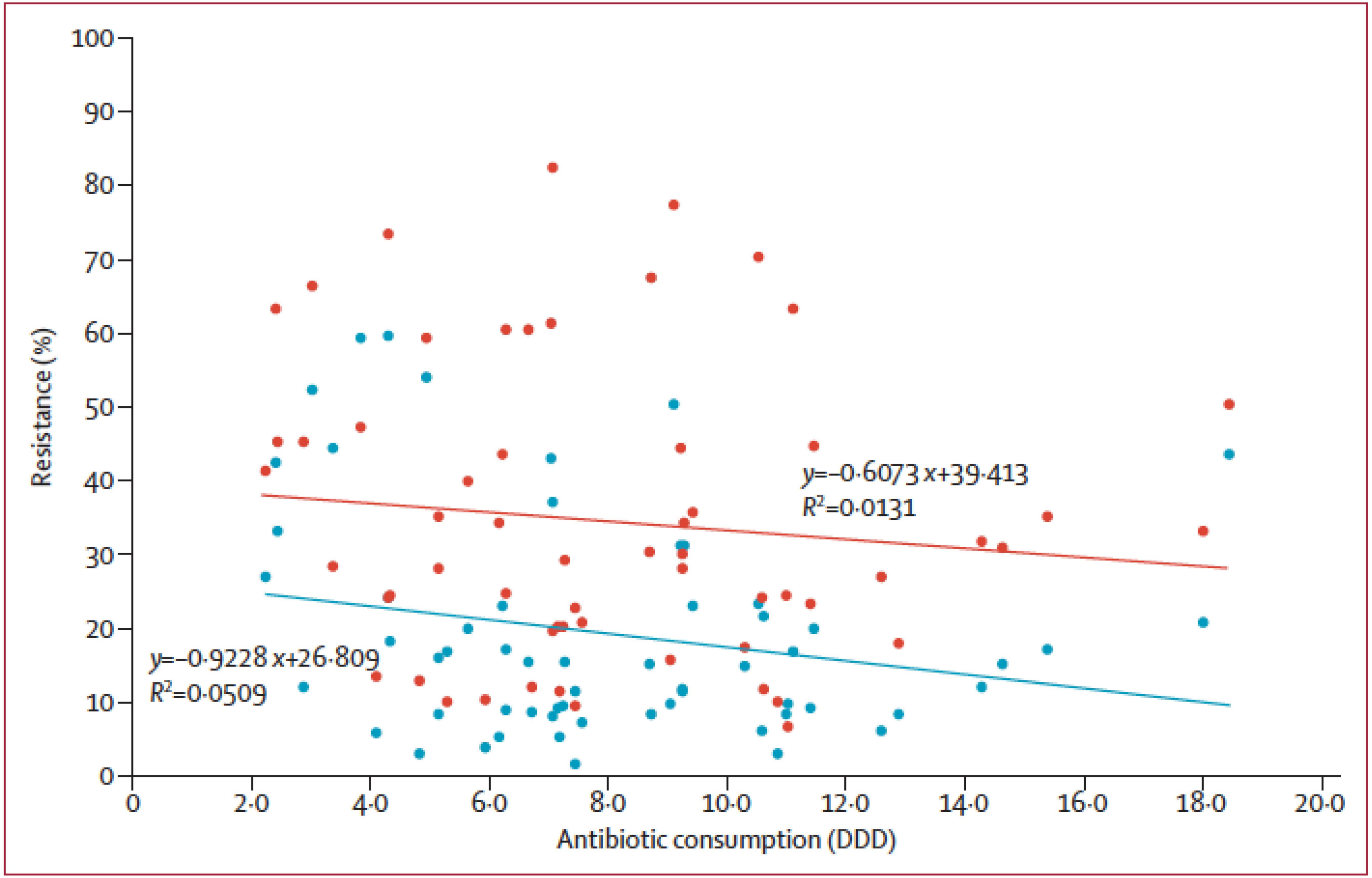
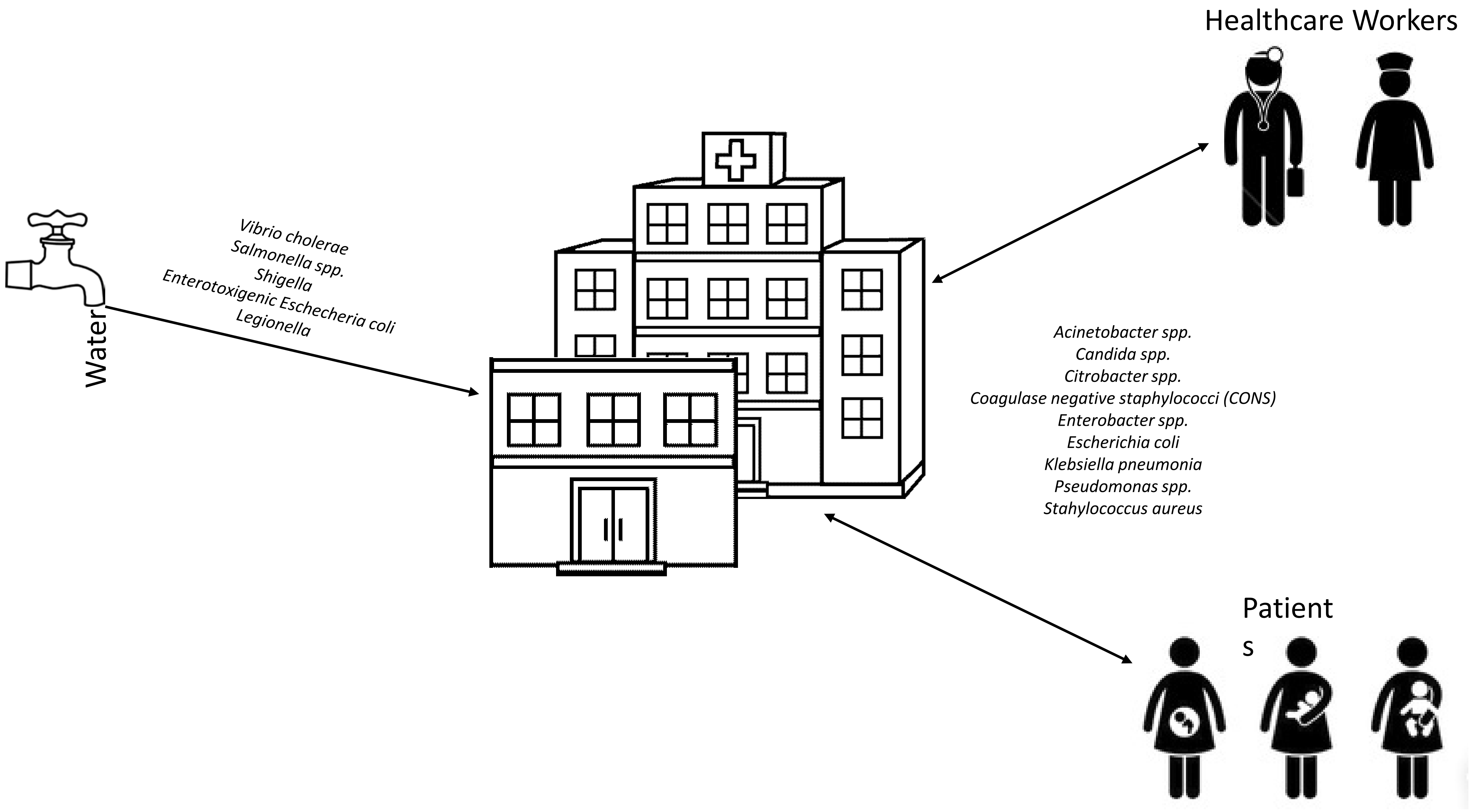


Figure 2: *Escherichia coli* **resistance levels for fluoroquinolones and third-generation cephalosporins compared with antibiotic consumption**

	Effect on resistance rate of 1 SD increase in each explanatory variable (logit)	p value
Usage (standardised)	–0·88	0·64
Governance index	–7·89	0·025
Health expenditure index	–5·54	0·093
GDP per capita (standardised)	6·62	0·030
Education index	7·93	0·058
Infrastructure index	–16·84	0·014
Climate index	2·01	0·33
R^2	0·54	..

GDP=gross domestic product. R^2=coefficient of determination.

Table 2: **Effect of changes in indices on the resistance of *Escherichia coli* to third-generation cephalosporins and fluoroquinolones**


Healthcare Workers
Water
Vibrio cholerae
Salmonella spp.
Shigella
Enterotoxigenic Eschecheria coli
Legionella
Acinetobacter spp.
Candida spp.
Citrobacter spp.
Coagulase negative staphylococci (CONS)
Enterobacter spp.
Escherichia coli
Klebsiella pneumonia
Pseudomonas spp.
Stahylococcus aureus
Patients

WASH and maternal/newborn health in low- and middle—income countries

- Assess the impact of improvements in water, sanitation, and hygiene (WASH) on reducing bacterial HAIs in mothers giving birth and in their neonates in low- and middle-income countries (LMICs)
- Develop cost-effectiveness estimates for WASH improvements in LMICs
- Identify gaps where research on WASH interventions can improve health-outcomes for pregnant mothers and neonates in LMICs

Cost effectiveness of interventions

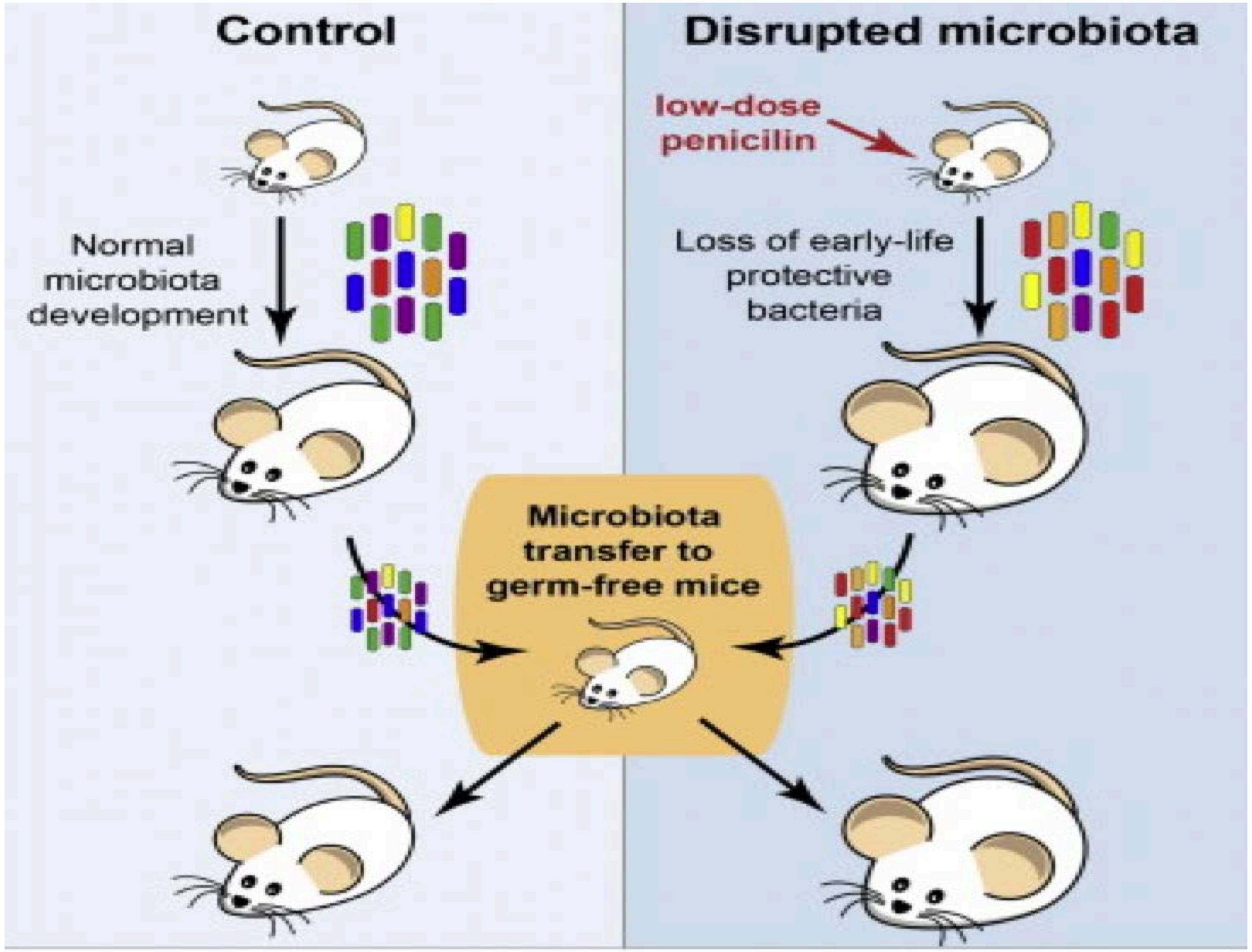
Table 14. Incremental Cost-Effectiveness

Intervention Scenario	Incremental Cost (INR)	Deaths/ Infections/ DALYs Averted	ICER (INR)	Incremental Cost ($)	ICER ($)
Deaths					
1 -> baseline	145,369	4.5	32,405	210,680	46,964
5 -> 1	319,881	7.0	45,858	463,596	66,461
2 -> 1	377,604	3.2	117,704	547,252	170,586
3 -> 2	1,889,736	101.0	18,716	2,738,747	27,124
4 -> 2	2,353,905	104.3	22,567	3,411,457	32,705
Infections					
1 -> baseline	145,369	14.1	10,337	210,680	14,982
5 -> 1	319,881	21.1	15,142	463,596	21,945
2 -> 1	377,604	11.3	33,322	547,252	48,293
3 -> 2	1,889,736	311.6	6,065	2,738,747	8,790
4 -> 2	2,353,905	322.4	7,301	3,411,457	10,581

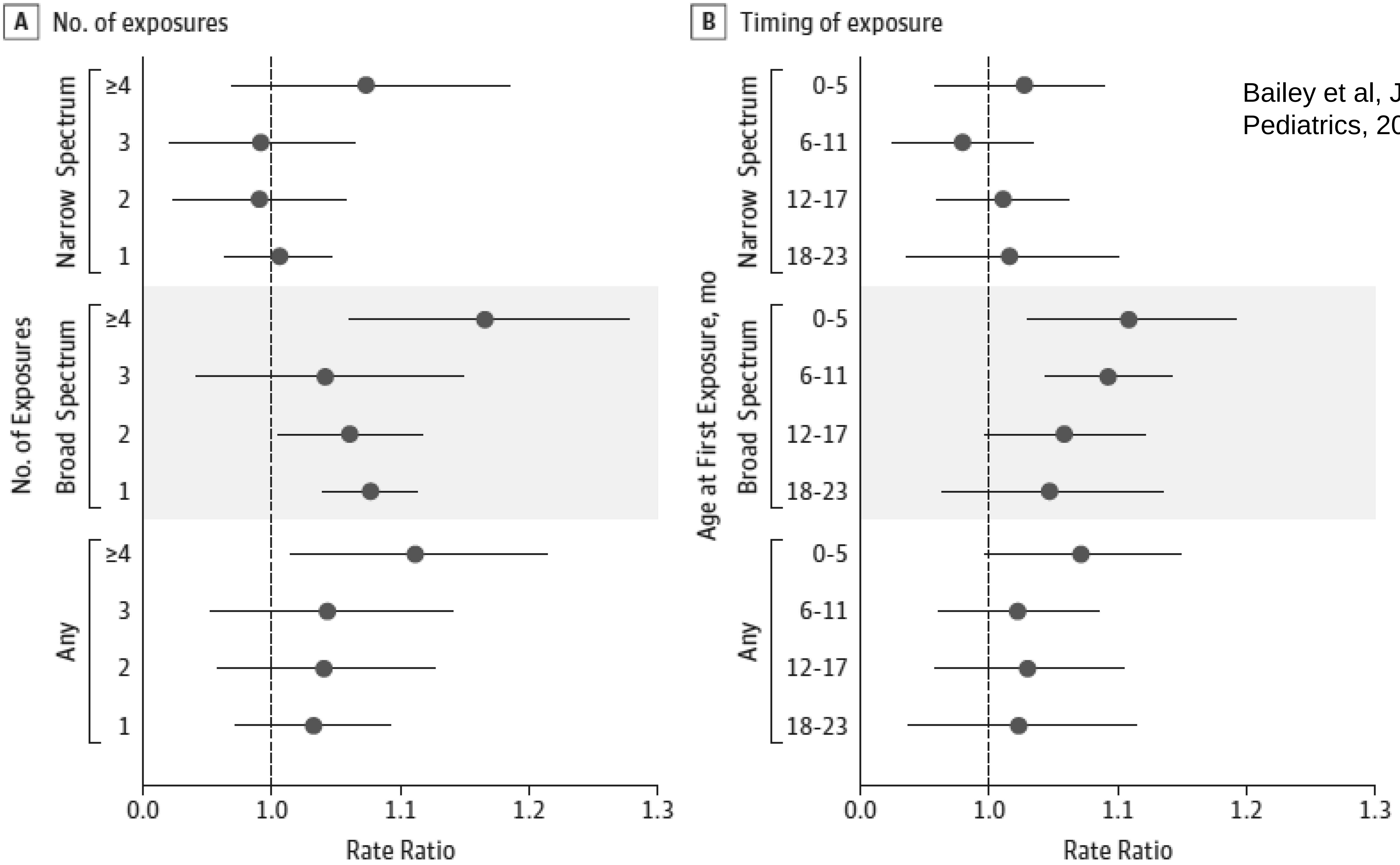
Study Conclusions

1. WASH interventions can be effective but are an expensive way of addressing AMR in hospitals
2. Water interventions are necessary because they facilitate IPC
3. Without IPC, water-based interventions are not nearly effective enough alone
4. Sanitation improvements only marginally impacted HAIs
5. Water-based interventions are more cost-effective than non-water-based interventions

Disrupted Gut Bacteria Lead to Obesity



LM Cox et al., Cell *158*, 705–721, August 14, 2014



Bailey et al, JAMA Pediatrics, 2014

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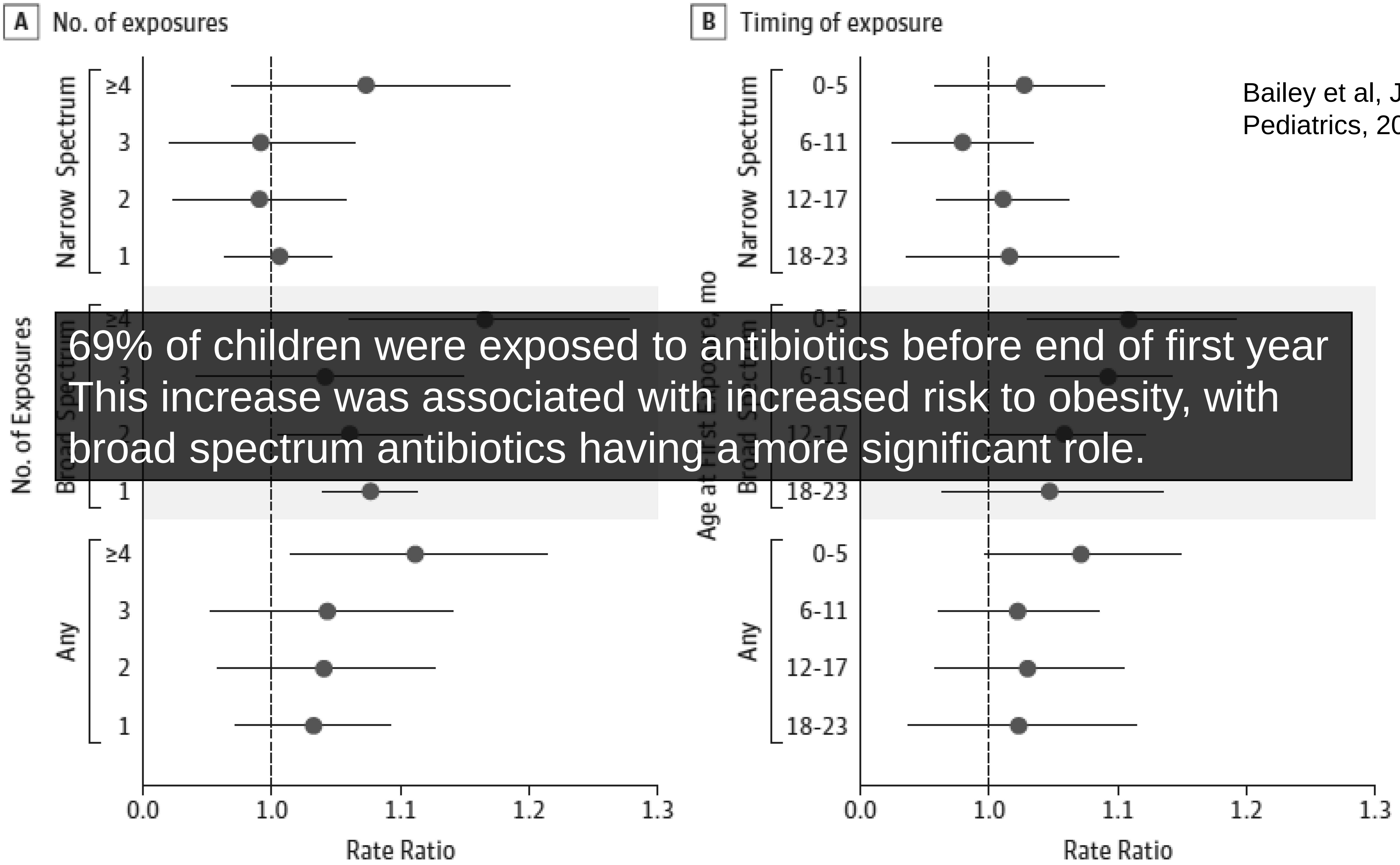

69% of children were exposed to antibiotics before end of first year
This increase was associated with increased risk to obesity, with broad spectrum antibiotics having a more significant role.

Costs of childhood obesity in the United States

Estimated lifetime cost of childhood obesity in 2011 US dollars and from the perspective of a 10-year-old child.

	Male		Female		All
$8,974.99	Thompson et al, 1999	$8,613.68	Thompson et al, 1999	$8,794.34	Thompson et al, 1999
$10,452.92	Tucker et al, 2006	$11,230.31	Wang et al, 2010	$11,592.33	Wang et al, 2010
$11,954.34	Wang et al, 2010	$13,973.07	Tucker et al, 2006	$12,213.00	Tucker et al, 2006
$15,644.52	Finkelstein et al, 2008	$17,808.29	Finkelstein et al, 2008	$16,726.40	Finkelstein et al, 2008
$29,024.88	Ma & Frick, 2011	$37,093.44	Ma & Frick, 2011	$18,900.12	Trasande, 2010
				$33,059.16	Ma & Frick, 2011
Average	$15,210.33		$17,743.76		$16,880.89

On in five school age children (about 11 million children in total) is classified as obese according to CDC.

If we project a 5% increase in childhood obesity rates attributable environmental exposures, the lifetime cost would be in the order of about $9.2 billion (2011 dollars) in the US alone.

Thank you