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The Global Point Prevalence Survey of Antimicrobial Consumption and Resistance (Global-PPS): Socioeconomic and environmental factors may contribute more to multi-drug resistance in gram-negative bacterial infections than antibiotic prevalence in hospital settings

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INTRODUCTION AND PURPOSE

Antimicrobial resistance (AMR) is a recognized world-wide problem and is a heavy economical and health-care burden. Despite the scale of this problem, there is limited data on the impact of socioeconomic and environmental factors on the rising global prevalence of multi-drug resistant gram-negative (MDRGN) bacteria. To effectively tackle this AMR problem, it is important to understand the main drivers that exist. In this study, we investigate the reported rates of AMR in Asia in terms of MDRGN infections and association if any, with gross domestic product (GDP), infrastructure, governance, health-care expenditure, climate, education and antimicrobial use.

METHODS

Antimicrobial resistance and prescribing data from the global point prevalence survey (Global-PPS) conducted in 2015 and 2017 was analyzed with World Bank Data on GDP per capita, health-care expenditure, climate, and community infrastructure. Nationmaster data on literacy and Transparency International's Corruption perception indices (CPI) were obtained. The relationship between higher than median prevalence of MDRGN at country level and socioeconomic and environmental factors was modelled. Factors which had a univariate p-value of <0.25 were sequentially entered into the multivariate Model 1. Model 2 included factors from Model 1 in addition to factors from *a priori* categories (GDP, infrastructure, health expenditure, CPI, climate, education, and antibiotic use).

RESULTS

Contributing Factors	Higher than median MDRGN prevalence (cases) N = 29	Lower than median MDRGN prevalence (controls) N = 29	Univariate (per SD)			Multivariate (per SD)					
						Model 1 (H-L p-val = 0.7601)			Model 2 (H-L p-val = 0.7513)		
	Mean (SD)	Mean (SD)	OR	95% CI	p-val	OR	95% CI	p-val	OR	95% CI	p-val
Univariate models (per SD):											
GDP											
GDP per capita in USD	$18,222 ($16,570)	$21,360 ($20,433)	0.84	(0.50-1.42)	0.5166				2.49	(0.73-8.49)	0.1464
Infrastructure											
Population using at least basic sanitation (%)	92.3 (11.2)	90.4 (16.9)	1.15	(0.68-1.96)	0.5992				1.61	(0.59-4.40)	0.353
Population using internet (%)	62.0 (19.6)	66.9 (21.2)	0.78	(0.46-1.32)	0.3508						
Population with access to electricity (%)	98.9 (3.0)	95.8 (13.0)	1.55	(0.70-3.44)	0.2841						
Urban population (%)	73.5 (16.8)	68.8 (17.9)	1.32	(0.77-2.25)	0.3075				2.72	(0.94-7.84)	0.0637
Corruption Perception											
CPI 2015	47.7 (18.4)	56.3 (20.4)	0.63	(0.37-1.09)	0.1009	0.78	(0.35-1.77)	0.5592	**0.22**	**(0.05-0.93)**	**0.0389**
Political stability and absence of violence	-0.28 (0.8)	0.20 (1.0)	0.58	(0.33-1.03)	0.0608						
Health expenditure											
Health expenditure per capita (% of GDP)	6.9 (2.2)	8.3 (2.8)	**0.55**	**(0.30-0.99)**	**0.0475**	0.74	(0.29-1.83)	0.50703	0.53	(0.18-1.59)	0.2589
Health expenditure per capita in USD	$1,295 ($1,457)	$2,197 ($2,640)	0.62	(0.34-1.15)	0.1271						
Climate											
Average yearly temperature (ºC)	18.2 (8.3)	12.5 (6.7)	**2.28**	**(1.22-4.24)**	**0.0094**	**2.57**	**(1.14-5.79)**	**0.0229**	2.35	(0.99-5.62)	0.0536
Latitude² (º)	1,170 (968)	1,827 (827)	**0.46**	**(0.25-0.84)**	**0.0122**						
Longitude (º)	25.6 (66.1)	27.6 (55.5)	0.97	(0.57-1.62)	0.8952						
Education											
Literacy of total population (%)	89.6 (14.1)	93.6 (11.5)	0.71	(0.40-1.27)	0.2505	1.41	(0.61-3.30)	0.4225	0.87	(0.25-2.96)	0.8198
Literacy among males (%)	92.2 (10.3)	95.5 (8.3)	0.68	(0.38-1.23)	0.2049						
Literacy among females (%)	86.7 (18.3)	91.7 (14.7)	0.73	(0.41-1.28)	0.2717						
Antimicrobial use											
Prevalence of antibiotic use (%)	44.9 (16.7)	40.1 (14.5)	1.38	(0.80-2.36)	0.2463	0.85	(0.39-1.85)	0.6782	0.86	(0.32-2.30)	0.7641

The mean prevalence of MDRGN in the 58 participating countries and 524 institutions, mainly from LMIC, was 2.3% of all inpatients on antimicrobials (SD = 2.2%, IQR = 0.7%-3.2%). We found that lower health expenditure (OR = 0.55, 95% CI = 0.30-0.99), higher average yearly temperature (OR = 2.28, 95% CI = 1.22-4.24), and lower squared latitude of capital city (OR = 0.46, 95% CI = 0.25-0.84) were independently associated with higher prevalence of MDRGN.

In the Model 1 multivariate analyses (H-L p-value = 0.76), we found that only higher average yearly temperature was significantly associated with higher prevalence of MDRGN. In Model 2 (H-L p-value = 0.75), lower CPI (OR = 0.22, 95% CI = 0.05-0.93) and higher average temperature (OR = 2.35, p-value = 0.05) were both associated with higher prevalence of MDRGN. Antibiotic use among all inpatients surveyed was not associated with prevalence of MDRGN in either multivariable or univariate analyses.

CONCLUSION

Higher prevalence of MDRGN was consistently associated with higher average yearly temperature. The number of inpatients on antimicrobials did not contribute to the MDRGN prevalence in hospitals. Further studies are required to determine the relationship between antimicrobial use, environmental and social factors and MDRGN prevalence in inpatient as well as outpatient settings.

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