# A climate for antibiotic resistance

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**PUBLIC HEALTH: A Climate for Antibiotic Resistance**

*Antibiotic resistance is a growing global health crisis. Research now suggests that higher local temperatures are associated with a greater incidence of resistant infections.*

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Antibiotic resistant bacterial infections kill around 700,000 people across the globe each year and the number is rising. Current estimates suggest that by 2050 antibiotic resistant bacterial infections kill 10 million people annually, a figure that would eclipse the death toll from cancer and diabetes combined[1]. Reporting in Nature Climate Change, MacFadden and colleagues[2] show that regions across the United States with higher local temperatures have greater rates of antibiotic resistance. Temperature differentials of 10°C were associated with a 2.2 - 4.2% difference in the number of resistant infections with greater temperatures associated with greater infection rates. The authors therefore suggest that increasing global temperatures could influence rates of antibiotic resistance meaning that current predictions of the scale of the antibiotic resistance crisis, which do not account for this effect, could be significantly underestimating the scale of problem.

Antibiotics underpin modern medicine. They are commonly used to treat bacterial infections in humans and animals and as a result we currently think of many infections as simple inconveniences that we can readily treat. In addition many medical procedures such as joint replacement, cancer chemotherapy and organ transplantation would not be possible without antibiotic treatments. However, bacterial infections are becoming harder to treat as bacteria evolve to survive treatment with antibiotic drugs; this is antibiotic resistance and it is a rapidly growing problem. Increased use of antibiotics globally continues to fuel the resistance problem while the slow rate of new drug discovery means we have few options to replace drugs as they become ineffective. The fundamental problem is that as the incidence of antibiotic resistant infections continues to rise, our ability to treat these infections diminishes which means more people will die. This is often referred to as a potential return to the dark ages of medicine where simple infections will once again kill. Understanding the causes and drivers of antibiotic resistance is critical in order to tackle this issue effectively.

In their study MacFadden and colleagues set out to explain varying rates of antibiotic resistance across the continental United States. They utilised a previously published large database of antibiotic resistance data from hospitals, laboratories and surveillance units to investigate rates of resistance for three important human pathogens (*Escherichia coli, Klebsiella pneumoniae* and *Staphylococcus aureus*)[3]. Importantly, resistance was defined as the percentage of each pathogen that was not susceptible to a particular antibiotic. For each data point the zip code was used to link it to local climate data from national databases as well as data on potential confounding variables including population density, socioeconomic status and local prescribing rates for each drug class. The key finding was that for all three species a higher minimum temperature was associated with higher rates of antibiotic resistant infections. In other words in regions with significantly warmer temperatures, a higher proportion of infections by these pathogens were resistant to first line drugs.

There was also an association between resistance rates and population density, probably reflecting higher rates of transmission of infection in these areas, but other potentially confounding variables including prescription rate, laboratory standards and socioeconomic status did not alter the association of temperature with resistance rate. After adjusting for other variables including population density and acquisition source a 10°C change in temperature was associated with an increase in resistance of 4.2%, 2.2% and 2.7% *for E. coli, K. pneumoniae* and *S. aureus*, respectively.

The reported association between temperature and antibiotic resistance is consistent across different antibiotic drug classes but interestingly resistance to certain drug types seems to be affected more strongly than others. Older drug classes such as the fluoroquinolones and beta-lactams were more strongly affected than their newer counterparts such as the cephalosporins or carbapenems and perhaps suggests the effect becomes more prominent over time or that different resistance mechanisms are differentially affected by temperature.

Global climate change has been identified by the WHO and others, as a major factor in the spread of emerging infectious diseases and this work extends our understanding of climate change effects by uncovering an additional ecological association with antibiotic resistance[4]. Although the study cannot be used to infer causation it is, interesting to speculate about potential mechanisms. MacFadden and colleagues suggest a few possibilities including that higher temperatures might allow better growth of bacteria in the environment or drive increased carriage rates. Alternatively, temperature may impact spread of resistance genes in the environment by horizontal gene transfer. Further investigation to elucidate the reason for the reported association is needed and it would also be interesting to see if the same pattern is evident in other countries and across continents.

Antibiotic resistance and global climate change are two of the biggest challenges facing humanity in the coming decades. The finding of MacFadden and colleagues[2] that local temperature is associated with increased rates of antibiotic resistance could be an important insight for our understanding of the trajectory of antibiotic resistance in a warmer world.

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