Collaboration for Environmental Evidence

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Plain Language Summary
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Systematic Map
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Mapping the research evidence shows how people can be exposed to, colonised by and infected with bacteria resistant to antibiotics from environmental sources

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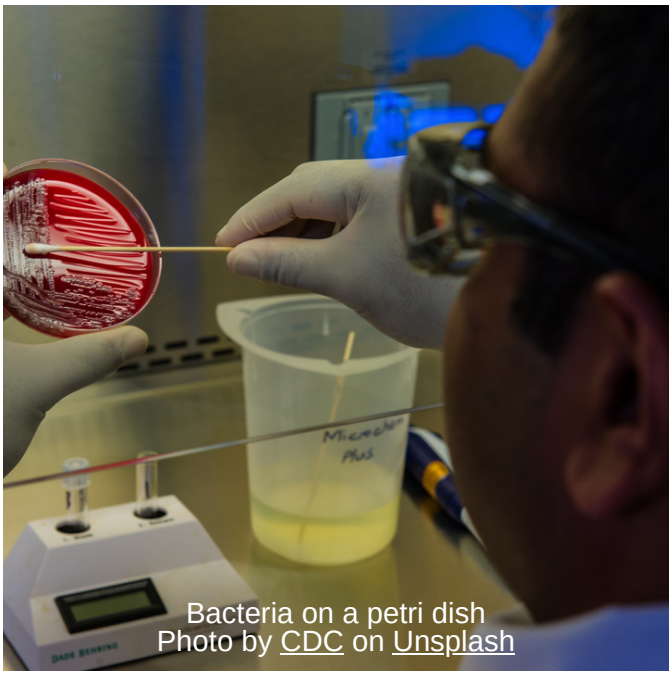

Bacteria on a petri dish
Photo by CDC on Unsplash

We found 40 studies globally (mostly from Europe) that had assessed whether people had been exposed to, colonised with, or infected by bacteria resistant to antibiotics from environmental sources including water, soil, food, and air. Most research has looked at this exposure through ingestion/ consumption of water or food (e.g., wild meat or plants consumed raw). Other potential routes identified included exposure to bacteria in water, soil, or air.

We also found 62 studies that measured the prevalence of antimicrobial resistant bacteria in the environment in the United Kingdom (UK). Most research conducted has assessed whether bacteria in water sources are resistant to antibiotics, particularly water flowing into, or out of, wastewater treatment plants.

Why is this Evidence Synthesis Needed?

Bacteria, and other microorganisms which cause infections, can change to become resistant to the drugs used to treat them. This means that treatments become less effective, which increases the difficulty and cost of treating infections. Antimicrobial resistant organisms (such as fungi, viruses and bacteria) are predicted to become the leading cause of death in people globally by 2050 with antibiotic resistant bacteria being an important component. Previous research has tended to focus on antimicrobial resistance in clinical settings like hospitals, and there is currently limited empirical evidence demonstrating whether humans are exposed to environmental antimicrobial resistance and whether this exposure can impact on human health. We undertook two systematic evidence maps to explore:

1. What research evidence is there about exposure and transmission of antibiotic resistant bacteria to humans from the environment?
2. What research evidence is there measuring the prevalence of antibiotic resistant bacteria in the environment in the UK?

We mapped the geographical location of identified relevant studies and catalogued their dates and study designs. We also examined what had been researched in terms of people's exposure routes (such as inhalation, consumption, direct contact), the types of bacterial species investigated (such as *E. coli, campylobacter, salmonella*), and the environmental source examined (such as water, soil, food (e.g., wild meat, raw vegetables, food), air).

These systematic maps, which were developed using guidelines from the Collaboration for Environmental Evidence, identified and described the existing research evidence assessing whether humans are exposed to, and affected by, bacteria in the environment which are resistant to antibiotics. The maps summarize evidence from 40 studies globally that met the inclusion criteria, and which assessed whether people had been exposed to, colonised by, or infected with antimicrobial resistant bacteria from environmental sources, and 62 UK studies measuring the prevalence of antimicrobial resistant bacteria in the environment.

Main Findings

What studies are included?

Map 1: What research evidence is there about exposure and transmission of bacteria resistant to antibiotics to humans from the environment?

Map 1 included 40 studies published from 2009 to 2020 assessing whether people had been exposed to, colonised by, or infected with antimicrobial resistant bacteria from environmental sources. These studies were from Europe, Southeast Asia, North America, and Africa.

E. coli was the most highly studied bacterium (16 studies). Consumption/ingestion was the most studied transmission route (30 studies), followed by direct contact (nine studies), and inhalation (seven studies). Research was focused on water sources, followed by wild meat or raw vegetable consumption. In terms of human health outcomes, most studies only looked at whether people had been exposed to (17 studies), or colonised by (11 studies), antibiotic resistant bacteria. Fewer studies looked at direct human health impacts, with 16 assessing whether this led to infection, and two assessing the impact on mortality.

Map 2: What research evidence is there measuring the prevalence of antibiotic resistant bacteria in the environment in the UK?

Map 2 included 62 studies from 2005 to 2020 measuring the prevalence of antimicrobial resistant bacteria in the UK environment.

Mixed communities of bacteria were studied the most (32 studies), with bacteria found in faeces (such as *E. coli, Campylobacter*) also frequently studied (27 studies). Phenotypic testing was the most common method (used in 37 studies) – this approach assesses whether bacteria grow in the presence of an antibiotic that should kill bacteria or inhibit their growth. Characterising antibiotic resistant bacteria involves analysing the DNA of the bacteria to identify the type of bacteria in the sample, or the antibiotic resistance genes they harbour. The most commonly reported outcome for studies in the map was characterisation of antibiotic resistant bacteria (40 studies), followed by characterisation of antibiotic resistance genes (35 studies).

What are the Implications of the Review Findings?

Research on environmental antimicrobial resistance is a rapidly growing field, attracting increasing public and policy interest and concern, and these maps identify and catalogue recent research that investigates this and its impacts on human health. This is relevant to various decision-makers, such as policy makers in public health and environmental management and environmental protection agencies both globally and in the UK. In 2017, the United Nations Environment Programme highlighted the environmental dimension of antimicrobial resistance as one of the most serious environmental pollution issues. Currently, however, environmental policy is often more focused on chemicals than microorganisms. To the best of our knowledge this map constitutes the first co-ordinated effort to collate data on the human impacts of antimicrobial resistance in the environment.

Policy-makers can search our maps to find and assess the extent of the available evidence that may support or contradict current or planned initiatives to manage environmental antimicrobial resistance and/or public health. Articles identified by these two maps providing evidence of transmission from the environment to humans may be used to support the need for surveillance and policy in this area to protect health. Likewise, this mapping exercise identifies topics where little evidence exists to underpin policy and management, where further research is necessary.

Surfers in the Sea
Photo by Kaspars Upmanis on Unsplash

Raw Radishes
Photo by Markus Spiske on Unsplash

Mussels by the sea
Photo by Shapelined on Unsplash

Synthesis Time Frame

The map authors searched for studies published between 2005/2009 to 2020. This CEE Systematic Review was published in March 2022

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