Livestock antimicrobial use embodied in global supply chains

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Global demand for protein has surged over the past decades, due to the booming population and increasing affluence. As the key protein source, the demand of animal protein has more than tripled over past decades from 70 to 350 million tons, and it is expected to grow another 12% between 2019 and 2029. The growth hotspots of the meat production are mostly concentrated in developing countries due to population and income. The growth was especially alarming in Asia, Africa, and South America over the past 20 years. However, the massive increase in meat production cannot be achieved without the excessive use of antimicrobials for the growth promotion and mass prophylaxis of the livestock. Today, antimicrobial use in animals represented 73% of all antimicrobials used worldwide, significantly contributing to antimicrobial resistance which has become a global concern, linking with an annual death toll of 700,000 and is projected to increase to up to 10 million fatalities worldwide by 2050.

However, animal products are not only driven by local demands but also significantly by the demands overseas. For example, global trade of animal products accounts for roughly 10% of total merchandise trade and keeps rising. Animal products can be beyond the global food system. By-products of animals are essential for industrial use, such as skin for apparel industry and fat for the chemical industry. This indicates the antimicrobial use is highly related to the manufactured goods and embodied in the international trade of both food and manufactured products, referring to a spillover effects along the global supply chain. As the new type of challenges, the global antimicrobial governance establishment requires a comprehensive accounting framework from primary use to final consumption via global supply chains. Therefore, we call for more academic efforts, public awareness, and international coordination to address the emerging global antimicrobial overuse issue.

In this study, we link antimicrobial estimates in livestock production with a global multi-regional inputâ€“output (MRIO) model, enabling us to quantify the antimicrobial footprint via global supply chains from 2010 to 2020. The footprints encompass both direct and indirect antimicrobial use throughout the production stages of food and non-food products. For example, the antimicrobial footprint of beef includes direct use in feeding cattle and indirect use in services supporting husbandry. We estimate global antimicrobial use in chicken, cattle, and pigs across 16 antimicrobial types for each country/region using Bayesian regression (6), based on official data from 43 countries and product-level data from the UN Food and Agriculture Organization (FAO). We then utilized the EXIOBASE model to quantify antimicrobial use embodied in global supply chains. We further examined the socioeconomic drivers behind trends in antimicrobial use for each country/region using structural decomposition analysis. Our study provides a novel perspective by linking on-site antimicrobial use with final demand via international trade, shedding light on the often-overlooked spillover effects of antimicrobial use in global supply chains. By shifting the focus from on-site to off-site responsibility, we aim to reshape the understanding of how responsibility for AMR should be shared between producers and consumers globally. This research lays the groundwork for more comprehensive strategies to address AMR, emphasizing the need for coordinated international efforts to mitigate this critical global health threat.