Drug industry's carbon impact could be cut by half

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In a first-of-its-kind analysis, Cornell researchers and partners at the

Clinton Health Access Initiative found that pharmaceutical producers could reduce their environmental impact by roughly half by optimizing manufacturing processes and supply chain networks and by switching to renewable energy sources.

The findings were published on the cover of the May 1 issue of *ACS Sustainable Chemistry & Engineering*. First author of the paper, "Environmental Sustainability of the Globalized Pharmaceutical Supply Chains: The Case of Tenofovir Disoproxil Fumarate," is Yanqiu Tao, M.S. '21, a doctoral student in the lab of Fengqi You, the Roxanne E. and Michael J. Zak Professor in Energy Systems Engineering and a senior faculty fellow with the Cornell Atkinson Center for Sustainability.

Pharmaceutical manufacturing is a major contributor to global greenhouse gas emissions, similar in magnitude to the automotive industry, though it has not received anywhere near the level of academic or regulatory scrutiny, You said.

"Much of the focus of decarbonization centers on products like solar panels and electric cars, which are very important, but pharmaceuticals are also a tremendous and growing contributor," he said. "We hope our study will become a motivating example for other academic collaborations and policy agenda studies around decarbonizing the pharmaceutical industry."

Most previous studies investigating the environmental impact of pharmaceuticals have focused on the manufacturing or formulation stage, while this study explored the full life-cycle carbon impact of the HIV antiretroviral drug Tenofovir Disoproxil Fumarate (TDF), Tao said.

"We included extraction, procurement and production of raw materials, to manufacturing and formulation, to packaging, transportation and distribution, and to waste treatment post-consumption by the patient,"

Tao said. "We are the first, very comprehensive and systematic assessment of the pharmaceutical life cycle of any drug."

By far the biggest contributor to carbon impact is the energy source used in manufacturing, the researchers found. Many generic drugs, including TDF, are produced in India, which primarily relies on coal for its energy. Drug producers should be encouraged to power their operations with renewables instead, the authors said. Large transportation distances between raw material sources, production facilities and patients also contribute to carbon impact; carefully optimizing supply chain networks could alone reduce life cycle carbon footprint by up to 9.3%, the study found. Changes in the way TDF is manufactured, such as improving recycling of used solvent chemicals, and minimizing packaging, could also reduce environmental impact.

The thorough analysis—which concluded that TDF producers could realistically reduce their carbon footprint by up to 45%—was possible only because of the close collaboration between faculty and students at Cornell and the nonprofit Clinton Health Access Initiative (CHAI), You said. Because of CHAI's long-standing work to support equitable access to HIV treatment in low-income countries, the organization had access to unique information about supply chains and manufacturing processes, said Neel Lakhani, MBA '07, M.I.L.R. '08, senior director of strategy and innovation for CHAI and a co-author of the new study.

"This paper as a standalone was incredibly well done, shining a light on an understudied and complex area," Lakhani said. "I believe this paper can also serve as a model for not just how this drug can be produced in a more environmentally conscious manner, but how many other drug molecules can be produced more sustainably."

In addition to Tao, You and Lakhani, study co-authors are Shoudong Zhu, a master's student in You's lab, and Janet Smith, M.S. '18, formerly

a project associate for strategic partnerships at Cornell Atkinson.

More information: Yanqiu Tao et al, Environmental Sustainability of the Globalized Pharmaceutical Supply Chains: The Case of Tenofovir Disoproxil Fumarate, *ACS Sustainable Chemistry & Engineering* (2023). DOI: 10.1021/acssuschemeng.2c06518

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