The authors conducted a targeted review of published literature to report on the global pharmaceutical industry’s carbon footprint and current mitigation strategies.

### INTRODUCTION

- The pharmaceutical industry develops and discovers new treatments that improve patient outcomes. However, improper disposal of unused and expired medicines, as well as pollutants from manufacturing, supply chain, and drug delivery systems contribute to a sizeable carbon footprint.
- Industry efforts to reduce the environmental impact are expanding from carbon emission reduction alone towards more holistic commitments to long-term sustainable practices.

### OBJECTIVES

- This literature review aims to identify the global pharmaceutical industry’s carbon footprint and understand various strategies for limiting healthcare-related carbon emissions.

### METHODS

- The authors conducted a targeted review of published literature on pharmaceutical companies’ environmental impact and sustainability goals, such as the Global GRI framework, the Pharmaceutical Supply Chain Initiative, and other professional organizations.
- A systematic review of the literature was conducted, focusing on pharmaceutical industry carbon footprint and mitigation strategies.

### RESULTS

#### SCOPE 1 DIRECT

- **Electricity**
- **Natural gas**
- **Water**
- **Fuel**
- **Direct air emissions**

#### SCOPE 2 INDIRECT

- **Electricity**
- **Natural gas**
- **Water**
- **Fuel**
- **Indirect air emissions**

#### SCOPE 3 INDIRECT

- **Electricity**
- **Natural gas**
- **Water**
- **Fuel**
- **Direct air emissions**

Key Finding: Pharmaceuticals companies should consider taking a comprehensive, data-driven end-to-end view of the clinical development process, including waste generation, solvents, energy use, and renewable materials, to identify opportunities for reducing emissions and waste.

Key Finding: Healthcare carbon emissions as a percentage of national carbon emissions averages at 4.4% globally. Many countries exceed this with the US at 7.6%, Japan at 6.4%, and the UK at 5.4%.

### DISCUSSION & CONCLUSION

- **Pharmaceutical companies** are using a three-pronged approach to reduce carbon emissions: direct, indirect, and supply-chain.
- **Emissions from the supply-chain fall within Scope 3** and is the largest contributor to carbon emissions in healthcare.
- Considering that 70% of healthcare emissions come from supply-chain in pharmaceutical, continuous instead of batch manufacturing can be effective in curtailing carbon emissions.
- **Efficient packaging of materials** can limit carbon emissions by reducing space in transport vehicles by up to 60%.
- **Investing in eco-conscious options** in the Pharmaceutical industry can have long-term financial benefits because of reduced waste and more efficient use of resources.
- Principles of a circular economy include reusing and recycling products and materials, and regenerating rather than leaving materials to degrade by natural systems.
- **Climate goal of companies** can be broken into 5 tiers, ranging from companies with science-based targets (Tier 3) to those that have no targets (Tier 5); 30% of the top 25 companies are in Tier 2, with Sanofi, Takeda, GSK, and Johnson & Johnson leading the way to a net-zero long-term science-based target.
- Carbon and waste reduction efforts other green initiatives in even a single manufacturing site can prevent harmful environmental impacts, in addition to long-term financial gains.

#### CONCLUSION

- By looking at the sustainability impact of a product or process in conjunction with the economic implications over its entire life cycle, pharmaceutical companies can balance initial monetary investment in sustainable practices with potential long-term cost savings.

#### Future Research Opportunities

- This research is foundational in understanding the pharmaceutical industry’s impact on the environment and what is needed to be more sustainable.
- Future research should further investigate the holistic supply chain from drug development to disposal of drugs; more robust data are needed to measure the true environmental impact so better solutions can be applied.
- While there are environmentally-centered goals and efforts in place, it can be challenging to quantify sustainable outcomes; therefore, health economics and outcomes research is necessary to support industry claims related to sustainability.

### REFERENCES

10. 10. Circular Life Cycle Management of Medicines4

Disclosures: All the authors are employees of Trinity Life Sciences (Waltham, MA), and MOH holds equity in Trinity Life Sciences.