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Integrating Environmental Sustainability into Health Economics: Concepts, Methods and Policy Pathways

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Abstract: *Incorporating environmental sustainability into health economics has become a critical requirement for developing health systems that remain effective, equitable and resilient in the long term. As populations continue to pursue improved health outcomes, the growing strain on ecological systems highlights the necessity of integrating environmental considerations into economic analyses of healthcare. This chapter presents a conceptual and methodological framework for embedding sustainability within health-economic thinking. It explores how healthcare activities contribute to environmental pressures, examines ways to adapt existing economic evaluation tools to account for ecological impacts and outlines policy reforms that can support greener and more resource-efficient health systems. By merging environmental and economic perspectives, health economics can help shape systems that uphold human well-being while protecting the planet's ecological boundaries.*

Keywords: Environmental Sustainability, Health Economics, Sustainable Health Systems, Green Healthcare, Cost-Effectiveness Analysis, Climate Change, Planetary Health

I. INTRODUCTION

Health economics has traditionally centred on the optimal allocation of limited resources to maximize population health. However, growing evidence shows that environmental degradation through climate instability, air pollution, loss of biodiversity and resource depletion undermines both health outcomes and economic productivity (Watts et al., 2023). As these ecological pressures intensify, the discipline increasingly recognizes that environmental stability is not merely an external factor but a foundational determinant of health.

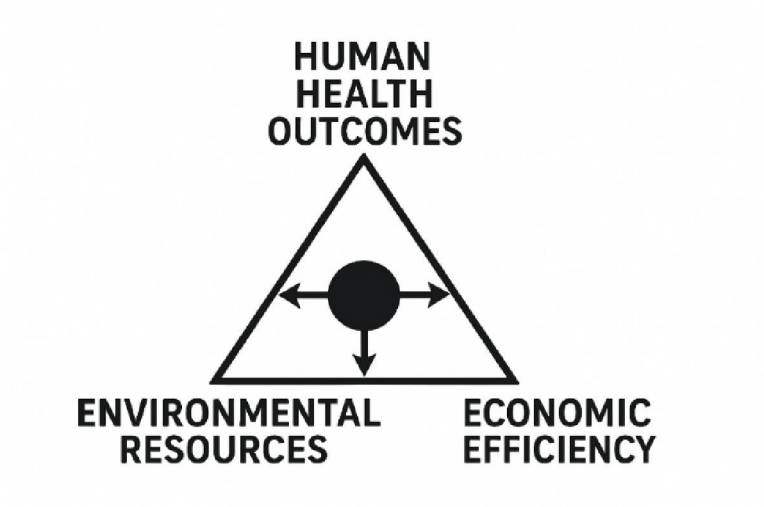
At the same time, healthcare systems themselves contribute substantially to environmental decline. Studies estimate that the health sector accounts for a sizeable share of national greenhouse gas emissions in high-income countries, ranging between 4% and 10% of national totals (Eckelman & Sherman, 2016). This dual role as both a sector affected by and contributing to environmental harms necessitates a reframing of traditional health-economic approaches. This chapter examines how the field can evolve through conceptual reframing, methodological expansion and policy innovations that place sustainability at its core.

The Three Pillars

The Triple Bottom Line (TBL) framework broadens the conventional economic lens by evaluating institutional performance across three interrelated domains: social well-being, environmental stewardship, and economic efficiency (Paula Fernandez, 2025). When applied to health systems, this framework underscores the mutual dependence between human health, ecological integrity, and economic viability.

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Human Health Outcomes (Top Vertex)

This dimension represents the overarching aim of any societal system: to enhance the physical, mental, and social well-being of individuals and communities. It includes access to essential services, safe living conditions, adequate nutrition and clean air and water.

Environmental Resources (Bottom-Left Vertex)

This pillar reflects the natural environments ecosystems, climate, biodiversity, soil, water, and atmospheric quality that support all biological and economic functioning. Sustainable development requires the protection, responsible use and restoration of these resources to preserve them for future generations.

Economic Efficiency (Bottom-Right Vertex)

Economic efficiency emphasizes long-term prosperity grounded in innovation, productivity, employment, and equitable resource distribution. It promotes economic growth that does not undermine social welfare or degrade environmental systems.

The Central Nexus

At the intersection of the three pillars lies a dynamic interaction in which actions in one domain inevitably influence the other two. For instance, economic policies that encourage industrial growth may increase pollution, thereby diminishing environmental quality and ultimately harming health. Conversely, investments in renewable energy can yield simultaneous benefits: reduced emissions, enhanced public health and new economic opportunities. This model reminds policymakers that sustainable progress must be pursued through coordinated strategies rather than isolated interventions.

The Model's Significance

This triangular framework is foundational to modern sustainability science and policy-making. It visually communicates that true progress is not achieved by optimizing any single pillar in isolation. Instead, it demands an integrated approach where decisions are evaluated for their impact across all three dimensions.

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II. CONCEPTUAL FOUNDATIONS

2.1. Environmental Sustainability in Health Economics

Environmental sustainability within health economics refers to designing and maintaining healthcare systems that meet present needs without compromising the ecological conditions necessary for future health (World Health Organization [WHO], 2022). It involves reducing the environmental impacts generated across the healthcare supply chain from manufacturing and procurement to treatment delivery and waste disposal.

2.2. The Health–Environment Nexus

Environmental conditions shape disease patterns, productivity, and population survival. According to WHO (2022), a substantial share of the global disease burden is linked to environmental exposures such as polluted air and water, climate-related hazards and toxic chemicals. Health economics must therefore view environmental degradation as a negative externality that distorts assessments of efficiency and leads to incomplete policy evaluations.

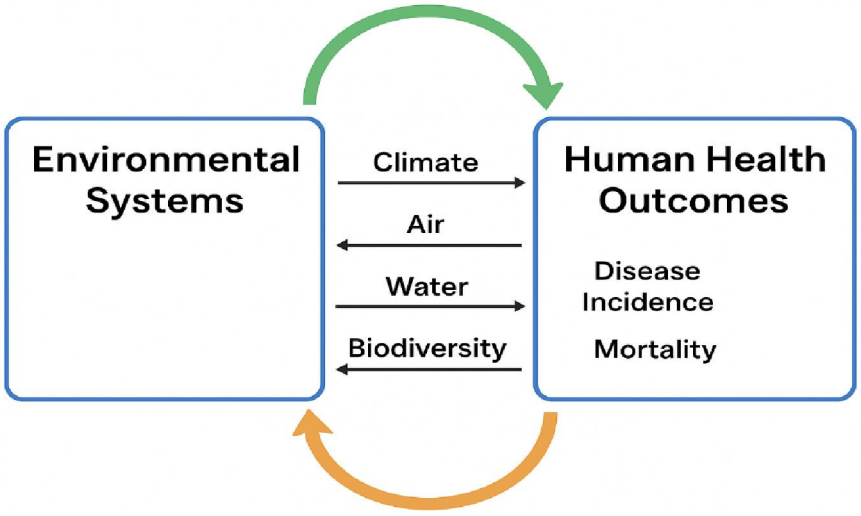


Figure 1 – Integration of Environment systems with Human Health Outcomes

A conceptual diagram can depict the continuous exchange between environmental systems (climate, biodiversity, water and air quality) and health outcomes (morbidity, mortality and productivity), emphasizing how healthcare operations feed back into ecological conditions through resource use and waste.

2.3. The Triple Bottom Line in Health Economics

Integrating the TBL framework into health economics calls for balancing three objectives simultaneously: improving population health, ensuring economic efficiency and protecting the environment (Pearce, 2018). Traditional cost-effectiveness analyses rarely consider ecological impacts, but sustainability requires redefining efficiency to include intergenerational welfare and the resilience of health and ecological systems.

III. THE ENVIRONMENTAL FOOTPRINT OF HEALTH SYSTEMS

3.1 Resource Consumption and Waste

Healthcare facilities are among the most resource-intensive public institutions. Hospitals consume large volumes of water and energy while producing significant quantities of hazardous and non-hazardous waste. Life-cycle assessments show that the U.S. healthcare sector alone generates hundreds of millions of metric tons of CO_2-equivalent

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emissions each year (Eckelman & Sherman, 2016). Similar patterns occur globally, positioning healthcare as both a casualty of environmental decline and a contributor to it.

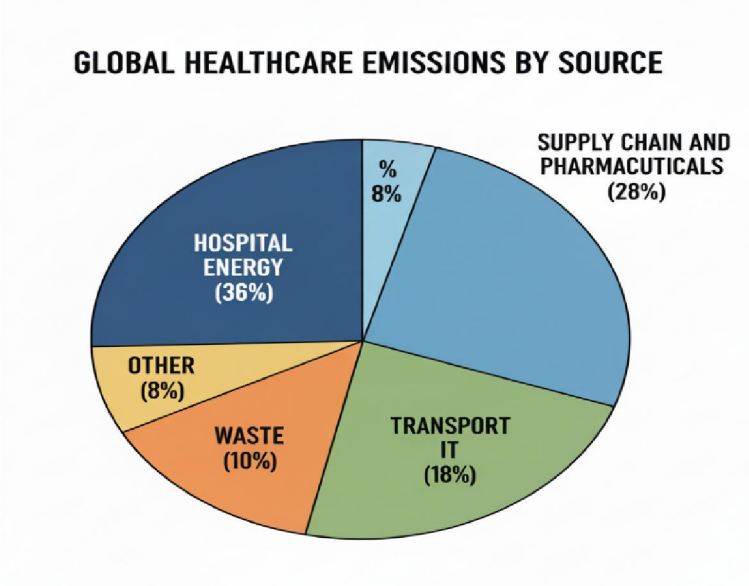


Figure 2 – Global Healthcare Emissions

A chart comparing emissions across national health sectors can highlight the scale of healthcare-related carbon footprints.

3.2. Pharmaceuticals and Environmental Risks

Pharmaceutical production, distribution, and disposal introduce chemicals into ecosystems, accelerating problems such as water contamination and antimicrobial resistance. From an economic perspective, these environmental damages represent external costs not accounted for in market prices (Kümmerer et al., 2021). Incorporating such impacts into economic evaluations can help align pharmaceutical policies with sustainability goals.

3.3. Digitalization and Environmental Implications

Digital health solutions including telemedicine, wearable devices and electronic health records may reduce travel and material consumption. However, the data infrastructure supporting digital technologies requires substantial energy. Ensuring that digital health contributes meaningfully to sustainability involves transitioning to low-carbon data systems and adopting circular economy principles for electronic devices (OECD, 2023).

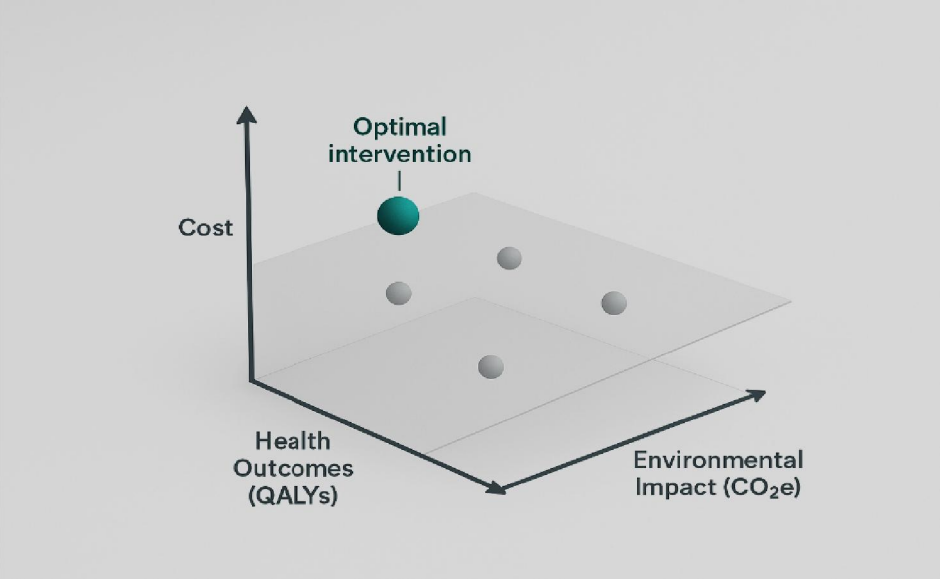
IV. METHODOLOGICAL APPROACHES FOR INTEGRATING SUSTAINABILITY

4.1. Extending Cost-Effectiveness Analysis (CEA)

Conventional cost-effectiveness analysis (CEA) assesses interventions based on financial cost relative to health benefits, such as quality-adjusted life years (QALYs). Extended CEA incorporates environmental impacts such as carbon emissions or pollution into evaluation frameworks (Verguet et al., 2015). This provides a more comprehensive assessment of intervention trade-offs and supports policy decisions that align with ecological and health objectives.

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Figure 3: Extending Cost-Effectiveness Analysis



An extended CEA model may include environmental indicators alongside cost and health outcomes.

4.2. Environmental Input–Output Modelling

Environmental input–output models estimate how healthcare spending drives resource use and emissions across interlinked economic sectors. By connecting national health expenditures to environmental data, researchers can pinpoint emission hotspots and evaluate the sustainability of different spending patterns (Lenzen et al., 2020). This facilitates system-level evaluations of sustainability trade-offs.

4.3. Multi-Criteria Decision Analysis (MCDA)

MCDA allows decision-makers to consider various criteria including environmental footprint, social acceptability, cost and health impact without collapsing them into a single metric (Baltussen & Marsh, 2014). This method is particularly helpful for sustainability-oriented decisions where trade-offs are complex and value judgments must be made explicit.

V. GOVERNANCE AND POLICY STRATEGIES FOR SUSTAINABLE HEALTH SYSTEMS

5.1. Green Health Financing

Environmental performance criteria can be embedded into funding mechanisms for healthcare institutions. Governments and funding bodies may encourage sustainability by providing financial incentives for low-carbon infrastructure, renewable energy adoption or waste reduction strategies. Instruments such as green bonds can also support investment in environmentally responsible healthcare facilities (OECD, 2023).

5.2. Carbon Pricing and Taxation

Assigning a price to carbon emissions encourages healthcare organizations to internalize environmental harms. Carbon taxes or carbon-adjusted procurement policies can shift the market toward cleaner technologies and sustainable medical supplies (Roehrich et al., 2021).

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5.3. Integrating Environmental Indicators in Health Accounts

Including environmental metrics such as emissions per hospital bed or waste generation per procedure within national health accounts provides a more holistic picture of system performance. These indicators help track progress toward sustainability goals and complement economic and epidemiological datasets.

VI. CASE STUDIES

6.1. The NHS Net Zero Commitment (United Kingdom)

The National Health Service (NHS) in the United Kingdom has committed to achieving net-zero emissions by 2045. Its strategy includes energy-efficient building upgrades, low-carbon clinical pathways, cleaner procurement processes, and workforce engagement initiatives. Early modelling suggests that these efforts could generate economic benefits in the long term through energy savings and reduced ecological burdens (NHS England, 2020).

6.2 Scandinavian Approaches to Sustainable Healthcare

Scandinavian countries, particularly Sweden, have integrated sustainability principles into healthcare planning and operations. Hospitals often operate with renewable energy, environmentally responsible procurement, and rigorous waste-minimization initiatives. These cases demonstrate that ecological performance can be compatible with high-quality, equitable healthcare delivery (Eriksson et al., 2018).

VII. CHALLENGES AND FUTURE DIRECTIONS

Despite increasing interest, several obstacles hinder the integration of environmental sustainability into health economics:

Data Limitations: Reliable environmental impact data vary across countries and healthcare settings.

Valuation Difficulties: Quantifying environmental and health co-benefits involves uncertainty and methodological debates.

Institutional Constraints: Health systems often prioritize short-term clinical outcomes over long-term ecological resilience.

Equity Concerns: Sustainability transitions must avoid exacerbating inequalities, especially in low-income regions.

Future research must develop standardized environmental metrics, strengthen interdisciplinary collaboration, and refine health technology assessment frameworks to incorporate ecological considerations.

VIII. CONCLUSION

Environmental sustainability must become an organizing principle of health economics. Because the health sector contributes to environmental harm while simultaneously being vulnerable to ecological change, it is imperative to transform healthcare systems into models of environmental responsibility. By broadening existing economic methodologies, integrating ecological costs into policy analysis, and promoting sustainable governance structures, health economics can guide societies toward health systems that safeguard both human well-being and planetary health. Ultimately, sustainable health economics offers a pathway toward resilient societies capable of flourishing within ecological limits.

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