

LEVERAGING SIMULATION TO STUDY HEALTH INEQUALITIES: INSIGHTS FROM SYSTEMATIC LITERATURE REVIEW AND SURVEY OF RESEARCHERS

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ABSTRACT

This study presents the applications, challenges, and future research directions of simulation for health inequalities research based on a systematic literature review and survey of authors included in the review.

1 INTRODUCTION

Simulation methods have been used to understand and predict the dynamics of health inequalities, enabling the investigation of different scenarios and testing interventions virtually before real-world implementation (Jayasekera et al. 2023; Mandelblatt et al. 2023; Mudd et al. 2024; Speybroeck et al. 2013). However, there are no recent studies that have comprehensively synthesized the applications, challenges, and future research directions of simulation methods for health inequalities research. The last systematic review was published in 2013 (Speybroeck et al. 2013). Even though several recent studies have attempted to examine the applications and challenges of simulation in health inequality research, they have focused only on simulation methods (Boyd et al. 2022), problem areas (Jayasekera et al. 2023), or geographical areas (Abuhay et al. 2025). Besides, the perspectives of researchers who have been using simulation methods to study health inequality remain underexplored. This study, hence, aims to fill these gaps based on a systematic literature review and a survey of authors who were included in the systematic review.

2 METHODS

We used a mixed-methods approach, combining a systematic literature review with a survey of researchers. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses ([PRISMA](#)) guidelines were applied, and screening was conducted using [Covidence](#). A comprehensive search was performed on PubMed, EMBASE, Scopus, Google Scholar, and Web of Science. Studies were included if they used simulation modeling, addressed health inequalities, were published in peer-reviewed journals from July 2012 to March 2025, and were available in English. An online survey containing both closed and open-ended questions on application, challenges, and future research directions was used to gather insights from authors who were included in the systematic literature review. The survey was approved by the Institutional Review Board of the University of Illinois Chicago (UIC) Office for the Protection of Research Subjects and administered using the [REDCap](#).

3 RESULTS

The systematic literature review showed an exponential rise in the use of simulation methods for health inequality research, with publications increasing from 3 in 2012 to 28 in 2024, see Fig. 1. A total of 41 researchers participated in the survey, representing diverse disciplinary backgrounds across the world. Most respondents (90%) held a PhD, with research experience ranging from 1–3 years (11%), 4–6 years (18%), to more than 6 years (68%). Participants reported using agent-based modeling (47%), system dynamics (36%), discrete event simulation (28%), hybrid models (22%), and other methods (22%) to study different health inequality issues, including healthcare access (42%), disease burden (53%), mortality rates (33%), policy impact (50%), cost-effectiveness (36%), racial/ethnic disparities (58%), socioeconomic disparities (57%), geographic disparities (29%), and other issues (6%). Their work covers North America (75%), Europe (19%), Africa (14%), Asia (17%), South America (8%), and Australia/Oceania (3%). Their biggest challenges while using simulation for healthcare inequality research are data availability (69%), data bias (35%), model validation (59%), computational complexity (21%), interpretability (38.6%), and ethical concerns (7%). While models were seen as useful for identifying disparities, 41% and 59% of participants believe that the current simulation models don't and somewhat capture the complexities of health inequalities. When asked whether current simulation models are sufficiently transparent and interpretable for decision and policy makers to act on, 33% said "no" and 67% said 'partially' and emphasized the need

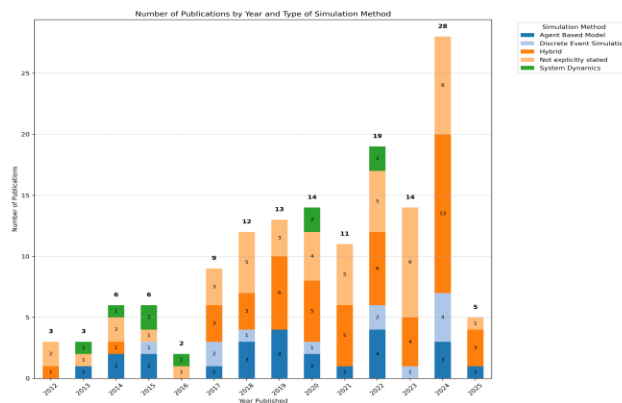


Fig. 1: Number of publications by year and simulation methods.

for greater transparency in model development and validation, better representation of intersectional factors, and caution against oversimplification and "one size fits all" approaches. Other concerns included a lack of robust frameworks or measures for equity and the challenge of translating model outputs into actionable insights for policymakers. Participants noted that methodologies were applied inconsistently, sometimes resulting in substandard work, and suggested incorporating more interdisciplinary approaches and improving training in hybrid modeling.

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