

Application and future potential of Generative Artificial Intelligence (Gen AI) and Large Language Model (LLM) in Health economics and outcomes research (HEOR)

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INTRODUCTION

Generative artificial intelligence (GenAI) refers to a deep learning model that can produce text, images, computer code, and audio-visual content in response to prompts and are powered by foundation models¹. Large language models (LLM) serve as foundation models, providing a basis for a wide range of natural language processing (NLP) tasks². LLM, as one specific application of GenAI, are specifically designed for tasks revolving around natural language generation and comprehension. LLM learn statistical patterns, grammar, and semantics from vast text datasets to predict relationships between words and phrases^{1,2}. GenAI and LLMs have emerged as key areas of innovation and discussion within numerous industries and disciplines, including healthcare, economics, and research. In the domain of Health Economics and Outcomes Research (HEOR), current practices strongly depend on human expertise, including critical thinking, domain-specific knowledge, and nuanced decision-making to evaluate health interventions, policies, and outcomes effectively. GenAI and LLMs are being examined for potential uses in HEOR, including automating large dataset analysis, processing clinical outcomes, supporting decision modeling, and generating evidence-based insights. Their use is currently at an early stage, and standardization of applications has not yet been achieved^{3,4}. While GenAI and LLMs show significant promise in automating large dataset analysis, synthesising evidence, and supporting modeling, their adoption in HEOR is hindered by concerns regarding accuracy and the necessity for expert oversight. Current HEOR practices rely heavily on human expertise, and GenAI/ LLM applications are still at a nascent stage, with no established frameworks or guidelines to ensure their responsible and effective integration. This highlights the need for robust validation methods, clearer standards, and collaborative efforts among researchers, health economists, artificial intelligence (AI) developers, and regulatory agencies to bridge the gap between technological potential and practical, reliable use in HEOR. This lack of established guidelines or frameworks implies that these technologies are not yet seamlessly integrated into HEOR workflows. Understanding the current landscape of GenAI and LLM usage is warranted to gain an understanding of how the field of HEOR is leveraging these innovations. This can further help relevant decision makers and key opinion leaders to critically evaluate what are the current strengths and limitations of using GenAI and LLM and pave the way for how their usage in HEOR can be standardized.

OBJECTIVE

The objective of this study was to evaluate the current applications of GenAI and LLMs in HEOR focusing on strengths and limitations that were observed during their applications specifically in health economic modeling and evidence synthesis.

METHOD

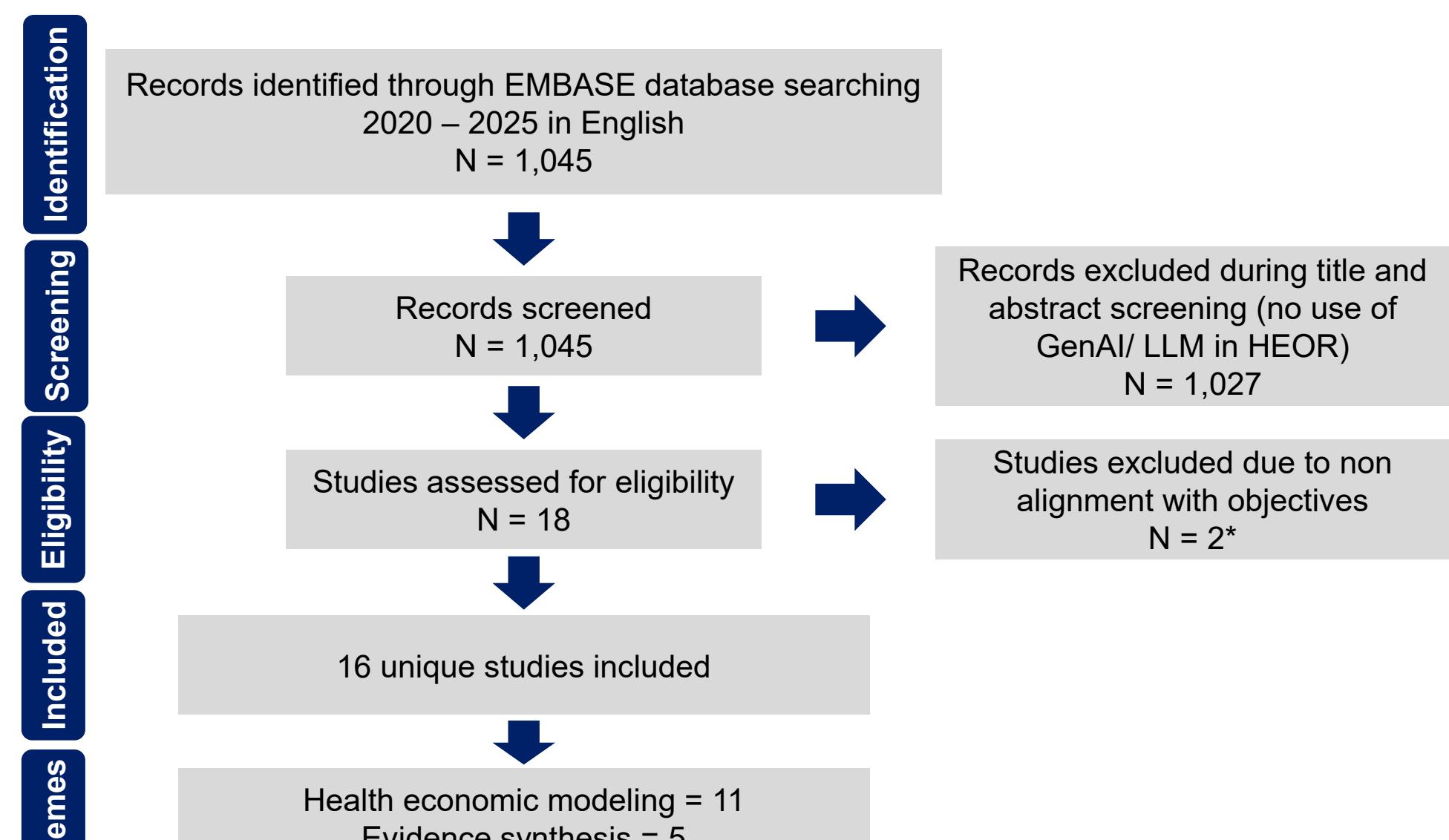
A targeted literature review (TLR) was undertaken using the EMBASE database to identify and analyze publications focusing on the application of GenAI and LLMs in HEOR. The review aimed to explore how these advanced technologies are being utilized, with a specific focus on their role in evidence synthesis and economic modeling. To carry out the review, a simple targeted search strategy was developed and implemented. This strategy involved the use of carefully chosen key terms and phrases associated with AI, LLMs, HEOR, and economic modeling. These terms were selected to ensure that all relevant literature from various subdomains of HEOR involving AI and LLMs would be captured. The search was conducted in April 2025. The search was restricted to publications from the last five years (2020-2025), English language. We included studies using GenAI and LLMs specifically for improving economic modeling or evidence synthesis processes in HEOR and excluded those that did not address these processes in this context for e.g. an HEOR study which would have used GenAI or LLM to enhance the screening process for the patients would be excluded for our purposes. However, if a cost-effectiveness model was built using the data from the same study and used GenAI or LLM to develop the model, that modeling study was included in our study. Among the total articles the title and abstracts were screened for against the selection criteria by three reviewers. All records that met the inclusion criteria were reassessed in full text independently by all three reviewers. Discrepancies were resolved by agreement or by input from another reviewer. Data extraction was done using a standardized data extraction template.

The studies identified in the review were classified into two principles themes according to the application areas of GenAI and LLMs: health economic modeling and evidence synthesis. Under the umbrella of health economic modelling, the key subthemes included model development, model adaptation, model conceptualisation, and model optimisation. For evidence synthesis, the subthemes comprised data extraction and report summarisation.

RESULTS

The TLR yielded a total of 1,045 initial results, which underwent a rigorous screening process for titles and abstracts conducted independently by three reviewers to ensure consistency and quality. Following the initial screening, the reviewers performed a full-text assessment of the relevant articles, resulting in the inclusion of 16 publications. Of these, 5 were categorized under evidence synthesis, while the remaining 11 focused on applications in health economic modeling. The findings emphasized both the potential and challenges associated with using GenAI and LLMs in HEOR.

Figure 1: Flowchart of study selection



*Please note the 2 articles were removed from the initial approved abstract with 18 articles based on the inclusion criteria.

The subthemes emerged are based on following definitions:

- Model development:** Includes building new models by conceptualizing, searching and extraction of model inputs and replicating existing models
- Model adaptation:** Gathering inputs from published sources or input files to modify or customize existing health economic models to suit different markets or scenarios.
- Model conceptualisation:** Using GenAI to design the framework and structure of health economic models, such as defining health states, transitions, and key parameters.
- Model optimisation:** Applying GenAI to enhance, review, or streamline health economic models by improving formulas, writing codes and identifying errors.
- Data extraction:** Includes retrieving quantitative and qualitative data from publications, reports, or databases.
- Reporting simplification:** Condensing complex health economic model results or evidence into clear, accessible summaries tailored for different stakeholders.

Discussion

1. Our study highlighted the growing use of GenAI and LLMs in HEOR. The application in health economic modelling outweighed the use in evidence synthesis as the primary application of GenAI and LLMs. GenAI and LLMs were used across the workflow for specific tasks. Health economic modelling applications involved data synthesis, model conceptualisation, software implementation, and quality assurance—demonstrating the versatility and increasing significance of GenAI and LLMs in the field. Usage of LLMs for evidence synthesis was primarily limited to data extraction and reporting simplification. It also involved processing large amounts of information for the purpose of extracting data and compiling reports for stakeholders based on synthesized content. AI tools were also utilized to convert technical HEOR concepts into outputs that were more accessible and easier to interpret for stakeholders. 2. The utilisation of GenAI and LLMs presented multiple advantages. These technologies supported the optimisation of health economic models through comprehensive formula review and refinement, output interpretation, and the provision of targeted recommendations for improvement. Their capacity to evaluate code, including VBA scripts, further contributed to enhanced productivity and transparency within model development. Additionally, these tools demonstrate proficiency in proposing and structuring sophisticated models, as well as accurately extracting and validating essential parameters. The ability to replicate published models and generate new ones with minimal error rates illustrates their significant potential to streamline the modelling process. 3. In terms of limitation, GenAI and LLM tools require human experts to validate results, correct mistakes, and ensure quality. While these tools can efficiently extract structured data from scientific literature for reporting and evidence synthesis, they struggle with nuanced qualitative information in economic modeling. Expert review remains essential for maintaining quality and context in health economic research. 4. The review had certain limitations. The use of a TLR rather than a systematic approach may have increased the risk of selection bias. The application of multiple reviewers, structured data extraction methods, and predefined themes for article classification helped reduce potential biases associated with the targeted literature review methodology. Another limitation was the short search time frame, which could have potentially excluded older studies. However, all selected studies were within the three-year window, indicating that the chosen time frame was appropriate for this review. 5. Overall, the integration of GenAI and LLM into health economic modeling offers substantial benefits in terms of efficiency, accuracy, and adaptability. Yet, the success of these technologies depends on thoughtful prompt design, careful tool selection, and continuous human validation to maintain high standards of quality and reliability. This review could not find studies covering application of GenAI and LLMs in some other areas of HEOR. Future areas where these tools can be used may include other established economic modeling frameworks - budget impact analysis, cost minimization, and discrete event simulation and executing the full spectrum of evidence synthesis activities like systematic literature review but not limited to the ones mentioned.

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