Systematic Literature Review of Artificial Intelligence Based Models Predicting COPD Exacerbations

CO228

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Introduction

- **High burden**
  - COPD affects ~9–10% of adults over 40 [1]
  - Chronic respiratory diseases rank as the 3rd leading cause of death worldwide [2]
- **Why it matters**
  - COPD exacerbations worsen quality of life, accelerate lung decline, and increase healthcare utilization [3]
  - Earlier exacerbation detection and management improves outcomes and speeds recovery [3]
- **Opportunity**
  - Artificial intelligence (AI) using real-world data enables the early detection and prevention of exacerbations in COPD, supporting more personalized patient care [4]

Objectives

- **To identify existing AI based prediction models for COPD exacerbations and to assess their methodological characteristics, predictive performance and clinical applicability**

Methods

- A systematic search was conducted in MEDLINE (via PubMed), Embase, and relevant grey literature sources (ERS and IPCRG congress abstracts)
- Search strings were built by combining several synonyms for COPD, exacerbation, and AI using Boolean operators (OR, AND), and limiting results to English-language publications
  - The date of search was 24th of March 2025
- Title/abstract and full-text screening were performed independently by two reviewers using Covidence
- The included studies from relevant systematic reviews were screened for additional evidence, and backward/forward citation chasing was performed using Citationchaser to identify further eligible articles
- Data extraction covered population characteristics, data sources, AI model types, predictors used, validation methods, performance metrics and clinical implementation
- Extracted data were double-checked by a second reviewer
- Methodological quality of studies was assessed using the TRIPOD+AI checklist

Table 1: PICOS criteria

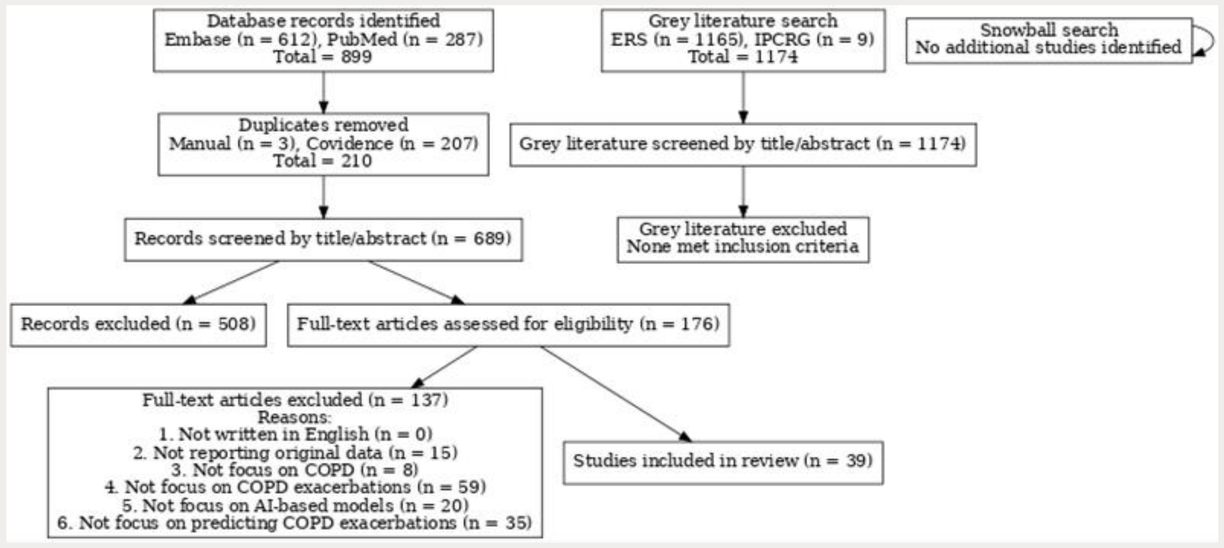
P (patient/population)	Patients with COPD
I (intervention/indicator)	Any treatment patterns
C (comparison)	Not applicable or different AI models and methodologies used in predicting COPD exacerbations
O (outcomes of interest)	Data related to AI based models that leverage comprehensive real-world data to predict COPD exacerbations, with a focus on their methodologies, predictive performance, and clinical applicability
S (study design/setting)	Primary research studies* reporting on AI based models for COPD exacerbation prediction (+ systematic literature reviews used for identifying additional studies without direct data extraction)

* No restriction on study design was used. Expert opinions, editorials, letters and non-systematic reviews were excluded.

Results

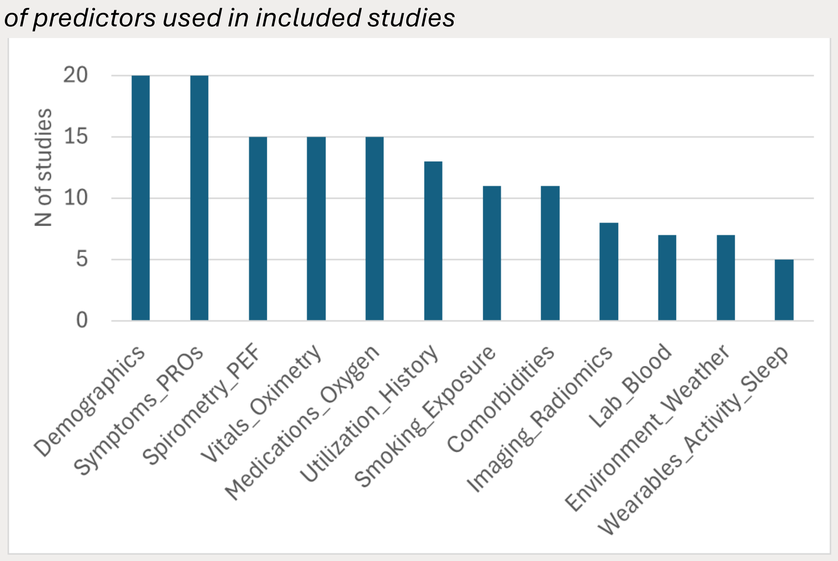
- A total of **39 studies** were included published between 2012 and 2025 were included, representing research from 16 countries

Figure 1: PRISMA flow chart



- Across the included studies, a total of **123 AI models** were identified for predicting COPD exacerbations
  - 22 studies (78 models) targeted short-term forecasting (<1 month)
  - 17 studies (45 models) addressed mid-/long-term forecasting (≥1 month)
- The most frequently applied AI approaches for the prediction of COPD exacerbation were
  - Tree-based models (34%)
  - Linear models (16%)
  - Kernel methods (15%)
- Used predictors varied between the included studies

Figure 2: Types of predictors used in included studies



- For short-term (<1 month) prediction, the best-performing models were XGBoost and logistic regression and a deep neural network
  - These models achieved accuracy values between 0.92 and 0.97
- For mid/long-term (≥1 month) forecasting, the top-ranked models included logistic regression, an auto-metric graph neural network, and a deep belief network
  - These models reported accuracies between 0.90 and 0.94
- 97.6% of the AI models applied internal validation; however, only a minority reported external validation (14.6%) or prospective validation (19.5%)

Conclusions

- **Performance and predictors of current models varied, and overall generalizability was limited**
- **Most studies relied on retrospective data, and robust external or prospective validation was often lacking, reducing confidence in their real-world applicability**
- **Medication adherence, although recognized as a key behavioural determinant, was included in only one model, and the methodology for its incorporation was not clearly described**
- **Addressing current model gaps is essential to develop reliable and clinically meaningful AI prediction tools**
- **Incorporating patient and healthcare professional perspectives prior to implementation would be crucial for clinical usability**

Funding: COPD-ALERT research project is supported by the National Research, Development and Innovation Office (NKFIH), Hungary (Grant Agreement No. 2024-1.2.3-HU-RIZONT-2024-00018).

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