

Supplementary Materials

Advances in Gastroenterology and Hepatology: A Systematic Review of NLP and LLM Applications.

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Specific Booleans used in each database.

PubMed

Search number	Query	Filters	Search Details	Results
5	("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND ("gastroenterology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "inflammatory bowel disease management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment")	English, from 2003 - 2024	((("natural language processing"[All Fields] OR "NLP"[All Fields] OR "large language models"[All Fields] OR "LLM"[All Fields] OR "BERT"[All Fields] OR "GPT-3"[All Fields] OR "GPT"[All Fields] OR "ChatGPT"[All Fields] OR "GPT-3.5"[All Fields] OR "GPT-4"[All Fields] OR "transformer language models"[All Fields]) AND ("gastroenterology"[All Fields] OR "digestive health"[All Fields] OR "gastrointestinal oncology"[All Fields] OR "endoscopic imaging"[All Fields] OR "colorectal cancer screening"[All Fields] OR "hepatocellular carcinoma"[All Fields] OR "liver fibrosis"[All Fields] OR "inflammatory bowel disease management"[All Fields] OR "IBD"[All Fields] OR "Crohn's disease"[All Fields] OR "ulcerative colitis treatment"[All Fields])) AND ((english[Filter]) AND (2003:2024[pdat]))	393
4	("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND ("gastroenterology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "inflammatory bowel disease management" OR "IBD" OR	from 2003 - 2024	((("natural language processing"[All Fields] OR "NLP"[All Fields] OR "large language models"[All Fields] OR "LLM"[All Fields] OR "BERT"[All Fields] OR "GPT-3"[All Fields] OR "GPT"[All Fields] OR "ChatGPT"[All Fields] OR "GPT-3.5"[All Fields] OR "GPT-4"[All Fields] OR "transformer language models"[All Fields]) AND ("gastroenterology"[All Fields] OR "digestive health"[All Fields] OR "gastrointestinal oncology"[All Fields] OR "endoscopic imaging"[All Fields] OR "colorectal cancer screening"[All Fields] OR "hepatocellular carcinoma"[All Fields] OR "liver fibrosis"[All Fields] OR "inflammatory bowel disease management"[All Fields] OR "IBD"[All Fields] OR "Crohn's disease"[All	404

	"Crohn's disease" OR "ulcerative colitis treatment")		Fields] OR "ulcerative colitis treatment"[All Fields])) AND (2003:2024[pdat])	
3	("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND ("gastroenterology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "inflammatory bowel disease management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment")		("natural language processing"[All Fields] OR "NLP"[All Fields] OR "large language models"[All Fields] OR "LLM"[All Fields] OR "BERT"[All Fields] OR "GPT-3"[All Fields] OR "GPT"[All Fields] OR "ChatGPT"[All Fields] OR "GPT-3.5"[All Fields] OR "GPT-4"[All Fields] OR "transformer language models"[All Fields]) AND ("gastroenterology"[All Fields] OR "digestive health"[All Fields] OR "gastrointestinal oncology"[All Fields] OR "endoscopic imaging"[All Fields] OR "colorectal cancer screening"[All Fields] OR "hepatocellular carcinoma"[All Fields] OR "liver fibrosis"[All Fields] OR "inflammatory bowel disease management"[All Fields] OR "IBD"[All Fields] OR "Crohn's disease"[All Fields] OR "ulcerative colitis treatment"[All Fields])	474
2	((("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models" OR "deep learning" OR "machine learning" OR "AI" OR "artificial intelligence" OR "text mining" OR "computational linguistics") AND ("gastroenterology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "liver diseases" OR "gastrointestinal diseases" OR "digestive system diseases" OR "inflammatory bowel disease	from 2003 - 2024	((("natural language processing"[All Fields] OR "NLP"[All Fields] OR "large language models"[All Fields] OR "LLM"[All Fields] OR "BERT"[All Fields] OR "GPT-3"[All Fields] OR "GPT"[All Fields] OR "ChatGPT"[All Fields] OR "GPT-3.5"[All Fields] OR "GPT-4"[All Fields] OR "transformer language models"[All Fields] OR "deep learning"[All Fields] OR "machine learning"[All Fields] OR "AI"[All Fields] OR "artificial intelligence"[All Fields] OR "text mining"[All Fields] OR "computational linguistics"[All Fields]) AND ("gastroenterology"[All Fields] OR "digestive health"[All Fields] OR "gastrointestinal oncology"[All Fields] OR "endoscopic imaging"[All Fields] OR "colorectal cancer screening"[All Fields] OR "hepatocellular carcinoma"[All Fields] OR "liver fibrosis"[All Fields] OR "liver diseases"[All Fields] OR "gastrointestinal diseases"[All Fields] OR "digestive system diseases"[All Fields] OR "inflammatory bowel disease management"[All Fields] OR "IBD"[All Fields] OR "Crohn's disease"[All Fields] OR "ulcerative colitis	13,056

	management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment" OR "gastrointestinal inflammation" OR "gastrointestinal imaging" OR "gastrointestinal diagnostics"))		treatment"[All Fields] OR "gastrointestinal inflammation"[All Fields] OR "gastrointestinal imaging"[All Fields] OR "gastrointestinal diagnostics"[All Fields])) AND (2003:2024[pdat])	
1	((("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models" OR "deep learning" OR "machine learning" OR "AI" OR "artificial intelligence" OR "text mining" OR "computational linguistics") AND ("gastroenterology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "liver diseases" OR "gastrointestinal diseases" OR "digestive system diseases" OR "inflammatory bowel disease management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment" OR "gastrointestinal inflammation" OR "gastrointestinal imaging" OR "gastrointestinal diagnostics"))		("natural language processing"[All Fields] OR "NLP"[All Fields] OR "large language models"[All Fields] OR "LLM"[All Fields] OR "BERT"[All Fields] OR "GPT-3"[All Fields] OR "GPT"[All Fields] OR "ChatGPT"[All Fields] OR "GPT-3.5"[All Fields] OR "GPT-4"[All Fields] OR "transformer language models"[All Fields] OR "deep learning"[All Fields] OR "machine learning"[All Fields] OR "AI"[All Fields] OR "artificial intelligence"[All Fields] OR "text mining"[All Fields] OR "computational linguistics"[All Fields]) AND ("gastroenterology"[All Fields] OR "digestive health"[All Fields] OR "gastrointestinal oncology"[All Fields] OR "endoscopic imaging"[All Fields] OR "colorectal cancer screening"[All Fields] OR "hepatocellular carcinoma"[All Fields] OR "liver fibrosis"[All Fields] OR "liver diseases"[All Fields] OR "gastrointestinal diseases"[All Fields] OR "digestive system diseases"[All Fields] OR "inflammatory bowel disease management"[All Fields] OR "IBD"[All Fields] OR "Crohn's disease"[All Fields] OR "ulcerative colitis treatment"[All Fields] OR "gastrointestinal inflammation"[All Fields] OR "gastrointestinal imaging"[All Fields] OR "gastrointestinal diagnostics"[All Fields])	14,478

Embase

('natural language processing' OR 'nlp' OR 'bert' OR 'gpt-3' OR 'gpt' OR 'chatgpt' OR 'gpt-3.5' OR 'gpt-4' OR 'transformer language models' OR 'ai language technology') AND ('gastroenterology' OR 'hepatology' OR 'gastrointestinal oncology' OR 'endoscopic imaging' OR 'colorectal cancer screening' OR 'hepatocellular carcinoma' OR 'liver fibrosis' OR 'inflammatory bowel disease management' OR 'ibd' OR 'crohns disease' OR 'ulcerative colitis treatment')

AND (2003:py OR 2004:py OR 2005:py OR 2006:py OR 2007:py OR 2008:py OR 2009:py OR 2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py OR 2019:py OR 2020:py OR 2021:py OR 2022:py OR 2023:py OR 2024:py) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ('article'/it OR 'conference paper'/it)

Scopus

(TITLE-ABS-KEY(("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models")) AND ("Gastroenterology" OR "Hepatology" OR "peptic ulcer disease" OR "PUD" OR "Endoscopy" OR "colorectal cancer" OR "hepatocellular carcinoma treatment" OR "IBD predictive modeling" OR "endoscopic imaging")) AND PUBYEAR > 2002 AND (NOT DOCTYPE(re) OR DOCTYPE(le) OR DOCTYPE(ed) OR DOCTYPE(cr) OR DOCTYPE(cp))

Web of science

TS=("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND TS=("Gastroenterology" OR "Hepatology" OR "peptic ulcer disease" OR "PUD" OR "Endoscopy" OR "colorectal cancer" OR "hepatocellular carcinoma treatment" OR "IBD predictive modeling" OR "endoscopic imaging")) AND PY=(2003-2023) NOT DT=("Review" OR "Editorial Material" OR "Letter" OR "Meeting Abstract" OR "News Item")

Cochrane library

("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND ("gastroenterology" OR "hepatology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "inflammatory bowel disease management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment")

IEEE Xplore

("natural language processing" OR "NLP" OR "large language models" OR "LLM" OR "BERT" OR "GPT-3" OR "GPT" OR "ChatGPT" OR "GPT-3.5" OR "GPT-4" OR "transformer language models") AND ("gastroenterology" OR "hepatology" OR "digestive health" OR "gastrointestinal oncology" OR "endoscopic imaging" OR "colorectal cancer screening" OR "hepatocellular carcinoma" OR "liver fibrosis" OR "inflammatory bowel disease management" OR "IBD" OR "Crohn's disease" OR "ulcerative colitis treatment")

Risk of Bias tables.

Additional information, such as sample sizes, years of publication and settings for each of the included papers can be found organized in the summary of the included studies table in the main manuscript.

Table S1: PROBAST.

Author	Risk of bias				Applicability		
	Participants	Predictors	Outcome	Analysis	Participants	Predictors	Outcome
Li et al.	low	low	low	low	low	low	low
Blumenthal et al.	low	low	low	low	high	low	low
Wang et al. (2022)	low	low	low	low	low	low	low
Sherman et al.	low	low	low	low	high	low	low

Tables S2: QUADAS.

Author	Risk of Bias				Applicability Concerns		
	Patient Selection	Index Test	Reference Standard	Flow and Timing	Patient Selection	Index Test	Reference Standard
Schneider et al.	low	low	low	unclear	low	low	low
Truhn et al.	low	low	low	low	low	low	low
Imler et al. (2013)	low	low	low	low	low	low	low
Imler et al. (2014)	low	low	low	low	high	low	low
Bae et al.	low	low	low	unclear	high	low	low
Denny et al. (2012)	low	low	low	low	high	low	low
Laique et al.	low	low	low	low	low	low	low
Harkema et al.	low	low	low	low	high	low	low
Raju et al.	low	low	low	unclear	low	low	low
Nayor et al.	low	low	low	low	low	low	low
Seong et al.	low	low	high	low	low	low	high

Lee et al.	low	low	low	unclear	high	low	low
Denny et al. (2010)	low	low	low	low	high	low	low
Parthasarathy et al.	low	low	low	low	low	low	low
Song et al.	low	low	low	unclear	high	low	low
Tinmouth et al.	high	low	low	low	high	low	low
Mehrotra et al.	low	low	low	low	low	low	low
Becker et al.	high	low	low	unclear	high	low	low
Hou et al.	low	low	low	low	high	low	low
Wenker et al.	low	low	low	unclear	low	low	low
Imler et al. (2018)	low	low	low	low	low	low	low
Li et al. (2021)	low	low	low	low	high	low	low
Li et al. (2022)	low	low	low	low	low	low	low
Stidham et al.	low	low	low	unclear	high	low	low
Ganguly et al.	low	low	low	unclear	low	low	low
Van Vleck et al.	low	low	low	low	low	low	low
Ma et al.	low	low	low	low	high	low	low
Fevrier et al.	low	low	low	low	low	low	low
Benson et al.	low	low	low	low	low	low	low
Sada et al.	low	low	low	unclear	high	low	low
Zand et al.	high	low	low	unclear	high	low	low
Ananthakrishnan et al.	low	low	low	unclear	high	low	low

Tables S3: ROBINS-I.

Author	D1	D2	D3	D4	D5	D6	D7	Overall
Kong et al.	high	high	low	low	low	low	low	moderate
Lahat et al.	high	high	low	low	low	low	low	moderate
Benedicenti et al.	moderate	high	low	low	low	low	low	moderate
Zhou et al.	high	high	moderate	low	unclear	low	low	high
Choo et al.	low	low	low	low	low	low	low	low
Huo et al.	moderate	high	moderate	low	low	low	low	moderate
Lim et al.	moderate	high	moderate	low	unclear	low	low	moderate
Lahat et al. (2023)	low	moderate	low	low	low	low	low	low
Atarere et al.	moderate	high	moderate	low	unclear	low	low	moderate
Rammohan et al.	moderate	high	moderate	low	low	moderate	low	moderate
Pereyra et al.	moderate	low	low	low	low	low	low	low
Peng et al.	low	low	low	low	low	low	low	low
Yeo et al.	low	high	low	low	low	low	low	low
Gorelik et al.	moderate	high	moderate	low	low	low	low	moderate

Samaan et al.	low	high	low	low	unclear	low	low	moderate
Cankurtaran et al.	high	high	low	low	low	low	low	moderate
Wagholikar et al.	low	low	low	low	low	low	low	low
Sciberras et al.	moderate	high	low	low	low	low	low	moderate
Gravina et al.	low	high	moderate	low	low	low	low	moderate
Pradhan et al.	moderate	moderate	moderate	low	unclear	low	low	moderate
Wang et al. (2024)	moderate	moderate	low	low	low	low	low	moderate

Abbreviations:

- D1: Bias due to confounding.
- D2: Bias in selection of participants into the study.
- D3: Bias in classification of interventions.
- D4: Bias due to deviations from intended interventions.
- D5: Bias due to missing data.
- D6: Bias in measurement of outcomes.
- D7: Bias in selection of the reported result.

Tables S4: Journals, quartiles and SJR's of the included studies.

Author	journal	Q	SJR
Kong et al.	Helicobacter	1	1.04
Schneider et al.	eClinicalMedicine	1	3.52
Lahat et al.	Diagnostics	2	0.67
Benedicenti et al.	Gastroenterology Report	2	0.86
Truhn et al.	the journal of pathology	1	2.43
Zhou et al.	International Journal of Interactive Multimedia and Artificial Intelligence	1	0.9
Choo et al.	ANZ Journal of Surgery	2	0.45
Huo et al.	Health and Technology	2	0.62
Imler et al.	Clinical Gastroenterology and Hepatology	1	3.09
Lim et al.	Clinical Gastroenterology and Hepatology	1	3.09
Imler et al.	Clinical Gastroenterology and Hepatology	1	3.09
Bae et al.	JMIR Medical Informatics	2	0.95
Denny et al.	Medical Decision Making	1	1.17
Li et al.	Cancer Medicine	1	1.17
Lahat et al.	Scientific Reports	1	0.9
Laique et al.	Gastrointestinal Endoscopy	1	1.75
Blumenthal et al.	Journal of General Internal Medicine	1	1.73
Harkema et al.	Journal of the American Medical Informatics Association: JAMIA	1	2.12
Raju et al.	Gastrointestinal Endoscopy	1	1.75
Nayor et al.	Digestive Diseases and Sciences	1	1.07
Atarere et al.	Digestive Diseases and Sciences	1	1.07

Seong et al.	BMC Medical Informatics and Decision Making	1	1
Lee et al.	Journal of Clinical Gastroenterology	2	0.91
Denny et al.	Journal of the American Medical Informatics Association: JAMIA	1	2.12
Parthasarathy et al.	Gastrointestinal Endoscopy	1	1.75
Rammohan et al.	Cuerues	NA	NA
Pereyra et al.	Journal of Clinical Gastroenterology	2	0.91
Song et al.	Journal of Clinical Medicine	1	0.88
Peng et al.	Scientific Reports	1	0.9
Tinmouth et al.	Gastrointestinal Endoscopy	1	1.75
Mehrotra et al.	Gastrointestinal Endoscopy	1	1.75
Becker et al.	International Journal of Medical Informatics	1	1.11
Hou et al.	Digestive Diseases and Sciences	1	1.07
Wang et al.	Frontiers in Artificial Intelligence	2	0.76
Yeo et al.	Clinical and molecular hepatology	1	3.13
Gorelik et al.	Gastrointestinal Endoscopy	1	1.75
Samaan et al.	Arab journal of gastroenterology	3	0.34
Cankurtaran et al.	Cuerues	NA	NA
Wenker et al.	Clinical Gastroenterology and Hepatology	1	3.09
Imler et al.	Gastrointestinal Endoscopy	1	1.75
Li et al.	Clinical Gastroenterology and Hepatology	1	3.09
Li et al.	eClinicalMedicine	1	3.52
Wagholikar et al.	Proceedings - 2012 IEEE 2nd Conference on Healthcare Informatics, Imaging and Systems Biology	NA	NA
Sciberras et al.	Journal of Crohn's & colitis	1	2.71
Sherman et al.	Hepatology communications	1	2.22
Stidham et al.	Inflammatory bowel diseases	1	1.55
Ganguly et al.	Journal of clinical gastroenterology	2	0.91

Van Vleck et al.	International journal of medical informatics	1	1.11
Ma et al.	Surgical Endoscopy and Other Interventional Techniques	1	1.12
Gravina et al.	Digestive and Liver Disease	2	0.87
Fevrier et al.	Journal of Medical Systems	1	0.97
Benson et al.	JCO clinical cancer informatics	1	1.4
Sada et al.	Medical Care	1	1.38
Zand et al.	Journal of Medical Internet Research	1	2.02
Ananthakrishnan et al.	Inflammatory bowel diseases	1	1.55
Pradhan et al.	Hepatology communications	1	2.22
Wang et al.	Journal of gastroenterology and hepatology	1	1.18

Abbreviations: Q: Quartile | SJR: SCImago Journal Rank

