

Original Article

Enteral nutrition intolerance: Evidence mapping of definitions and assessment practices to inform future gastric cancer–specific assessment tool development

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Background and Objectives: Enteral nutrition intolerance can limit achievement of nutrition goals, but its definitions and assessment methods vary widely. This review mapped operational definitions and identified evidence gaps relevant to patients after gastrectomy for gastric cancer. **Methods and Study Design:** The Web of Science Core Collection was searched for original clinical studies published from 2015 to 2025 that reported explicit operational definitions or ascertainment criteria. Study populations, feeding routes, assessment components, incidence rates, and outcomes were charted and synthesized descriptively. **Results:** Forty-seven studies were included. Most involved critically ill populations, whereas only three focused on patients after gastric cancer surgery. Definitions used heterogeneous combinations of gastrointestinal symptoms, gastric residual volume, feeding interruption or rate reduction, failure to meet energy targets, and other indicators, with inconsistent thresholds and observation windows. A preliminary three-domain framework was identified: gastrointestinal and dumping-related symptoms, route-appropriate objective indicators, and treatment response or feeding adjustments. **Conclusions:** Existing definitions are heterogeneous and largely derived from intensive care settings. Standardized reporting and disease-specific validation are required before a gastric cancer-specific assessment tool can be developed.

Key Words: enteral nutrition intolerance, gastric cancer, evidence mapping, assessment tool, enteral nutrition

INTRODUCTION

Gastric cancer (GC) is one of the most common malignant tumors of the digestive tract worldwide and ranks fifth in both incidence and mortality.¹ Owing to factors such as tumor consumption, neoadjuvant therapy, and anatomical and physiological changes after gastrectomy, the incidence of perioperative malnutrition in patients with gastric cancer can reach 80%, as defined by a Patient-Generated Subjective Global Assessment (PG-SGA) score ≥ 4 .² Studies have shown that malnutrition is closely related to increased postoperative complications, prolonged hospital stays, and poor prognosis.³ Therefore, providing active and effective nutritional support during the perioperative period has become an important treatment measure to improve the prognosis of gastric cancer patients. According to the guidelines of the European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN), enteral nutrition (EN) is the preferred energy supply route.^{4,5}

However, the implementation of EN is often challenging in patients after gastric cancer surgery, and enteral nutrition intolerance (ENI) is one of the main limiting factors in clinical practice. ENI usually manifests as nausea, vomiting, abdominal distension, abdominal pain,

diarrhea and constipation, which may lead to subjective discomfort, slowing down/interruption of feeding and insufficient energy intake. The literature reports that the incidence of ENI in patients after radical gastrectomy for gastric cancer ranges from 49.3% to 68%,^{6,7} but the incidence varies greatly among different studies due to differences in the definition of ENI. At present, there is still a lack of unified and operable definitions and assessment criteria for ENI. In clinical practice, ENI is usually determined through a combination of clinicians' experience, symptom observation, and assessment of energy-target achievement; some clinical practices still refer to assessment indicators used in intensive care unit (ICU) populations, such as monitoring gastric residual volume (GRV).

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However, GRV is not applicable to patients who have undergone total gastrectomy or are fed through a naso-jejunal feeding tube or jejunostomy; even in measurable scenarios, the correlation between GRV and energy target achievement or complications is still controversial. Furthermore, the occurrence of ENI in ICU patients is usually associated with factors such as sedation, high-dose vasoactive drugs, and antibiotics, which is quite different from the pathophysiological basis of patients after gastric cancer surgery.

Therefore, this study aimed to map how ENI has been defined and assessed in recent clinical studies and to identify evidence gaps relevant to postgastrectomy gastric cancer. Rather than estimating pooled effects, this review focuses on operational definitions, assessment components, reporting practices, and their implications for future disease-specific assessment tool development. The findings are intended to provide a conceptual basis and practical reporting framework for developing and validating a gastric cancer-specific ENI assessment tool in future research.

METHODS

Review design and reporting framework

This study was designed as a Web of Science Core Collection (WOSCC)-based evidence-mapping review to describe how ENI has been operationally defined and assessed in recent clinical studies and to identify evidence gaps relevant to postgastrectomy gastric cancer. The methodological approach was informed by scoping review methodology, particularly in defining the research question, selecting eligible studies, charting data, and summarizing evidence; however, given the single-database scope, this study is presented as a WOSCC-based evidence map rather than as a full scoping review, exhaustive systematic review, or meta-analysis. Because the primary objective was to map definitions, assessment components, and reporting practices rather than to estimate pooled effects, quantitative synthesis was not planned.

Search strategy

A core concept term strategy was used to balance search relevance and sensitivity. The Topic (TS) field was searched using the following expression: TS = ("Enteral Nutrition Intolerance*" OR "Intestinal nutrition intolerance*" OR "Feeding intolerance*"). The document type was limited to original articles, and the search period was from January 1, 2015, to December 1, 2025. A sensitivity search using the synonym "Enteral Feeding Intolerance*" was also conducted to evaluate search coverage. No additional eligible records were identified after merging the sensitivity search results with the main search and removing duplicates.

Eligibility criteria

Studies were included if they met all of the following criteria: (1) adult patients receiving EN; (2) original clinical research, including interventional and non-interventional studies; and (3) explicit operational definition or ascertainment criteria for ENI, feeding intolerance, enteral feeding intolerance, or tube-feeding intolerance in the context of EN.

Studies were excluded if they: (1) mentioned ENI or related terms without providing an operational definition or ascertainment criteria; (2) were reviews, editorials, letters, conference abstracts, protocols without results, case reports, or guidelines; (3) focused on pediatric populations; or (4) provided insufficient methodological or operational information to determine eligibility or extract ENI-related data.

Study selection and data charting

After duplicate records were removed using Microsoft Excel, two trained reviewers independently screened titles and abstracts according to the predefined eligibility criteria. Potentially relevant records were retrieved for full-text review. The same two reviewers independently assessed the full texts, and disagreements at either stage were resolved through discussion. If consensus could not be reached, a third reviewer was consulted for adjudication. Reasons for full-text exclusion were recorded and summarized in the study selection flow diagram.

Data were extracted using a structured Excel-based data-charting form developed before formal extraction. The extracted variables included DOI, article title, first author, publication year, journal, study background, methods, research topic, main results, conclusions, sample size, study design (prospective or retrospective; randomized controlled trial or cohort study), operational definition of ENI, ENI incidence, EN route, EN initiation time, enteral formula, and study population. Data extraction was conducted by two reviewers and checked for consistency. Any discrepancies were resolved through discussion or consultation with a third reviewer. Formal inter-rater agreement statistics, such as Cohen's kappa, were not calculated.

Terminology

In this review, ENI was used as the umbrella term. Studies using related terms such as "feeding intolerance," "enteral feeding intolerance," or "tube-feeding intolerance" were included when the intolerance occurred in the context of EN and an operational definition was provided. For consistency, ENI is used throughout the manuscript unless referring to the exact terminology used in an original study.

Assessment of methodological quality

Formal risk-of-bias assessment was not performed because the purpose of this evidence map was to characterize operational definitions, assessment components, and reporting practices rather than to evaluate intervention efficacy or synthesize effect estimates. Instead, the review focused on extracting reporting elements relevant to reproducibility, including study design, population, sample size, feeding route, EN initiation time, operational ENI definition, reported incidence, and outcomes. This limitation is addressed in the Discussion.

Data synthesis

Extracted data were summarized descriptively. Studies were grouped by clinical setting/population, study design, feeding route, ENI definition components, and reported outcomes. ENI definition components were categorized

into gastrointestinal symptoms, GRV, feeding interruption or rate reduction, energy-target failure, and other indicators. Reported ENI incidence rates were summarized descriptively rather than pooled because of substantial heterogeneity in population, operational definitions, thresholds, observation windows, and denominators.

Ethics statement

Institutional review board approval was not required because this review used data from previously published studies and did not involve direct participation of human subjects, identifiable personal information, or animal experiments.

RESULTS

Study selection and included studies

The search identified 2,950 records. After title and abstract screening, 2,791 records were excluded, leaving 159 full-text articles for eligibility assessment. During full-text review, 112 articles were excluded for the following reasons: no operational ENI definition or ascertainment criteria ($n = 71$), non-adult or otherwise ineligible population ($n = 27$), and insufficient ENI-related data for extraction ($n = 14$). Finally, 47 studies met the eligibility criteria and were included in the evidence map. The study selection process is shown in Figure 1.

Populations and clinical settings represented

ENI studies focused primarily on critically ill patients, accounting for more than 60% of the included studies. In contrast, evidence specific to patients after gastrectomy for gastric cancer is relatively scarce. Studies conducted outside the ICU were scattered across heterogeneous surgical and medical inpatient populations receiving EN, with significant differences in feeding routes and clinical pathways.

How ENI was operationally defined and assessed

Across studies, ENI was operationalized using heterogeneous combinations of five major components: gastrointestinal symptoms, GRV, feeding interruption or rate reduction, failure to achieve energy targets, and other indicators such as intra-abdominal pressure, imaging findings, or gastrointestinal bleeding. Gastrointestinal symptoms commonly included nausea, vomiting, abdominal distension, abdominal pain, diarrhea, and constipation; however, symptom lists, severity thresholds, and observation windows varied across studies. GRV was frequently used in ICU or gastric feeding settings, but thresholds differed and were not applicable to postgastrectomy patients without a gastric reservoir or those receiving jejunal feeding. Feeding interruption, rate reduction, inability to advance EN, or escalation to alternative feeding routes were also used, but these criteria may be influenced by local practice patterns. Energy-target failure was used in some studies, although target calculation methods and time windows were inconsistently reported. Overall, many studies did not provide sufficient operational detail to allow direct replication of ENI ascertainment.

Reported incidence and study outcomes

Reported ENI incidence varied substantially across populations and operational definitions, ranging from approximately 3.5% to 81.9%.^{8,9} The broadest variation was observed in ICU populations, where reported incidence ranged from approximately 21% to 81.9%.^{9,10} Because populations, ENI definitions, observation windows, and denominators differed substantially, incidence estimates were summarized descriptively rather than pooled. Existing studies primarily focused on ENI incidence, risk factors, and prediction models; some studies assessed associations between ENI and nutritional delivery outcomes, such as feeding interruption or failure to meet energy/protein targets, and clinical outcomes, such as complications and length of stay. Only three studies focused on

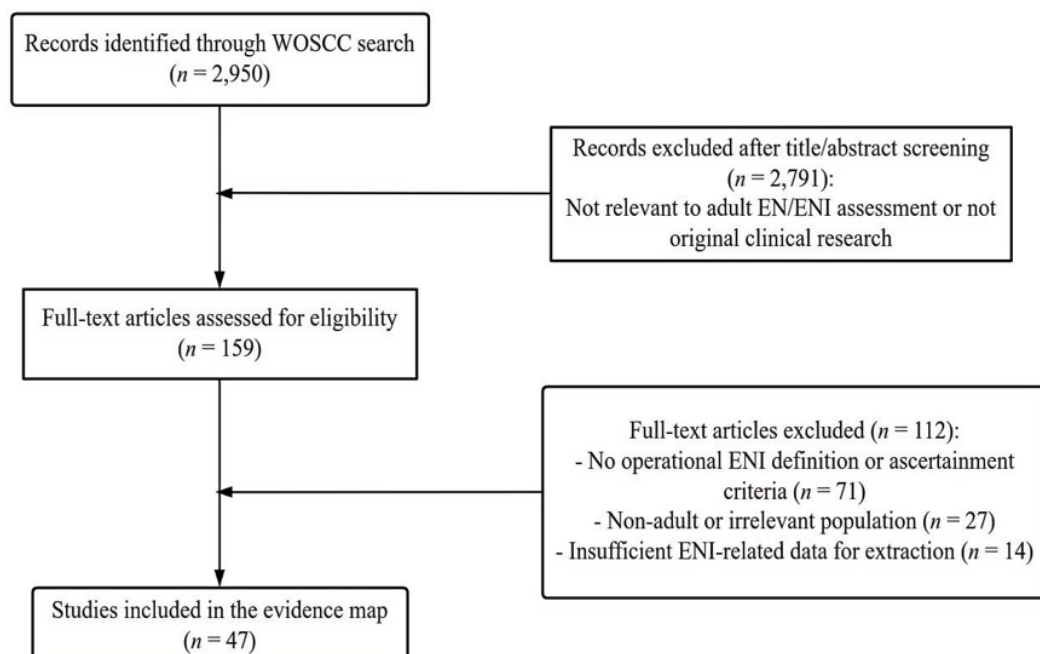


Figure 1. Study selection flow diagram

patients after gastric cancer surgery, highlighting the lack of disease-specific measurement evidence and supporting the need for standardized, route-appropriate ENI assessment frameworks in this population.

DISCUSSION

What the evidence map shows: current status, trends, and evidence gaps

This WOSCC-based evidence map shows that ENI research has expanded over the past decade but remains concentrated in ICU populations and prediction-model studies. The central finding is not the publication trend itself, but the persistent heterogeneity in how ENI is defined, measured, and reported. Across studies, ENI was operationalized using different combinations of gastrointestinal symptoms, GRV, feeding interruption or rate reduction, energy-target failure, and other indicators, with variable thresholds and observation windows. This heterogeneity limits comparability across studies and complicates translation into standardized bedside protocols. The evidence gap is particularly important for postgastrectomy gastric cancer, where altered anatomy, reconstruction type, vagal manipulation, and dumping-related manifestations may make ICU-derived indicators less applicable. These findings support the need for standardized reporting before a validated disease-specific assessment tool can be developed.

Heterogeneity in the Definition and Reporting Practice of ENI

Over 60% of studies focused on ICU patients, with limited research on postoperative populations; only three studies focused on patients after gastric cancer surgery. However, ENI is not unique to critically ill patients, especially after gastric cancer surgery. Changes in anatomical structure and functional reconstruction make ENI more distinctive. Underrepresentation of this population may obscure postgastrectomy-specific intolerance patterns and limit the applicability of current evidence to gastric cancer care. Second, in the 47 articles included in this study, ENI definitions incorporated multiple dimensions, such as gastrointestinal symptoms, GRV, failure to meet energy intake targets, feeding interruption, and intra-abdominal pressure. Some studies even used self-defined criteria or provided insufficient operational details, leading to significant differences in the incidence of ENI among similar studies. This inconsistency in definitions makes it difficult to compare research results; the results of intervention studies may reflect changes in diagnostic criteria rather than genuine improvements in tolerability, thus affecting the generalizability of intervention programs. Furthermore, the initiation time, route, formulation, and infusion strategy of EN vary across studies, making cross-study comparisons and evidence integration difficult even in similar populations.

The nutritional pathways and unique characteristics of ENI in patients after gastric cancer surgery

Postoperative gastric cancer patients face multiple physiological and pathway challenges in EN management, which means that their ENI has significant disease characteristics. The stomach serves as a reservoir that regu-

lates mechanical digestion and controlled emptying of ingested nutrients. Both partial gastrectomy and total gastrectomy can lead to severe damage or even complete loss of these functions.¹¹ After gastrectomy, owing to the lack of buffer and storage space, nutrient mixtures may enter the jejunum rapidly with limited buffering capacity, creating osmotic and volume-related stimulation of the small intestine. Clinically, this can manifest as early dumping syndrome and upper gastrointestinal symptoms, such as nausea, vomiting, abdominal distension, palpitations, and sweating.¹² These changes constitute the physiological basis for the reduced feeding tolerance threshold after surgery. Second, intraoperative digestive tract reconstruction (such as Billroth II or Roux-en-Y) alters the flow of food, causing the nutrient solution to mainly enter the alimentary limb, while bile and pancreatic juice flow into the intestinal lumen via the biliopancreatic limb; the mixing point of the two shifts distally, resulting in a loss of synchronicity between the release of digestive juices and the arrival of nutrient solution in time and space.¹³ Bile and pancreatic juice may mix with nutrient flow more distally in the lower duodenum or the middle and lower jejunum, leading to insufficient digestion and absorption of fat and protein. Indigestion and incomplete fat absorption are the main causes of steatorrhea or osmotic diarrhea.¹⁴ Different reconstruction techniques (such as Roux-en-Y vs others) differ in complications such as reflux esophagitis, dumping, and Roux retention, which in turn affect the tolerance of oral/enteral feeding.^{15,16} In addition, gastrectomy may involve vagal nerve (VN) manipulation or transection, depending on the surgical procedure. The VN is the longest cranial nerve in the body. It not only provides key parasympathetic innervation for the gastrointestinal tract and pancreas but also participates extensively in the regulation of the cardiovascular, respiratory, immune and endocrine systems.¹⁷ This not only affects gastrointestinal motility but also changes gastric acid secretion, gastric emptying and hormone levels, leading to neurohormonal disorders.¹⁸ In summary, postoperative ENI in patients with gastric cancer cannot be characterized simply by gastrointestinal symptoms and GRV; rather, it represents a multidimensional condition influenced by anatomical, neurohormonal, and feeding-pathway factors. Especially in the case of total gastrectomy or postpyloric feeding, the traditional approach of relying on GRV is limited; however, using only general gastrointestinal symptom scales may miss related atypical manifestations. These features support the need for a postgastrectomy-specific assessment framework and future validation of disease-specific tools.

The disconnect between existing assessment tools and clinical practice

Currently, commonly used assessment tools in clinical practice include the Gastrointestinal Symptom Rating Scale (GSRS), Acute Gastrointestinal Injury (AGI) grading, and I-FEED score, but the applicable populations and the threshold standards for these tools are not consistent. The GSRS was created in the 1980s and is one of the classic gastrointestinal symptom scales. However, it was initially used for patients with chronic diseases (such as irritable bowel syndrome and inflammatory bowel dis-

ease).¹⁹ Moreover, the items of the GSRS do not include key contents such as dumping syndrome, feeding interruption, formula adjustment or energy target achievement. AGI is mainly used to assess the gastrointestinal organ dysfunction grade (I-IV) of ICU patients²⁰ and includes feeding intolerance as one of the manifestations of gastrointestinal function impairment, emphasizing organ function and prognosis. However, there is currently a lack of specific validation of the reliability and validity of AGI grading in ENI identification, severity stratification and its association with clinical outcomes (energy target achievement, complications, and length of hospital stay) for patients after radical gastrectomy for gastric cancer. I-FEED, as a grading framework for postoperative gastrointestinal function, has been preliminarily validated in colorectal surgery²¹ and has been shown to be correlated with clinical outcomes such as length of hospital stay and complications in other specialties, such as orthopedics²² and obstetrics and gynecology.²³ However, for postoperative ENI in patients with gastric cancer, I-FEED currently lacks evidence of disease-specific reliability and validity and does not include key management and outcome dimensions, such as feeding interruption/energy target achievement/tube feeding pathway. Therefore, existing tools may be useful for symptom description or background risk stratification in postoperative ENI management after gastric cancer surgery, but they are insufficient to directly support disease-specific goals, including standardized identification, severity stratification, and management-linked decision-making. This mismatch between tools and scenarios also explains why individual studies often define or combine indicators differently, thereby further aggravating the heterogeneity of studies.

Need for a future disease-specific ENI assessment framework

Currently, the definition of ENI involves multiple indicators, such as symptoms, GRV, and energy target achievement, leading to significant inconsistencies in the correlation between incidence and outcomes across studies. Future development of a validated gastric cancer-specific ENI assessment tool could help address this measurement gap and support more precise nutritional management. Its value lies primarily in improving assessment sensitivity, standardizing what should be measured and how to measure it, reducing incomparability across studies and centers, and promoting the standardization of perioperative pathways. Symptoms resulting from gastric surgery, including changes in digestive tract structure and function and vagus nerve manipulation, are distinctly different from those in the ICU or other surgical fields. Furthermore, the choice of postoperative feeding route renders traditional indicators such as GRV ineffective. The Postgastrectomy Syndrome Assessment Scale-45 (PGSAS-45), developed by a multicenter team in Japan, provides a useful example. It combines the 8-item Short Form Health Survey, 15 GSRS items, and 22 items selected by gastric surgeons, and has been used in large postgastrectomy cohorts to compare surgical procedures and reconstruction methods and to describe disease-specific symptoms and quality of life.²⁴ This experience suggests that disease-specific measurement in postgas-

trectomy populations is feasible. For ENI assessment, however, feeding-process variables—such as feeding interruption, rate reduction, formula adjustment, and energy-target achievement—should be incorporated into the conceptual framework.

Implications for future assessment framework development

Until a validated gastric cancer-specific ENI assessment tool is available, a preliminary three-domain framework may help standardize bedside observation and future research reporting: (1) gastrointestinal and dumping-related symptoms; (2) route-appropriate objective indicators; and (3) treatment response or feeding adjustments. This framework should be viewed as a conceptual basis rather than a validated scale. Future tool development should include systematic item generation, expert consensus, patient input, content validity testing, scoring-rule development, inter-rater reliability assessment, construct validation, and evaluation of associations with clinical outcomes such as energy/protein delivery, complications, and length of stay.

To improve reproducibility, we also propose a minimum reporting set for future ENI studies in postoperative gastric cancer and upper gastrointestinal surgery (Table 1).

Limitations and challenges

This study has several limitations. First, this evidence map was limited to WOSCC-indexed original studies. Although WOSCC provides standardized indexing and multidisciplinary coverage, studies indexed exclusively in PubMed, Embase, Cochrane Library, regional databases, or unpublished sources may have been missed. Therefore, the findings should be interpreted as a structured WOSCC-based evidence map rather than an exhaustive systematic review of all ENI literature. Future systematic or scoping reviews should use comprehensive multi-database searches and focus specifically on patients undergoing gastrectomy for gastric cancer to provide a more complete synthesis of disease-specific ENI definitions, assessment practices, incidence estimates, and related clinical outcomes. Second, formal risk-of-bias assessment was not performed because the objective was to map operational definitions, assessment components, and reporting practices rather than to evaluate intervention effects or synthesize pooled estimates. Third, substantial heterogeneity in populations, ENI definitions, thresholds, observation windows, and denominators limited direct comparison of incidence estimates. Finally, evidence specific to postgastrectomy gastric cancer remains limited, and the proposed framework should be considered preliminary. Future research is needed to generate items, establish content validity, develop scoring rules, and test reliability, construct validity, responsiveness, and clinical utility.

Conclusion

In summary, ENI research over the past decade remains concentrated in critically ill populations, whereas studies directly addressing postgastrectomy gastric cancer are limited. Operational definitions vary widely and commonly combine gastrointestinal symptoms, GRV, feeding

Table 1. Minimum reporting set for ENI studies after gastric or upper gastrointestinal surgery

Category	Minimum elements to report
Population & surgery	cancer type/stage; procedure (distal/total/proximal gastrectomy); reconstruction (Billroth I/II, Roux-en-Y); postoperative day/time when EN initiated
Feeding protocol	route (gastric vs postpyloric/jejunal); formula type/osmolality; initiation time; advancement schedule; target energy/protein calculation method
Operational definition of ENI	symptom list included; objective indicators and thresholds; observation window; whether feeding interruption/rate reduction counts as ENI
Management actions	criteria for rate reduction/hold; medications (prokinetics/antiemetics/acid suppression); formula switch; escalation to postpyloric feeding; supplemental PN criteria
Outcomes	energy/protein delivery (% target) at prespecified time points; aspiration/pneumonia; GI complications; length of stay; readmission; patient-reported comfort or satisfaction
Assessment processes	who assessed ENI (nurse/dietitian/physician); standardized training; interrater approach if applicable; handling of missing data

EN, enteral nutrition; ENI, enteral nutrition intolerance; GI, gastrointestinal; PN, parenteral nutrition.

interruption or rate reduction, and energy-target failure, which constrains comparability and translation into standardized protocols. Given postgastrectomy-specific anatomical and functional features, a disease-specific ENI assessment tool may be needed in the future. This evidence map provides a preliminary conceptual framework and minimum reporting set to support future tool development, validation, and implementation in nutrition support practice.

DISCLOSURE ON THE USE OF AI AND AI-ASSISTED TECHNOLOGIES

AI-assisted language proofreading was performed using DeepSeek (large language model). The authors have reviewed and edited the manuscript and accept full responsibility for the final content.

CONFLICT OF INTEREST AND FUNDING DISCLOSURES

The authors declare no conflict of interest.

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