

REVIEW

## What is the role of physical exercise after surgery for gastric cancer? A scoping review

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The overall role of physical exercise (PE) in addressing the disabling effects of gastric cancer (GC) after surgery remains uncertain. This scoping review (ScR) aims to systematically collect, map, and present the current evidence on studies reporting data on PE in individuals with GC. This ScR followed the 2020 recommendations of the *Joanna Briggs Institute Methodological Guidance* and adhered to the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews*. A comprehensive search was conducted in PubMed, Scopus, and the Cochrane Central Register of Controlled Trials (CENTRAL) up to January 2024. Original studies were identified, and findings were presented both numerically and thematically. Out of 1115 articles initially identified, 9 studies met the inclusion criteria. The number of publications on this topic has increased over time, with most studies conducted in Western countries. Of the included studies, 6 (66.7%) were primary research articles, while 3 (33.3%) were systematic reviews. The overall sample size comprised 226 individuals, with a mean age of  $61 \pm 5.3$  years. The studies consistently reported a positive impact of PE in both inpatient and outpatient settings. However, significant heterogeneity was observed in the types and characteristics of PE, outcome measures, and reference populations. Physiotherapists were the primary healthcare professionals involved in delivering care. This review highlights the need for further high-quality studies dedicated to investigating the role of PE after surgery for GC. In addition, multidisciplinary rehabilitation is recommended to address the complex needs of this patient population.

**Key words:** gastric cancer, physiotherapy, rehabilitation, scoping review, epidemiology

### INTRODUCTION

Gastric cancer (GC) was responsible for over one million new cases in 2020 and an estimated 769 000 deaths, ranking fifth in incidence (5.6%) and fourth in mortality (7.7%) worldwide.<sup>1</sup> Incidence rates are highest in Eastern countries of Asia and Europe, while lower rates are recorded in northern countries of America, Europe, and Africa.<sup>1</sup>

About 90% of GCs are adenocarcinoma.<sup>2</sup> GC is classified into two topographical subgroups: cardia (20%) and non-cardia (80%). Obesity, gastroesophageal reflux, and Epstein–Barr virus infection are the main risk factors for upper stomach cancer, while alcohol, high salt intake, low consumption of fruits and vegetables, and *Helicobacter pylori* infection are associated with lower stomach cancer.<sup>2</sup>

In the early stages, GC may be asymptomatic, while in advanced stages, the clinical features include asthenia, dysphagia, vomiting, weight loss, and anemia.<sup>3</sup> In many cases, the diagnosis is often made when the disease has reached an advanced or metastatic stage, characterized by a significant reduction in quality of life (QoL) due to persistent pain, respiratory difficulties, and impairments in basic body movements such as walking, sitting, or dressing.<sup>4</sup> Mood and psychological disorders are also often present.<sup>5</sup>

Oncological treatments (i.e. surgery, chemotherapy, and radiotherapy) are of primary importance, but a rehabilitative approach addressing the principal issues resulting from GC should also be recommended.<sup>6</sup>

A systematic review (SR) reported the positive effects of physical exercise (PE) on esophageal and gastro-esophageal cancers during preoperative, perioperative, and post-operative periods; however, further evidence was needed to understand the real contribution of PE to GC after surgery.<sup>7</sup> Another SR highlighted the potential of PE to enhance physical function; however, most of the studies included only focused on esophageal cancers.<sup>8</sup>

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To our knowledge, there is currently no comprehensive overview of the effect of PE on the disabling consequences of GC after surgery. Therefore our goal was to gather, evaluate, and summarize the existing evidence through a scoping review (ScR) to map the literature.<sup>9</sup> Contrary to an SR of the literature, an ScR tends to cover broader topics, including various study designs. It avoids overly focused research questions or does not evaluate the quality of the studies included in the search.<sup>9</sup>

The following study question was formulated: ‘What does the existing literature reveal about the impact of post-operative physical exercise as a consequence GC?’. In particular, the goals of this investigation were (i) to conduct an ScR to systematically map and summarize the literature by reporting post-operative data on the PE of individuals with GC; (ii) to identify any potential gaps in knowledge related to this topic; (iii) to provide indications and recommendations for clinicians, researchers, and third parties regarding the management of the disabling effects of GC.

## METHODS

The protocol of this ScR was registered in the Open Science Framework database (<https://doi.org/10.17605/OSF.IO/6V2TE>).

This research was conducted following the ‘2020 version of the Joanna Briggs Institute Reviewers’ Manual’<sup>10</sup> and the ‘Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews’ (PRISMA-ScR) checklist.<sup>11</sup> The PRISMA checklist is accessible as [Supplementary Table S1](https://doi.org/10.1016/j.esmogo.2024.100117), available at <https://doi.org/10.1016/j.esmogo.2024.100117>.

Studies were included in the ScR if they met specific criteria related to population, concept, and context.<sup>9</sup>

In terms of population, we considered original research studies involving individuals from any country who had undergone surgery for GC; cases where GCs extended to the esophagus were also included. However, studies focusing on tumors involving bowel cancers were excluded.

The concept focused on the post-operative impact of PE in managing the disabling effects of GC across various rehabilitation settings, including inpatient/outpatient, and home-based facilities. We thus included studies that reported indicators relevant to the contribution of PE (e.g. pain, disability, QoL, motor abilities, body composition, and blood chemistry), as recently suggested.<sup>12</sup> Conversely, we excluded (i) studies that investigated the pre- and perioperative effects of PE; (ii) studies that examined the effects of PE on other clinical outcomes (e.g. survival rate, imaging) or broader health outcomes (e.g. access to health services, clinical preventive services, environmental quality); (iii) studies that monitored long-term (i.e. >1 year) motor performance after treatment cessation; (iv) feasibility studies that evaluated the effects of PE; and (v) studies that addressed physical activity (i.e. any body movement requiring energy expenditure without the specific aim of recovering physical abilities).

SRs, randomized controlled trials (RCTs), observational studies, and case reports were considered without any restrictions in terms of time, setting, or country; narrative reviews, letters to editors, and commentaries were excluded. Only articles written in English were included. The literature was searched from inception to January 2024.

The existing literature was searched by consulting the following evidence-based biomedical repositories: PubMed, Scopus, and Central (Cochrane). Furthermore, we carried out a hand search of reference lists. Query strings were tailored to the functionality of each database, incorporating Medical Subject Headings (MeSH) terms where applicable. The queries are provided in [Supplementary Table S2](#), available at <https://doi.org/10.1016/j.esmogo.2024.100117>.

The web app ‘Rayyan—The Intelligent Systematic Review’ web app ([www.rayyan.ai](http://www.rayyan.ai)) was used to manage the search strategy results.<sup>13</sup>

Duplicates were automatically removed, and records were initially screened by title and/or abstract, followed by full-text review. Two blinded authors (MM and BR) independently screened the studies, with any disagreements resolved through a discussion with a third author (FDF). The main characteristics of the included articles, in line with the goals of this ScR, were documented using a preestablished data extraction form. This form was collaboratively developed, reviewed, and adopted by the authors. The key features extracted from the included works were year of publication and country, type of journal, study aims, study design, sample size, description of the exercise-based activity (including typology, duration, frequency, intensity, and timing), healthcare professionals involved, outcome measures used, and the population under study. In addition, a summary of the major findings was reported.

Data were presented both numerically and thematically. Descriptive statistics were provided, including details (when relevant) on means, standard deviation, median, interquartile ranges, and percentages for the relevant outcomes.<sup>14</sup>

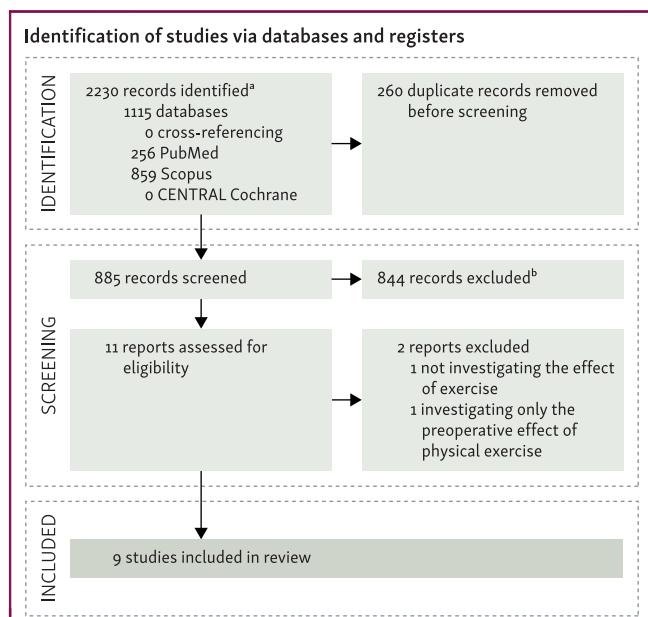
Findings were evaluated by two blinded reviewers (MM and BR), and subsequently, specific thematic areas were identified through discussions with a third author (FDF).

## RESULTS

A total of 1115 articles were identified through the initial database search. After removing 260 duplicates, 855 studies remained for the title and abstract screening. Of these, 844 did not meet the inclusion criteria and were consequently excluded. After the full-text review, two additional records were excluded with reasons. Consequently, nine studies were included in the qualitative synthesis.<sup>7,8,15-21</sup> Further details about the article selection process are provided in the PRISMA flow diagram ([Figure 1](#)).

### General overview of the studies

Among the included articles, 6 (66.7%) were primary research studies (3 RCTs and 3 observational studies; [Table 1](#)).<sup>15-20</sup> The remaining 3 (33.3%) studies were



**Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.**

<sup>a</sup>We included articles with indicators as: pain, disability, QoL, motor abilities, body composition, and blood chemistry. <sup>b</sup>We excluded: studies investigating the pre- and peri-operative effect of PE; studies investigating the effect of PE on other clinical or health outcomes; studies that monitored the long-term motor performance after cessation of treatment; feasibility studies evaluating the effect of PE; and studies dealing with physical activity (i.e. any movement of the body that requires energy expenditure without the aim of specifically recovering physical abilities).

SRs.<sup>7,8,21</sup> Geographically, most studies (6/9, 66.7%) were conducted in North America and Europe.<sup>7,8,16,18,19,21</sup> The remaining studies (3/9, 33.3%) were conducted in West Asia and North Africa.<sup>15,17,20</sup> Over time, the number of publications increased, with most concentrated between 2018 and 2023 (7/9, 77.8%).<sup>7,17,18,18-21</sup> In terms of publication outlets, most studies (7/9, 77.8%) were published in oncological and gastroenterological journals.<sup>7,8,16,17,19,21</sup> One study (11.1%) appeared in a physiotherapy/rehabilitation journal,<sup>15</sup> and 2 studies (22.2%) were published in surgical journals.<sup>18,20</sup> The primary research studies included in this ScR involved 226 participants (mean 37.7, median 36, interquartile range 18-63). The mean age of the participants was  $61 \pm 5.3$  years. Gender was reported in 5 studies, with 30 (55.6%) participants identified as female<sup>16-20</sup> (Table 1).

### Physical exercise

The RCTs and observational studies consistently implemented general PE, which included mobilization activities, strengthening programs, cardiorespiratory training, and walking. The exercises targeted the entire body, including the arms, trunk, and legs. All studies reported the duration of treatment and the frequency of sessions,<sup>15-20</sup> while the intensity was described in three studies<sup>18-20</sup> and the duration of individual sessions was reported in one paper.<sup>15</sup> Physiotherapists were the most frequently involved healthcare professionals ( $n = 3$ ).<sup>15,16,20</sup> In terms of context,

the investigations were conducted in inpatient settings ( $n = 3$ )<sup>15,17,20</sup> and outpatient ( $n = 3$ )<sup>16,18,19</sup> facilities. All primary research studies indicated that PE significantly contributed to improvements in the outcome measures assessed.<sup>15-20</sup>

### Outcome measures

The RCTs and observational studies used different types of outcome measures. Specifically, pain and disability were assessed in one article,<sup>16</sup> QoL in four,<sup>17-20</sup> motor ability in two,<sup>17,20</sup> body composition in four,<sup>17-20</sup> and blood chemistry in one.<sup>15</sup>

### Populations under study

Among the primary research articles, three studies included individuals with GC,<sup>15,17,20</sup> while the remaining studies included individuals with cancers that also extended into the esophagus.<sup>16,18,19</sup> All the SRs included studies addressing gastroesophageal cancers.<sup>7,8,21</sup>

### Thematic areas

As a result of the review process, the authors reached a consensus identifying four thematic areas that emerged from this literature mapping: (i) a growing interest, though not uniformly distributed; (ii) heterogeneity of exercises; (iii) heterogeneity of outcome measures; and (iv) heterogeneity of the reference populations.

These topics are discussed in the following section.

### DISCUSSION

This ScR provides a summary of the literature regarding the contribution of PE to the recovery of patients with GC after surgery. Our findings indicate a growing interest in this field, suggesting that this ScR accurately represents the current evidence. However, the number of RCTs on this topic remains low, with only three conducted to date. Consequently, an increase in high-quality original research is anticipated to provide more evidence in this area. Overall, the included studies reported a positive impact of PE in mitigating the disabling consequences of GC in both inpatient and outpatient settings.

Most studies included in this ScR consist of RCTs and analytical observational studies, which investigated cause-effect relationships between interventions and outcomes using robust study designs.<sup>9</sup> This review also includes two SRs that examined studies covering the preoperative and perioperative phases.<sup>7,8</sup> Thus more evidence is recommended to specifically evaluate the impact of PE during the post-operative phase.

Most investigations originated from North America, Europe, and Asia.<sup>7,8,16,18,19,21</sup> However, additional data from other regions are recommended to facilitate the sharing of clinical experiences and outcomes across different cultural contexts. Another notable finding is that most studies were published in oncological, gastroenterological, and surgical journals, with only a minority

**Table 1.** Main characteristics of the primary studies included in the mapping review

	Na et al., 2000 <sup>15</sup>	Chasen and Bagharva, 2010 <sup>16</sup>	Cho et al., 2018 <sup>17</sup>	O'Neill et al., 2018 <sup>18</sup>	Kennedy et al., 2021 <sup>19</sup>	Nishida et al., 2023 <sup>20</sup>
Geographic area	Asia	North America	Asia	Europe	Europe	Asia
Journal type	Oncology	Gastroenterology	Gastroenterology	Surgery	Gastroenterology	Surgery
Study design	Randomized controlled trial	Clinical trial	Clinical trial	Randomized controlled trial	Randomized controlled trial	Clinical trial
Study period (months)	Not available	Not available	12	13	Not available	13
Setting	Inpatient	Outpatient	Inpatient	Outpatient	Outpatient	Inpatient
Rehabilitation stage	Post-operative	Post-operative	Post-operative	Post-operative	Post-operative	Post-operative
Total female sample size (N)	35 (not available)	53 (11)	20 (9)	63 (8)	37 (7)	18 (6)
Exercise modality	General exercise	General exercise	General exercise	General exercise	General exercise	General exercise
Treatment protocol	Standard	Semistandard	Standard	Standard	Semistandard	Semistandard
Area of application	Whole body	Whole body	Whole body	Whole body	Whole body	Whole body
Was the treatment duration reported?	Yes	Yes	Yes	Yes	Yes	Yes
Was the treatment frequency reported?	Yes	Yes	Yes	Yes	Yes	Yes
Was the treatment intensity reported?	No	No	No	Yes	Yes	Yes
Was the duration of each session reported?	Yes	No	No	No	No	No
Healthcare professional involved	Physiotherapist	Physiotherapist	Other	Team	Team	Physiotherapist
Concomitant oncological therapies	No	No	No	No	No	No
Concomitant rehabilitative therapies	No	Yes	No	Yes	Yes	No
Comparison	Not available	Not available	Not available	No treatment	No treatment	Not available
Primary outcomes	Blood analysis	Pain and quality of life	Adverse events and adherence	Cardiorespiratory fitness, body composition, and quality of life	Body composition and quality of life	Body composition, quality of life, and motor abilities
Were medium- or long-term follow-ups considered?	No	No	Yes	Yes	Yes	Yes
Was the efficacy for the primary outcome reached?	Yes	Yes	Yes	Yes	Yes	Yes

appearing in physiotherapy or rehabilitation journals. This is rather surprising, given that PE was the primary focus of these investigations, which should align closely with the readership of rehabilitation journals. More original publications in these journals are therefore expected.

The descriptions of exercise-based activities consistently provided a comprehensive understanding of the interventions' characteristics. Mobilization activities, strengthening programs, cardiorespiratory training, and walking exercises were commonly included in general physiotherapy programs. We recommend focusing on specific clinical evaluations to develop more detailed rehabilitative protocols rather than relying on generic exercises. This should include a thorough inspection of the locomotor system, an assessment of joint mobility, an evaluation of muscle strength and abnormalities or pain/tenderness, and a peripheral neurological examination, which considers reflexes (superficial/deep responses) and sensitivity (superficial/deep). Additional assessments, such as evaluating walking, balance, and transfers, are essential for completing a functional evaluation, as previously proposed for other populations.<sup>22,23</sup>

All the included studies provided comprehensive information on treatment duration and exercise session frequency. However, many authors did not provide detailed information about two aspects of PE: session duration and intervention intensity. This may be attributed to the use of semistandardized protocols and the physical deconditioning that often results from cancer.<sup>15,18-20</sup>

The primary healthcare professionals involved in delivering care were physiotherapists. Given the diverse features of the disease, a multidisciplinary approach to rehabilitation should be implemented to enhance the effectiveness of the intervention. Other allied healthcare professionals can play key roles in rehabilitation. For example, *rehabilitation nurses* can care for dependent or semidependent individuals and educate patients with disabilities. *Speech therapists* can assess and treat swallowing and breathing problems, while *clinical psychologists* can provide mental health support through psychological evaluations and talk therapy, helping patients cope with life challenges and interpersonal issues.<sup>24</sup> Multidisciplinary care should also include oncologists, who are involved from treatment to follow-up, and abdominal surgeons,

who manage oncological conditions affecting the gastrointestinal tract. In addition, orthodontists and oral surgeons may be involved when GC extends to the oral cavity, treating teeth and jaw irregularities as well as temporomandibular joint disorders.<sup>25,26</sup>

The researchers in the included studies used several outcome measures to assess the impact of PE, which represents a notable strength. Pain, disability, and QoL were commonly evaluated using patient-reported outcome measures. In rehabilitation studies, it is essential to thoroughly investigate such measures to provide a comprehensive assessment of individuals.<sup>14</sup> We further recommend reporting the minimum clinically important differences of a patient-reported outcome measure, defined as the smallest change in the score of a construct that patients perceive as meaningful. This addition would strengthen the findings of future research.<sup>14</sup> Some studies also examined the effects of PE on motor abilities, body composition, and blood chemistry. This is particularly noteworthy, as these outcomes may contribute to slowing the progression of cancer and alleviating its symptoms.<sup>27</sup>

In addition, many articles included in this study focused on esophagogastric cancers. This emphasizes the importance of planning clinical studies that specifically address the impact of PE in individuals with GC to generate more evidence on this specific condition. A selective focus on GC will allow researchers and clinicians to concentrate on signs and symptoms specific to the stomach, rather than on those related to the upper esophageal region (e.g. coughing, hoarseness, choking on food, or difficulty swallowing). This approach will enable the development of tailored physical evaluations and rehabilitation treatments.

This study acknowledges several limitations. First, we included only studies that primarily focused on GC, which may have led to the exclusion of relevant records that could have influenced our findings. Furthermore, our search strategy might have overlooked some pertinent studies. Besides, we restricted our reporting to original research, thereby excluding other forms of literature, such as editorials, letters, and narrative reviews.

In conclusion, this study reviewed the existing literature on the overall positive impact of PE in mitigating the disabling effects of general complications after surgery. The findings demonstrate a growing interest in this field in recent years. However, significant variability was observed in the types of exercises used, the outcome measures employed, and the reference populations studied. Based on these observations, we provided recommendations aimed at enhancing research quality and advancing rehabilitative approaches in this area.

### Research agenda

- Conduct trials and observational studies to evaluate the efficacy of PE in the post-operative setting.

- Design multidisciplinary rehabilitation interventions to address and investigate the disabling consequences of GC.
- Utilize outcome measures capable of estimating the minimal clinically important difference at both individual and group levels to evaluate disability comprehensively.

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### DISCLOSURE

The authors have declared no conflicts of interest.

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