Original Article

Feasibility of a Home-Based Multimodal Prehabilitation Program for Patients Undergoing Esophagectomy: A Prospective Feasibility Study in a Portuguese Tertiary Hospital

Viabilidade de um Programa Multimodal de Pré-Habilitação Domiciliária em Doentes Propostos para Esofagectomia: Estudo Prospetivo de Viabilidade num Hospital Terciário Português

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ABSTRACT

Introduction: Esophageal cancer is a lethal malignancy and can be treated with neoadjuvant therapy and esophagectomy, a complex procedure associated with significant morbidity. Prehabilitation is increasingly recognized as an important part of perioperative optimization of patients' physical and mental status before surgery and can potentially improve postoperative outcomes. The feasibility of prehabilitation before surgery within the Portuguese public healthcare system remains unclear. This study aims to evaluate the feasibility, acceptability, and safety of a home-based multimodal prehabilitation program for esophageal cancer patients in a tertiary hospital.

Methods: This prospective, interventional feasibility study consisted of a home-based program combining aerobic and resistance training with nutritional support. Feasibility outcomes included recruitment, completion, dropout and adherence rates. Acceptability among patients and healthcare professionals was assessed using a Likert scale. Safety was evaluated by recording adverse events during the intervention period.

Results: Between January and May 2026, eight patients were screened, seven were enrolled, four completed the program (recruitment rate: 100%; completion rate: 57.1%) and three patients were discontinued due to disease progression. Adherence to the exercise program was 64.2%, and participation in weekly monitoring calls reached 100%. No exercise-related adverse events occurred. The intervention was well accepted by patients and healthcare professionals.

Conclusion: This home-based program proved to be feasible and safe, showing high patient engagement and retention. The findings also highlight the importance of organizational support and workflow adjustments. Nevertheless, the small number of patients screened over three months and the fact that only four completed the full program indicate that recruitment and retention will require careful attention before a larger trial.

Keywords: Enhanced Recovery After Surgery; Esophageal Neoplasms/surgery; Esophagectomy; Nutritional Status; Nutrition Therapy; Postoperative Complications/prevention & control; Preoperative Care; Preoperative Exercise

RESUMO

Introdução: O cancro do esófago é uma neoplasia letal frequentemente tratada com terapia neoadjuvante e esofagectomia, uma cirurgia complexa associada a morbilidade significativa. A pré-habilitação é um componente importante na otimização perioperatória do estado funcional dos doentes, podendo melhorar os resultados pós-operatórios. A viabilidade da pré-habilitação cirúrgica no sistema público de saúde português permanece incerta. Este estudo visa avaliar a viabilidade, aceitabilidade e segurança de um programa de pré-habilitação domiciliária em doentes com neoplasia do esófago num hospital terciário.

Métodos: Este estudo prospetivo, intervencional e de viabilidade consistiu num programa multimodal domiciliário com treino aeróbio e de força muscular e suporte nutricional. Resultados de viabilidade incluíram taxas de recrutamento, conclusão, desistência e adesão. A aceitabilidade foi avaliada com escala de Likert. A segurança foi avaliada através do registo de eventos adversos.

Resultados: Entre janeiro e maio de 2026, foram abordados oito doentes, sete incluídos, quatro concluíram o programa (taxa recrutamento: 100%; taxa conclusão: 57,1%) e três descontinuados por progressão da doença. A adesão ao programa de exercício foi 64,2% e a monitorização semanal atingiu 100%. Não ocorreram eventos adversos associados ao exercício. A intervenção foi bem aceite por doentes e profissionais de saúde.

Conclusão: Este programa domiciliário provou ser exequível e seguro, demostrando elevado envolvimento e retenção dos doentes. Os resultados destacam também a importância do apoio organizacional e de ajustes no fluxo de trabalho. No entanto, o pequeno número de doentes identificados ao longo de três meses e o facto de apenas quatro terem concluído o programa, indicam que o recrutamento e a retenção vão exigir um cuidado acrescido antes de um ensaio de maior dimensão.

Palavras-chave: Complicações Pós-Operatórias/prevenção & controle; Cuidados Pré-Operatórios; Esofagectomia; Estado Nutricional; Exercício Pré-Operatório; Neoplasias Esofágicas/cirurgia; Recuperação Pós-Cirúrgica Melhorada; Terapia Nutricional

INTRODUCTION

Esophageal cancer is a highly lethal malignancy worldwide, ranking among the leading causes of cancer-related mortality.[1] For locally advanced cases, standard curative treatment involves multimodal therapy, combining esophagectomy with neoadjuvant chemotherapy (NAC) or chemoradiotherapy

(CRT).[2] Despite advances in minimally invasive techniques, esophagectomy remains a highly invasive procedure with substantial morbidity and mortality, frequently complicated by pulmonary, anastomotic, and cardiac events.[3]

To improve perioperative outcomes and standardize care for this high-risk population the Enhanced Recovery After Surgery (ERAS®) Society developed an evidence-based perioperative protocol, which includes a moderate recommendation for prehabilitation.[4]

Prehabilitation is defined as rehabilitation before surgery: a continuum of care whose goal is to optimize the patient's physiological state between diagnosis and surgery. Multimodal prehabilitation programs include structured exercise training, nutritional support, psychological counselling, and medical optimization. These programs usually start by assessing the baseline function of the patient, identifying pre-existing limitations and physiological vulnerabilities, followed by interventions designed to improve patient health before surgery and treatment outcomes.

This concept is particularly relevant in esophageal cancer, where many patients are older, frail, physically inactive, and burdened by multiple comorbidities. Tumor-related dysphagia, anorexia, cancer cachexia, and sarcopenia frequently lead to progressive functional decline and malnutrition before treatment even begins.[5,6] Malnutrition affects up to 80% of esophageal cancer patients and is a major risk factor for postoperative morbidity and mortality in gastrointestinal surgical patients.[5] This physiological state is often inadequate to withstand the major stress of surgery, exacerbating surgical risk and reducing tolerance to treatment.[5,6]

Patients who adhered to a personalized exercise program showed better skeletal muscle preservation and improved nutritional status.[7] In addition to preventing weight loss, preoperative nutrition also helps maintain muscle mass, strengthens the immune system, and improves wound healing. These factors are essential to lower the risk of infectious complications and enhance the body's ability to withstand the metabolic stress of surgery.[8] Therefore, maintaining an adequate nutritional status is essential when preparing for esophageal surgery.

Prehabilitation improves neoadjuvant treatment tolerance,[9] enhances inspiratory muscle function, reducing postoperative pneumonia and hospital stay[10,11] and maintains or improves cardiorespiratory fitness during NAC.[12,13]

To optimize compliance, the delivery method is crucial and a key part of the proposed protocol is its home-based design. The rationale for this choice is supported by evidence suggesting that reducing the burden of travel is essential to optimize patient participation.[14] This is particularly relevant for oncology patients, who already face a high frequency of appointments, as well as for those facing significant travel distances to the hospital.

Recent evidence demonstrates that home-based prehabilitation achieves higher compliance rates than hospital-supervised interventions while being equally effective in maintaining cardiorespiratory fitness and improving functional capacity during NAC.[15] Systematic reviews also confirm that home-based exercise programs are generally feasible and can achieve good adherence. However, both the magnitude of these benefits and the feasibility of delivery vary according to cancer type, treatment pathway, and implementation model, so evidence generated in one setting cannot be assumed to transfer directly to esophageal cancer patients treated within a public healthcare system.[16]

Given this, it seems logical that improving patients' physiological reserve before surgery may enhance their ability to withstand surgical stress. This could lead to better recovery, reduced postoperative complications, shorter hospital stays, lower readmission rates, and potentially improved overall survival.

Despite growing evidence acknowledging prehabilitation's benefits and feasibility, structured programs have not yet been systematically implemented in standard clinical guidelines. Furthermore, the recruitment, adherence, and retention are highly context-dependent and influenced by logistical and organizational factors.

In this context, it remains unclear whether a structured multimodal prehabilitation program can be feasibly implemented for esophageal cancer patients undergoing NAC and esophagectomy in a Portuguese tertiary hospital. This knowledge gap forms the basis for the present feasibility study.

This study was designed to evaluate the feasibility of implementing a multimodal home-based prehabilitation program for esophageal cancer patients, undergoing NAC and surgery.

By assessing recruitment, adherence, completion and dropout rates, as well as the acceptability and safety of the intervention, this work may inform the design of a future randomized controlled trial (RCT), while recognizing that the

recruitment and retention challenges observed here will need to be addressed before a larger study is undertaken.

MATERIAL AND METHODS

1. STUDY DESIGN

This was a prospective, interventional, single-center feasibility study taking place in the Department of General Surgery at the Hospital Universitário de Coimbra (HUC) – Unidade Local Saúde (ULS) Coimbra, Coimbra, Portugal. It was conducted according to the Declaration of Helsinki 2013 and approved by the Ethics Committee of the ULS Coimbra (Date 29/12/2025; Nº 519/25CE). All patients provided written informed consent.

Patients were approached on their first visit after being referred to the multidisciplinary esophagogastric team upon the completion of the diagnosis of esophageal cancer. Patients aged over 18 years with potentially resectable esophageal cancer planned for both NAC and surgery were considered eligible and were invited to participate in the program. Metastatic esophageal cancer, medical or physical conditions that contraindicate exercise, or inability to provide informed consent were the exclusion criteria. Patients were recruited between January and March 2026, and follow-up for the prehabilitation intervention continued until May 2026.

Sociodemographic and clinical data were collected by the study team through a structured interview at the baseline visit and were cross-checked against the patient's electronic medical record.

2. INTERVENTION

Patients were enrolled in a multimodal prehabilitation program encompassing exercise and nutritional support, developed by a MDT comprising surgeons, a nutritionist, and a physiatrist.

2.1. EXERCISE

In our study, participants began with an initial personalized session in the Department of Physical Medicine and Rehabilitation conducted by two department nurses. The goal of this session was to introduce the exercise protocol, demonstrate all the exercises and correct techniques through guided practice, and answer any questions or concerns the patients might have.

Before starting the intervention, we conducted a baseline physical assessment to gather important health information. This included measuring their weight, height, a spirometry test to assess lung function, a 6-minute walk test (6MWT) to evaluate their endurance, and handgrip strength using a Charder MG4800 hand dynamometer to assess muscle strength. Habitual physical activity level was assessed through a structured interview about weekly activity habits, and nutritional status were evaluated by the study team using body mass index, recent weight loss, and the ESPEN criteria.

The prescribed exercise program combined aerobic and strength training. Following the World Health Organization (WHO) Guidelines, we aimed for patients to participate in at least 150 minutes of moderate- to vigorous-intensity aerobic activity each week.[17] The goal was to break this down into three to five sessions of around 30 minutes each. Examples of aerobic exercises included walking, jogging, swimming, and cycling, which allowed for variety and personalization based on each individual's preferences. The target intensity corresponded to a moderate-to-vigorous level, equivalent to a Borg CR10 rating of perceived exertion (RPE) of 3 to 5; frequency and duration were progressed as tolerated over the program.

The strength training part was based on international recommendations and consisted of 2 to 3 sessions weekly. Each session included 3 sets of 10 to 12 repetitions of various exercises, such as calf raises, sit-to-stands, biceps curls, shoulder elevation, chest presses, and hip abductions – aimed to target major muscle groups.[18,19]

Each set was performed at an intensity allowing completion with approximately one to two repetitions in reserve, and resistance was progressed by increasing repetitions, sets, or added load once the target was comfortably achieved. The study team encouraged patients to progressively increase their exercise workload based on their reported RPE and individual tolerance during weekly monitoring calls. Patients undergoing concurrent neoadjuvant treatment were instructed to adopt a more conservative progression if they experienced fatigue.

Given that the patients had different fitness levels at the start, we adjusted both the intensity and duration of the workouts throughout the program to match their individual abilities and comfort levels. Each patient received a detailed educational booklet (Supplementary Data I). This booklet outlined the exercise guidelines and offered practical tips for incorporating these lifestyle changes into their daily lives.

Resistance training relied on body-weight exercises alongside low-cost, accessible options—such as elastic resistance bands, light free weights if patients already owned them, or common household substitutes—to avoid imposing any additional financial burden on participants. For participants with higher baseline fitness, body-weight-only exercises may

have provided an insufficient training stimulus, which was considered a tailoring and feasibility issue even though the study was not designed to assess efficacy.

2.2. NUTRITION

The nutritional component was delivered to all participants through an educational booklet (Supplementary Data II), developed by a dietitian from the Nutrition Department in accordance with the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines for surgery and oncology.[6,8] Individual nutritional consultations were not routinely provided. However, referral to the Nutrition Department was available for high-risk patients, identified through weekly monitoring calls or routine hospital visits by the surgical and oncology teams.

The diet plan was balanced and adapted to each patient's individual needs, particularly for those experiencing dysphagia. This plan included guidelines for calorie, protein, and carbohydrate intake, as well as fruit and vegetable consumption. An energy and protein-enriched diet is the preferred way to maintain or improve nutritional status.

Patients were advised to eat five to six small meals throughout the day and we also recommended modifying food textures to soft, pureed, or liquid forms for those experiencing swallowing difficulties.

Oral nutritional supplements (ONS) were prescribed whenever a diet alone was insufficient to meet nutritional requirements. In the ten days before surgery, patients were instructed to take specific ONS – such as Meritene Extra Protein®, Fresubin®, Fortimel Protein®, or TDiet 2® – between their main meals. This strategy ensured an adequate intake of both energy and protein, which is essential to prepare the body for the surgical procedure.

Because ONS are not covered by the national health system, patients were responsible for their cost, which may have limited uptake; actual use of the prescribed supplements was checked during the weekly monitoring calls.

Enteral nutrition was considered for patients who could not meet their nutritional needs through diet and oral supplements alone. If enteral feeding was not possible or was inadequate, parenteral nutrition was then considered.

Patients received weekly phone calls conducted by the study team to monitor nutritional intake, check exercise adherence and to record any adverse events. During these calls, a structured interview was used to systematically screen participants for nutritional risk, evaluating perceived weight loss, dietary changes, appetite reduction, and worsening dysphagia.

Any adaptations (for example, substitution of specific exercises, adjustment of intensity, or modification of meal texture) could be made at any time by the physiatrist or the dietitian in response to patient-reported difficulties recorded during the weekly calls; as reported in the Results, no structured modifications of the exercise plan were ultimately required during the study period.

3. OUTCOMES

The study's main outcomes were to assess the feasibility of the program, including the recruitment rate, completion and dropout rate, as well as adherence to the home-based program, acceptability and safety of the intervention.

Recruitment rate was defined as the number of eligible patients who agreed to be part of the program, compared to the total number of patients initially approached.

Completion rate refers to the number of patients who completed the program. Dropout rate represents the number of patients who dropped out during the study.

Adherence to the home-based exercise program was defined as the primary feasibility outcome, while recruitment, completion, dropout, acceptability, and safety were considered secondary feasibility outcomes. In this manuscript, adherence refers to the proportion of prescribed exercise sessions actually completed, whereas participation in the weekly monitoring calls reflects follow-up engagement and does not, by itself, indicate exercise performance.

Feasibility was assessed for the full multimodal program, encompassing both the exercise and the nutritional components. A priori, the program was considered feasible if the recruitment rate exceeded 70%, the completion rate exceeded 50%, and no serious exercise-related adverse events occurred. An average of 75% total adherence was considered an acceptable goal, a threshold consistent with the a priori feasibility criteria adopted in comparable home-based prehabilitation studies.[16,22] These data were obtained during weekly telephone contacts.

Patient and healthcare professional acceptability of the home-based prehabilitation program was assessed using a Likert scale. A Likert scale is a type of rating scale in which

respondents indicate their level of agreement or disagreement with a series of statements, and it is designed to measure attitudes, opinions, preferences, and satisfaction regarding a specific construct.[20]

In this study, a 5-point Likert scale was used, ranging from "strongly disagree" to "strongly agree", and including items on clarity of instructions, feasibility, perceived safety, perceived benefit, motivation, and willingness to recommend the program.

Finally, safety was monitored by recording the frequency of any major or minor adverse events related to the exercise intervention.

4. STATISTICAL ANALYSIS

Neither a control group nor a formal sample size calculation were included in this study, as these were not aligned with our main objectives. In line with recommendations for pilot and feasibility studies, including the CONSORT 2010 extension for randomised pilot and feasibility trials and related guidance for non-randomised feasibility studies,[23-28] the sample size was not based on a formal power calculation but was determined pragmatically by the number of eligible patients presenting at our center during the recruitment period, reflecting feasibility rather than effectiveness aims.

Descriptive statistics were used to summarize the participants' demographic and clinical characteristics. Categorical variables were presented as frequencies and percentages (n, %). Continuous variables were presented as mean ± standard deviation (SD).

RESULTS

Clinical and demographic characteristics of the included patients are shown in Table 1.

During the recruitment period (January – March 2026), 8 patients referred to our esophagogastric center were identified as potentially eligible for the study. However, only 7 of these met the inclusion criteria; one patient was excluded due to cervical-esophageal cancer without surgical treatment. No patient declined to participate, so all eligible patients were enrolled after providing written informed consent, corresponding to a recruitment rate of 100%. The flow of patients from screening through the end of prehabilitation is represented in Fig. 1.

The completion rate was 57.1%. Four patients completed the full prehabilitation program and were included in the study's

Table 1. Sociodemographic and clinical characteristics of the study participants (n = 4).

Variable	Total (N = 4)
Age (Mean years ± SD)	61.5 ± 9.1
Gender (Male)	4 (100.0) [1]
Residence (Mean km to Coimbra ± SD)	102.5 ± 64.4
Higher Education Degree (Yes)	1 (25)
Comorbidities	
Cardiovascular disease	0 (0)
Hypertension	2 (50)
Liver disease	0 (0)
Chronic pulmonary disease	0 (0)
History of pneumonia (Yes)	2 (50)
DM	0 (0)
History of substance abuse (Yes)	1 (25)
Smoking Habits	
Current	2 (50)
Past	1 (25)
Never	1 (25)
Units (Mean Pack-Years + SD)	47.3 ± 27.7
Alcohol Consumption	
Current	1 (25)
Past	2 (50)
Never	1 (25)
Units (Mean g/day + SD)	71.7 ± 10.4
Tumor Histology	
Adenocarcinoma	2 (50)
Squamous cell carcinoma	2 (50)
Tumor Stage (cTNM)[2]	
cT3N0M0	3 (75)
cT3N1M0	1 (25)
Tumor Location	
Thoracic (superior or middle)	2 (50)
Thoracic (lower)	0 (0)
GEJ Siewert Type I	1 (25)
GEJ Siewert Type II	1 (25)
Treatment Characteristics	
Neoadjuvant CRT	2 (50)
Perioperative CT	2 (50)
ECOG Performance Status	
0	2 (50)
1	1 (25)
2	1 (25)
Weight Loss ≥ 10% last year (Yes)	3 (75)

[1] Results are expressed as frequency (percentage) unless otherwise indicated.
[2] CTNM: clinical tumor-node-metastasis; GEJ: gastroesophageal junction; CRT: chemoradiotherapy; CT: chemotherapy; ECOG: Eastern Cooperative Oncology Group.

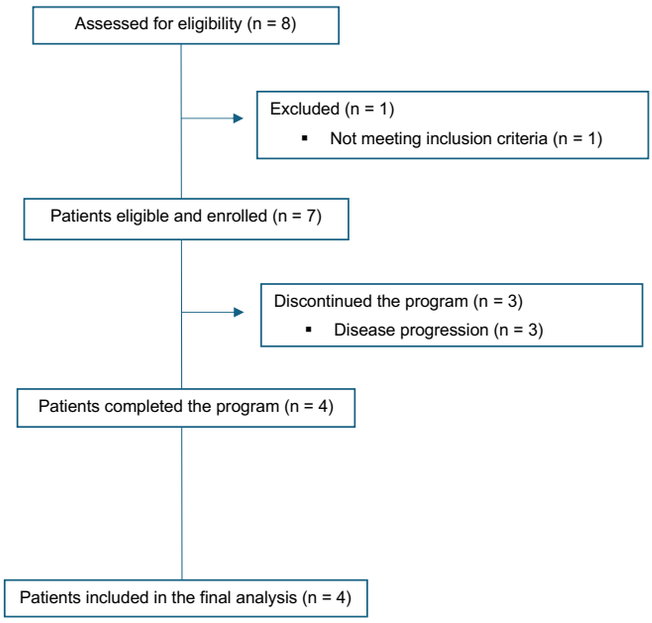

Figure 1. Flow diagram of patient enrollment and follow-up.

final analysis. Three patients were discontinued due to disease progression and loss of curative intent. No patients dropped out during the intervention period.

Three out of the four patients (75.0%) who completed the program attended their first session at the Physical Medicine Department, with one absence due to logistical constraints. Baseline physical performance of the three patients and anthropometric data are detailed in Table 2. Habitual physical activity level, assessed by structured interview at baseline, varied markedly across the participants, ranging from largely sedentary to regularly physically active.

Participants followed two distinct timelines relative to neoadjuvant treatment: two patients (50.0%) underwent prehabilitation before initiating neoadjuvant therapy (either NAC or CRT), while two patients (50.0%) completed the prehabilitation program after finishing their neoadjuvant treatment.

The mean duration of the exercise program was 40.3 days (14-70). For patients starting prehabilitation after NAC, the mean duration was 24.5 days (14-35), while those starting before NAC completed a mean of 56 days (42-70).

Overall adherence to the exercise program was 64.2% (48.3%-83.3%), with one participant achieving the predefined threshold of 75%. Adherence to aerobic exercise

Table 2. Baseline physical performance and respiratory function characteristics (n = 3).

Variable	Patient 1	Patient 2	Patient 3	Mean ± SD
BMI (kg/m²)[1]	17.87	20.32	24.97	**21.05 ± 3.61**
Spirometry				
FVC (L)	3.82	2.87	3.78	**3.49 ± 0.54**
FEV1 (L)	3.17	1.76	3.40	**2.78 ± 0.89**
PEF (L/s)	7.56	2.92	5.80	**5.43 ± 2.34**
FEV1/FVC Ratio (%)	83	61	89	**77.7 ± 14.7**
6MWT				
Distance (m)	547.8	380.6	527.0	**485.1 ± 91.1**
RPE – baseline	0.0	1.0	2.0	**1.0 ± 1.0**
RPE – end of test	1.0	3.0	2.0	**2.0 ± 1.0**
RPE – after resting	0.0	1.0	2.0	**1.0 ± 1.0**
Dynamometry				
Strength (kgf)	25.5	37.7	40.0	**34.4 ± 7.8**

[1] BMI: body mass index; FVC: forced vital capacity; FEV1: forced expiratory volume in the first second; PEF: peak expiratory flow; 6MWT: 6-minute walk test; RPE: rating of perceived exertion (Borg CR10 Scale).

was 61.3% (17.0%-100.0%) and to resistance exercise was 67.1% (41.7%-100.0%). Adherence to the weekly phone calls for exercise and nutritional monitoring was 100%. The use of an exercise diary was reported by one patient, although none achieved regular documentation.

The most frequently reported barriers to exercise adherence were bad weather and lack of motivation. No serious adverse events or exercise-related injuries were reported during the intervention period, and no modifications of the exercise structured plan were required.

Regarding the nutritional component, only one patient was identified as high-risk and formally referred to a specialized dietitian consultation. Oral nutritional supplements (ONS) were recommended to and utilized by all participants except one, who maintained adequate oral intake and showed no clinical need. Prescription translated directly into active use across all recommended patients.

The acceptability scale was completed by three out of four patients (75% response rate). One questionnaire was not collected due to the participant's hospitalization before the assessment could be conducted. The acceptability results,

Table 3. Patient acceptability of the prehabilitation program: Likert Scale (N=3)

Item	Mean (SD)	Median	Range	Interpretation
Clarity of home exercise instructions	4.00 (0.00) [1]	4.00	4-4	Favorable response
Ease of performing exercises at home	4.00 (0.00)	4.00	4-4	Favorable response
Acceptability of the required effort	3.67 (0.58)	4.00	3-4	Moderately favorable response
Perceived safety of the exercises	4.00 (0.00)	4.00	4-4	Favorable response
Perceived benefit for surgical preparation	3.00 (1.00)	3.00	2-4	Neutral
Motivation to perform exercises regularly	3.67 (0.58)	4.00	3-4	Moderately favorable response

[1] Results are based on a 5-point Likert scale (1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree).

Table 4. Healthcare professionals' acceptability of the prehabilitation program: Likert Scale (N=4)

Item	Mean (SD)	Median	Range	Interpretation
Ease of explaining program instructions to patients	4.75 (0.50) [1]	5.00	4-5	Strongly favorable response
Feasibility of integration into daily clinical routine	4.00 (0.82)	4.00	3-5	Favorable response
Confidence in the safety of home exercises	5.00 (0.00)	5.00	5-5	Strongly favorable response
Perceived positive impact on patient surgical outcomes	5.00 (0.00)	5.00	5-5	Strongly favorable response
Recommendation for hospital-wide implementation	5.00 (0.00)	5.00	5-5	Strongly favorable response

[1] Results are based on a 5-point Likert scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree.

assessed through the Likert scale, are presented in Table 3. All items achieved mean scores at or above the neutral midpoint of 3.0. The most favorable responses were observed in the clarity of instructions, the ease of performing exercises at home and perceived safety, all reaching a mean score of 4. The perceived benefit for surgical preparation received the lowest rating with a mean of 3.00.

Healthcare professionals' acceptability and perceptions regarding the prehabilitation program were evaluated among four clinicians (including doctors and nurses) who worked closely with the protocol. These results are summarized in Table 4.

DISCUSSION

This study evaluated the feasibility of implementing a home-based prehabilitation program in the Portuguese healthcare setting.

Initial engagement was highly successful, resulting in a 100% recruitment rate among eligible patients and zero voluntary dropouts during the program, which contrasts with previous prehabilitation studies where decline rates ranged from 28% to 55%[12,15,21] and where several patients discontinued the intervention after enrolment.[15,22,23]

Although the completion rate was 57.1%, the three non-completing patients were discontinued strictly due to disease progression, a well-recognized cause of withdrawal in cancer populations.[16] Performing recruitment before MDT staging led to exclusions due to loss of curative intent. Future studies should either align recruitment with MDT consensus or establish adaptive pathways transitioning patients to palliative care.

The protocol proved safe, with no exercise-related adverse events reported, supporting the safety of physical activity during oncological pathways.[16,18]

Although the overall adherence rate (64.2%) fell below the predefined 75% threshold, it suggests acceptable feasibility and matches rates in comparable trials.[12,13,22] Notably, resistance exercise adherence was better maintained than aerobic exercise, and engagement with weekly phone calls was high, highlighting the value of regular remote monitoring.[14]

Considerable inter-patient variability in adherence was observed across our cohort. While baseline functional capacity varied widely (e.g., 6-minute walk test distance ranging from 253.4 m to 380.6 m), we hypothesize that variations in baseline fitness levels and treatment timing may have influenced individual engagement. Future trials should incorporate baseline stratification to optimize resource allocation and for more accurately interpret outcomes.

Furthermore, concurrent neoadjuvant therapy may have impacted energy levels and adherence. However, as treatment-related symptoms such as fatigue were not systematically tracked, this interpretation remains a hypothesis requiring formal evaluation in future trials. Nevertheless, starting prehabilitation early, including during NAC, is safe, enhances chemotherapy tolerance, and preserves cardiorespiratory fitness.[9,13] The four-to-six-week window post-NAC and before surgery represents the optimal period to intensify the program.

Regarding the nutritional component, delivering an educational booklet alongside an on-demand referral pathway for high-risk patients proved feasible. Despite the lack of public health coverage for ONS, financial outlays did not compromise adherence within this cohort. However, self-funding may still represent a significant perceived financial burden for patients and their families and future institutional support or public coverage for ONS should be evaluated.

Furthermore, low educational levels may affect health literacy and the perceived importance of the intervention, a particularly relevant concern in our study as only one patient had higher education. Incorporating sociodemographic variables in future studies will ensure more patient-centered programs.

Patient acceptability was generally positive regarding the clarity of home instructions, but lower scores for "perceived benefit for surgical preparation" and moderate exercise motivation suggest a need to strengthen prehabilitation education. Incorporating psychological support, such as Motivational Interviewing, could address low motivation as a key barrier to engagement and may positively affect self-efficacy, functional performance and depressive symptoms in cancer patients.[24]

All necessary equipment for the physical evaluation was already available within the department, and the implementation of this project did not require any type of financial or infrastructural investment.

All professionals involved were highly cooperative and demonstrated high acceptability and strong consensus, viewing this project as an opportunity to improve patient outcomes and reflecting openness to innovation and institutional support necessary for long-term sustainability. Nevertheless, high professional acceptability should not be equated with operational feasibility at the pathway level: the workflow reorganization required and the one baseline assessment missed due to schedule incompatibility indicate that implementation was not entirely straightforward. Long patient travel distances (mean 102.5 ± 64.4 km) highlight practical barriers to hospital-based evaluations.[14]

Future projects could benefit from establishing a new patient-centered pathway in which a Physical and Rehabilitation Medicine appointment is automatically generated once the treatment plan is confirmed by the MDT, leading to improved coordination between departments. Furthermore, transitioning toward hybrid models – combining home-based exercise with occasional supervised visits – could balance patient convenience with oversight.[23]

Given that smoking and alcohol consumption are major risk factors for anastomotic leakage and postoperative complications,[5,25,26] integrating targeted cessation programs is essential to align institutional practice with ERAS recommendations.[4] However, the current 7-month wait time for smoking cessation consultations at our center far exceeds the typical prehabilitation window, highlighting the need for streamlined referral workflows.

All eligible patients were assessed, and no eligible patient was missed, which helped minimize selection bias. Naturally, this study has several limitations. First, the small final sample size (n = 4) and single-center design naturally limit statistical power and the generalizability of our findings to broader populations. Second, patient adherence relied on self-reported logs, introducing potential reporting bias; integrating objective monitoring tools (e.g., smartwatches or pedometers) in future trials will improve data reliability.[22]

Ultimately, the integration of this program into routine clinical practice represents a significant step toward elevating the quality of preoperative care. Aligning our institutional practices with the ERAS pathway has the potential to improve surgical recovery and patient well-being.

CONCLUSION

This study confirms the feasibility, acceptability, and safety of a home-based multimodal prehabilitation program for patients scheduled for esophagectomy.

The recruitment and completion rates observed underscore the potential of recruiting patients from our center into larger randomized controlled trials. Although adherence was moderate, the study identified key areas for improvement, specifically regarding patient motivation and the need for a more integrated clinical pathway within the hospital structure.

Moving forward, subsequent research should implement an enhanced version of this protocol with a longer recruitment period to include a larger sample size and assess pre- and post-prehabilitation functional capacity, correlating these directly with postoperative outcomes.

LEARNING-POINTS

Feasibility and safety: A multimodal, home-based prehabilitation program for esophageal cancer patients is safe and feasible within the Portuguese healthcare system.

Acceptability: The protocol achieved high satisfaction and strong agreement from both patients and healthcare professionals.

Future recommendations: To maximize adherence and outcomes, future trials should stratify patients by baseline fitness and also integrate objective monitoring tools, motivational interviewing, and smoking cessation pathways.

ETHICAL DISCLOSURES

Conflicts of Interest: The authors have no conflicts of interest to declare.
Financing Support: This work has not received any contribution, grant or scholarship
Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of patient data.
Protection of Human and Animal Subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and those of the Code of Ethics of the World Medical Association (Declaration of Helsinki as revised in 2024).
Provenance and Peer Review: Not commissioned; externally peer-reviewed.

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Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.
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Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.
Proteção de Pessoas e Animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pela Comissão de Ética responsável e de acordo com a Declaração de Helsínquia revista em 2024 e da Associação Médica Mundial.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

CONTRIBUTORSHIP STATEMENT

ABRG: Bibliographical search, study design, data collection, analysis and interpretation of results, drafting of the article.
JSC and PMAS: Critical reviewing of the content of the article.
All authors approved the final version of the manuscript for publication and assume responsibility for all aspects of the work, ensuring the accuracy and integrity of the data presented.

DECLARAÇÃO DE CONTRIBUIÇÃO

ABRG: Pesquisa bibliográfica, conceção do estudo, recolha de dados, análise e interpretação dos resultados, redação do artigo.
JSC e PMAS: Revisão crítica do conteúdo do artigo.
Todos os autores aprovaram a versão final do manuscrito para publicação e assumem responsabilidade por todos os aspetos do trabalho, garantindo a exatidão e a integridade dos dados apresentados.

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DICAS EXTRA

Conforto: Use sapatilhas fechadas, confortáveis (evite chinelos) e roupa adequada para fazer as sessões de exercício;

Hidratação: Beba água antes, durante e depois do treino.

Nutrição: tente ingerir uma fonte de proteína (ex: iogurte, ovo, batido proteico recomendado) após o treino de força para ajudar o músculo a crescer.

No dia-a-dia: Opte por usar as escadas, estacione mais longe, caminhe até ao supermercado/loja/café sempre que possível, levante-se para caminhar 2 minutos a cada hora que passar sentado. O importante é manter-se ativo.

Cansaço: Nos dias em que se sentir mais cansado, faça apenas 10 ou 15 minutos – o importante é não perder o hábito e manter-se ativo.

Treine acompanhado: A companhia de alguém pode tornar o treino mais agradável. Use música animada ou o seu podcast favorito para tornar o treino mais leve.

Programa de Pré-habilitação Cirúrgica Cancro Esófago - Exercícios Domiciliários

UNIDADE LOCAL DE SAÚDE COIMBRA

Programa de Pré-habilitação Cirúrgica Cancro Esófago - Exercícios Domiciliários

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Piso -1

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DESCUBRA A APP SNS COIMBRA

Disponível em Android e iOS

A ULS de Coimbra mais perto de si.

1º AQUECIMENTO

5-10min

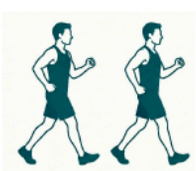
Ex: Caminhada lenta ou exercícios de força muscular com carga leve;

2º TREINO - EXERCÍCIO AERÓBIO

Meta: 150 minutos por semana

Sugestão: sessões de 30minutos x5 dias por semana. (pode começar com 10min por dia).

Exemplo: Caminhada rápida, Corrida, Bicicleta, Natação, Subir e descer escadas.

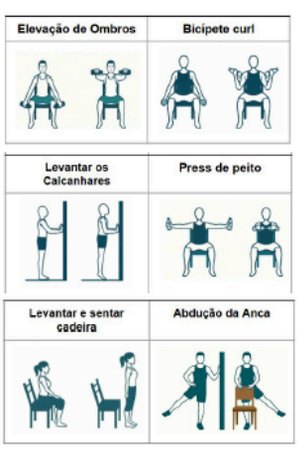


2º TREINO - FORÇA MUSCULAR

Meta: cerca de 2-3 sessões de 45min por semana; deve incluir 1 dia de descanso entre sessões;

Protoloco: 3 séries (conjunto de repetições); 10-12 repetições de cada exercício; descanso de 1min-1.30min entre cada série;

Nota: Pode realizar os **exercícios sentado ou de pé.**



Pode iniciar com o **peso do próprio corpo;**

Pode adquirir **pesos livres** ou utilizar **garrafas com água ou areia** (medir o peso numa balança). Também pode adquirir bandas elásticas.

3º ARREFECIMENTO

5-10min

Ex: Caminhada lenta, alongamentos suaves, respirar profundamente;

SEGURANÇA E SINAIS DE ALERTA

A sua segurança e bem-estar é a prioridade. Deve parar o exercício imediatamente e contactar a equipa médica se sentir:

- Dor ou pressão no peito;
- Falta de ar súbita, intensa, muito superior ao normal para o esforço que está a fazer;
- Tonturas, desmaios ou visão turva;
- Palpitações cardíacas ou batimento irregular;

ULS COIMBRA

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Alimentação antes da Cirurgia Esofago-gástrica

Um estado nutricional adequado é fundamental para preparar o organismo para a cirurgia ao esófago. Uma alimentação correta contribui para:

- Reduzir o risco de complicações cirúrgicas
- Favorecer a cicatrização dos tecidos
- Melhorar a recuperação pós-operatória
- Promover a força física e a qualidade de vida

A alimentação deve ser equilibrada, completa, variada e adaptada às necessidades individuais, tendo em conta eventuais dificuldades em engolir.

Grupos Alimentares e a Sua Importância

1. Proteínas

As proteínas são essenciais para a manutenção da massa muscular, a cicatrização e o bom funcionamento do sistema imunitário.

Fontes recomendadas:

- Carne magra (frango, peru, coelho)
- Peixe
- Ovos
- Leite e derivados
- Leguminosas (feijão, grão-de-bico, lentilhas)

2. Hidratos de Carbono

Constituem a principal fonte de energia do organismo, sendo indispensáveis para as atividades diárias e para a recuperação.

Fontes alimentares:

- Arroz
- Massa
- Batata
- Pão
- Cereais

3. Gorduras

As gorduras fornecem energia e facilitam a absorção de algumas vitaminas. Devem ser consumidas em quantidades moderadas.

Preferir: Azeite e Peixe gordo (sardinha, cavala, salmão)

Unidade Local de Saúde de Coimbra
Praceta Professor Mota Pinto
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Serviço Nutrição e Dietética
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Email: snd@ulscoimbra.min-saude.pt

4. Fruta e Legumes

A fruta e os legumes são importantes fontes de vitaminas, minerais, antioxidantes e fibra, contribuindo para o bom funcionamento do organismo.

Recomendações:

- Consumir diariamente
- Variar os tipos e as cores
- Adaptar a textura, se necessário (cozidos, assados ou em puré)

Recomendações Gerais

- Realizar **refeições pequenas e frequentes** (5 a 6 por dia)
- Em caso de dificuldade em engolir, optar por alimentos de **consistência mole, triturada ou líquida**
- Privilegiar alimentos **ricos em proteína**, tais como:
  - Leite e derivados
  - Ovos
  - Carne ou peixe bem triturados
  - Leguminosas passadas
- Evitar alimentos:
  - Muito duros, secos ou fibrosos
  - Muito quentes ou muito frios
- Comer lentamente e mastigar bem os alimentos

Suplementação Nutricional Pré-operatória

Nos 10 dias anteriores à cirurgia, recomenda-se a ingestão, entre as refeições principais e de forma fracionada, de um dos seguintes suplementos nutricionais:

- Meritene Extra Protein®
- Fresubin Pro®/ Fresubin 2Kcal
- Fortimel Protein 2 kcal®
- TDiet 2® (Nutrisens-239966373)

Estes suplementos ajudam a garantir um aporte adequado de energia e proteína, preparando o organismo para a cirurgia.

Apoio Nutricional

Sempre que existam dificuldades na alimentação ou dúvidas, deve contactar o **Serviço de Nutrição e Dietética da ULS Coimbra- 239 400 522**

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