Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Perspectives on the Direction of Cancer Prehabilitation in the Pandemic and Beyond

San San Tay MBBS, MRCP (UK), MMED (Int Med), FAMS

PII: S2590-1095(22)00068-4
DOI: https://doi.org/10.1016/j.arrct.2022.100236
Reference: ARRCT 100236

To appear in: *Archives of Rehabilitation Research and Clinical Translation*

Please cite this article as: San San Tay MBBS, MRCP (UK), MMED (Int Med), FAMS , Perspectives on the Direction of Cancer Prehabilitation in the Pandemic and Beyond, *Archives of Rehabilitation Research and Clinical Translation* (2022), doi: https://doi.org/10.1016/j.arrct.2022.100236

Title:

Perspectives on the Direction of Cancer Prehabilitation in the Pandemic and Beyond

Running Title:

Prehab models and COVID-19 adaptations

Author

San San Tay, MBBS, MRCP (UK), MMED (Int Med), FAMS[1]

Affiliations:

[1] Department of Rehabilitation Medicine, Changi General Hospital, Singapore

Corresponding Author:

San San Tay, MBBS, MRCP (UK), MMED (Int Med), FAMS

Department of Rehabilitation Medicine, Changi General Hospital, 2 Simei Street3, Singapore 529889

E-mail address: tay.san.san@singhealth.com.sg

Tay San San ORCID ID: https://orcid.org/0000-0002-6623-6265

Word count: 82 (abstract), 2452 words (Introduction to conclusion)

Number of figures: 1, Number of tables: 3

Declaration of Conflicting Interests

This research received no specific grants from any funding agency in the public, commercial, or not-for-profit sectors.

Disclosure: none

Perspectives on the Direction of Cancer Prehabilitation in the Pandemic and Beyond

Abstract

Growing attention has been placed on cancer prehabilitation in the recent years as the number of publications increase. The real-world application of prehabilitation remains heterogeneous and its implementation has been challenging during the COVID-19 pandemic. However, the pandemic has also provided impetus for change-leveraging technology and digitalization. This paper will discuss the pre-existing models of care, adaptations that had taken place in the pandemic, the model of care in the author's institution and the future direction of cancer prehabilitation.

Keywords: cancer prehab, prehabilitation, COVID-19, technology, digital, home-based prehabilitation

Abbreviations:

COVID-19: Coronavirus disease of 2019

EQ5D3L: European Quality of Life 5 Dimensions 3 Level Version

Introduction

Cancer prehabilitation has been defined as a process on the cancer continuum of care that occurs between the time of cancer diagnosis and the beginning of acute treatment[1]. The potential benefits of cancer prehabilitation[1] have been supported by international reviews and meta-analyses[2-3](Table 1). The benefits have been reported in gynecological[4], urologic[5], lung[6], colorectal[7], and hepatobiliary and upper gastrointestinal cancers[3]. The benefits differed between the different cancer diagnostic groups and included physical[4-9,11] and psychological[4,10] parameters, length of stay[3], postoperative complications[6,7], and quality of life[5,10]. More studies are needed on head and neck cancers[12].

Multimodal models of care include exercise, nutritional intervention and psychological support in general. Other domains such as respiratory muscle training and breathing exercises[13] may be applied prior to cardiothoracic surgery, whereas pelvic floor exercises and sexual well-being may be incorporated into the prostate cancer prehabilitation program[14]. In breast cancer patients, locoregional exercise pertinent to specific treatment-related impairments has been implemented[15].It appears that high-intensity interval training (HIIT)[16] may significantly improve peak O2 consumption, is safe, and produces positive outcomes on health-related events.

Due to the heterogeneity of cancer related impairments, randomized controlled studies are usually performed in single cancer diagnostic groups[14, 17-20](Table 2). The real-world application of prehabilitation in program implementation remains heterogeneous and not straightforward[21]. While cancer prehabilitation is gaining attention with the increasing literature, the COVID-19 pandemic has the potential to affect its implementation.

During the COVID-19 outbreak, new guidelines providing alternative treatment options for cancer have been established[22-23]; however, there are no guidelines for cancer prehabilitation during the COVID-19 pandemic, as it is a relatively new field. This paper aims to discuss the possible direction of prehabilitation in this pandemic and beyond.

Review of the existing prehabilitation models

Prior to the discussion of how the pandemic had affected the practice of cancer prehabilitation, a review of existing models of care was necessary. (Table 2) The review found many to be multimodal[15,24-29,] requiring multiple healthcare providers and that exercise training required supervision on site.[17,20,27-29,30-32]. Some home-based programs[24-26] are multimodal in nature, whereas others mainly involve exercise programs[33,34]. A study by Ngo-Huang involved patients with resectable pancreatic adenocarcinoma receiving preoperative chemotherapy and/or chemoradiation in a home-based exercise program, participating in 60 min of moderate-intensity aerobic exercises daily and strengthening exercises weekly. The patients showed meaningful improvements in physical function, and physical activity was associated with improved physical function and health related quality of life[33]. A review article on home-based prehabilitation suggested that it is a feasible alternative to hospital-based care[35]. Rarely would cancer prehabilitation be conducted in an inpatient setting[36].

In a study on a technology-supported multimodal prehabilitation program in moderate-to-high risk patients undergoing lung cancer resection, inputs from various healthcare professionals such as the dietician and psychologist were needed along with a supervised exercise program. Exercise trackers were utilized to monitor patient participation, and progress was assessed by a trained physiotherapist[37].

Infrequently, alternative models have been reported, of which one was a tele-rehabilitation program for esophagogastric cancer patients, which was found to be feasible with excellent recruitment and retention rates, no adverse events, and significant improvements in fatigue, quality of life, and physical and emotional well-being[38]. A community-based exercise prehabilitation program for colorectal surgery patients found that postoperative complication rates were lower in the prehabilitation group. This was a supervised program in community physical therapy practices[39].

Adaptations During COVID-19 Pandemic

During the COVID-19 pandemic, adaptations had to be implemented for various prehabilitation studies[40] and programs[41]. Interactions between participants and staff were conducted through telephone or web conferencing instead of in-person visits[40,41]. Exercise equipment, manuals, and protein supplementation were mailed to the patients, and exercises were conducted at home instead of being facility-based[40]. Study outcome measures that required in-person assessment were omitted[40].

With the capacity of hospitals affected by the need to care for COVID-19 patients, a shift of prehabilitation to the community may be required. In Europe, the effects of home-based prehabilitation for patients undergoing colorectal cancer surgery during the COVID-19 pandemic showed that it was effective, resulting in a shorter hospital length of stay, postoperative complications and attenuated lean mass loss in the early postoperative period[42]. Currently, the European project PAPRIKA leverages digital support[43,44] to implement prehabilitation programs. The program averages 4 weeks and involves endurance training, increasing physical activity, nutritional and psychological support. Digital support includes an adaptive case management platform for professionals, integrated with the electronic health record (EHR), and a self-

management app for patients, integrated with the regional health folder. Digital innovations are also being developed which allow community-based prehabilitation as well[45]. These innovations support multi-modal prehabilitation granting prehabilitation professionals' access to patients for communication and providing feedback while monitoring the task status of the patient.

Many UK prehabilitation programs were modified into online classes during the pandemic[46,47]. A UK telehealth-delivered home-based prehabilitation program that was adapted from a face-to-face program was reported to be feasible and effective in improving patient reported outcomes[48].The main outcomes of recruitment and retention rates were reported to be 76% and 75% respectively. Secondary outcomes were changes in patient-reported outcome measures upon completion of prehab and included the EQ-5D-3L and Functional Assessment of Chronic Ill-ness Therapy (FACIT)-Fatigue Scale. Statistically significant improvements were observed in self-rated health and fatigue. In the USA, a structured multimodal virtual prehabilitation program was organized for neoadjuvant surgical oncology patients during the pandemic with goals of promoting optimal outcomes and preparing the patient for surgery[49]. As many centers adapt, Verduzco-Guiterrez et al described how a virtual prehabilitation visit could be conducted with adaptations to the physical examination and could serve as guidance to other physicians[50].

The Approach at Changi General Hospital, Singapore

A cancer prehabilitation program for colorectal patients was started in our acute general hospital in January 2020 and has since expanded into a cancer prehabilitation framework for various surgical patients as well as patients on neoadjuvant and adjuvant chemotherapy and radiotherapy[51]. As the wait time for surgery averaged 19 days at our hospital, a service was planned to optimally utilize this window period. A systematic review and meta-analysis of the effects and duration of exercise-based prehabilitation found that the duration of prehabilitation varies between 2 and 14

weeks. There were significant improvements in functional capacity although prehabilitation lasting more than 3 weeks tended to lower overall complications (not statistically significant)[52]. There were studies that found delays of up to 56-62 days in colorectal surgery did not lead to poorer overall or cancer-free survival in patients with primary colorectal cancer who underwent curative surgical treatment[53,54]. Another study cited improved disease-free survival in stage 3 colorectal patients after prehabilitation[55] making the case of delaying surgery for prehabilitation. However, the decision was made in conjunction with the hospital medical board not to delay surgery for prehabilitation to avoid a backlog of cases. The average duration of prehabilitation was 19.3 days in our program.

This was designed as a one-stop service, where patients are referred to the prehabilitation coordinator from surgical clinics once they are planned or listed for surgery. The coordinator screens patients for frailty using Fried's physical frailty phenotype and administers baseline measurements. Frail and pre-frail patients were prioritized for participation in the program. Patients were assessed by a physiatrist on the same day in four domains: medical optimization, exercise prescription, nutritional advice, and mental wellness. A physiatrist typically spends an hour for each patient. The prescribed interventions can be started immediately without waiting for appointments with other professionals. It is a hospital-associated, home-based program. The prehabilitation coordinator made phone calls to monitor the patient's progress and compliance. Patients had access to the coordinator if they required clarifications regarding the exercise prescriptions or the program, and were referred to physiotherapists, dieticians, or psychiatrists if there were specific indications[51]. Four patients were referred to the physiotherapist. These patients had preexisting mobility issues. Two of them were prescribed seated exercises while awaiting a therapy appointment. Five patients were referred to the dietician, five to the social worker, (four

were referred by surgeons) and two to the psychologist, of which one had pre-existing appointments.

The prescribed exercises consisted of aerobic and strengthening exercises. Aerobic exercises are typically of moderate intensity and are self-measured by the "Talk" test (as per guidelines from the American College of Sports Medicine) for a minimum of 30 min on 5 days per week. This typically includes walking, jogging, cycling, or the use of exercise equipment depending on individual capabilities, preferences, and access to equipment. For already active individuals, high-intensity interval training was incorporated. For unfit and sedentary individuals, the initial intensity is low, and the duration is titrated according to individual capabilities. Strengthening exercises typically include 3-5 sets of 10-20 repetitions, 3–7 days a week of composite exercises, primarily targeting the major lower limb proximal muscle groups and upper limb proximal muscle groups. This approach remained feasible when Singapore faced a lockdown from 7 April to 1 June 2020 during which outpatient therapy services were disrupted, as only essential medical services were permitted. Outpatient therapy services were considered non-essential and were reinstated only partially by the end of 2020 due to social distancing measures. While cancer surgery was considered essential, hospital visits were limited, and many patients avoided leaving their homes. The cancer prehabilitation service was not disrupted, mainly because it was a hospital-associated home-based program. The outcome measures included the following:

1. Functional Outcome Measures, namely 6-minute-walk-test (6MWT), 30 seconds sit-to-stand test(30CST), timed up and go test
2. Psychological Outcome Measures, namely Hospital Anxiety and Depression Scale (HADS)
3. Health-related Quality of Life Outcome Measures

The outcomes of 188 pre-surgical cancer prehabilitation patients were analyzed in four groups: colorectal, hepatobiliary, upper gastrointestinal, and urological cancers. There were statistically significant improvements in the 6MWT, 30CST, time-up-and-go test and HADS at the pre-operative assessment compared to baseline and the EQ5D scores at 3 months assessment (Table 3).

In the period of March to September 2021, we had the opportunity to develop a digital platform to support prehabilitation. This was a cancer prehabilitation exercise diary on Health Buddy, a mobile application supported by SingHealth[56], a regional health system. Health Buddy is one of the regions' most comprehensive health mobile apps that provides quick access to essential healthcare-related services and information. A series of videos was produced to demonstrate the commonly prescribed prehabilitation exercises. The cancer prehabilitation exercise diary presents a personalized and customized exercise program for each patient. The exercise diary included customized exercise reminders, a patient exercise log, and achievement summaries (Fig. 1). This was officially launched in late November 2021. The Health Buddy application was used as an adjunct to the home-based exercise program.

Feasibility of the Program During the Pandemic

As of mid-January 2022, 219 patients were screened, and 188 patients were enrolled in our prehabilitation program. The recruitment rate was 86% (defined by the number enrolled versus total referred) and the retention rate was 73% (referred to as the percentage that completed the program up to the time of the surgery). The compliance or adherence rate was 65.9% (81/123). This was measured by the completion of the minimum number of prescribed exercise sets and the ability to demonstrate all exercises correctly during follow-up. This suggests that the program was feasible. At the end of the 3-month period, patients were reviewed for suitability for transition to

community exercise programs utilizing government-funded facilities and programs. 20% of the patients were undergoing active cancer treatment or had new impairments and were not suitable for transition. 10% of the patients had pre-existing exercise programs and declined to be referred to the community programs. The remaining patients were given a choice between community group programs and facilities versus continuing home exercise programs. 10% of all patients were referred to the community exercise programs. The majority preferred home exercises because of the pandemic.

Discussion

In addition to potential cost savings in pre-surgical prehabilitation[57-59], benefits include a reduction in cancer recurrence with regular exercise and lifestyle changes[55]. The Clinical Oncology Society of Australia recommends that exercise become a standard of care in oncology across all disease states, incorporated into cancer care from the time of diagnosis[60]. Prehabilitation programs that are practical, lower cost and empower the patient to take charge of their own health[61] would possibly be more sustainable. Home-based programs reduce the infrastructure costs of building exercise centers and site rental fees. Barriers that were removed included cost, time spent travelling, access to an exercise facility and geographic isolation. The drawbacks include a lack of supervision, which could result in exercises being performed incorrectly or not at all. A comprehensive assessment was performed at the initial visit to our center, especially regarding medical clearance for exercise. In our culture, patients may be more willing to exercise when encouraged by a physician. In the future, a clinical pathway could be instituted for screening and referral of patients[62].

In a study that implemented telehealth prehabilitation education sessions for patients prior to surgery, the majority (77%) responded that they preferred an online education session as opposed

to attending a hospital-based one[63]. Online classes make the program available to people who stay in rural areas and are more convenient for some. Smartphone ownership has increased over the years[64]. Furthermore, with the pandemic, digital literacy has increased, with programs to help the elderly acquire digital literacy[65] to reduce inequity in access[66].

The pandemic has caused disruptions but has also facilitated changes in how prehabilitation is practiced with digitalization and technological adaptations. According to a narrative review, surgical patients faced the threats of extended wait times for surgery, reduced access to supportive services and an elevated risk of poor outcomes[67], and accessible strategies were needed to reduce this impact. As COVID-19 moves towards endemicity, some changes may remain. The advantages of home-based or community programs with technological enablers include better access to care, lower costs, and greater scalability. The processes and integration would continue to evolve to improvise for the reduction in physical contact and clinical assessments. Other areas that would continue to improve include user-friendly technological enablers that would remain personalized to various degrees.

Challenges in cancer prehabilitation include the heterogeneity of exercise protocols, program duration, multimodal components used, and varying outcome measures applied. The implementation for different cancer diagnostic groups which have varying treatment protocols, prognosis and complications of disease or treatment can also be overwhelming. In the mitigation of this, one should lower barriers to start a cancer prehabilitation program, start with one diagnostic group at a time and expand to other diagnostic groups after sufficient study of the patient population, workflow, and discussion with relevant stakeholders[51]. Outcome measures should be captured, and workflow and protocols adapted to refine the program as the program matures. Despite these challenges, cancer prehabilitation will continue to gain traction in terms of

publication and implementation. The application is not straightforward as it is a relatively new field and will vary in different cultures and funding models. Publications describing different models of care in the various programs globally should be encouraged, so that cancer prehabilitation would be made available in many more parts of the world.

Conclusion

Cancer prehabilitation has gained increasing attention in the recent years and the number of published studies on prehabilitation has been rising. The COVID-19 pandemic poses a challenge to the implementation of cancer prehabilitation programs; however, it has also facilitated changes, especially in the areas of digitalization and the leverage of technology. As the world moves towards endemicity, one can look forward to some of these advances, gaining acceptance with potential scaling to the masses.

References

1. Silver JK, Baima J. Cancer prehabilitation: an opportunity to decrease treatment-related morbidity, increase cancer treatment options, and improve physical and psychological health outcomes. Am J Phys Med Rehabil (2013) Aug;92(8):715-27. doi: 10.1097/PHM.0b013e31829b4afe

2. Treanor C, Kyaw T, Donnelly M. An international review and meta-analysis of prehabilitation compared to usual care for cancer patients. J Cancer Surviv (2018) Feb;12(1):64-73. doi: 10.1007/s11764-017-0645-9

3. Lambert JE, Hayes LD, Keegan TJ, Subar DA, Gaffney CJ. The Impact of Prehabilitation on Patient Outcomes in Hepatobiliary, Colorectal, and Upper Gastrointestinal Cancer Surgery: A PRISMA-Accordant Meta-analysis. Ann Surg (2021) Jul 1;274(1):70-77. doi: 10.1097/SLA.0000000000004527

4. Schneider S, Armbrust R, Spies C, du Bois A, Sehouli J. Prehabilitation programs and ERAS protocols in gynecological oncology: a comprehensive review. Arch Gynecol Obstet. 2020 Feb;301(2):315-326. doi: 10.1007/s00404-019-05321-7

5. Briggs LG, Reitblat C, Bain PA, Parke S, Lam NY, et al. Prehabilitation Exercise Before Urologic Cancer Surgery: A Systematic and Interdisciplinary Review. Eur Urol. 2022 Feb;81(2):157-167. doi: 10.1016/j.eururo.2021.05.015

6. Ferreira V, Lawson C, Ekmekjian T, Carli F, Scheede-Bergdahl C, et al. Effects of preoperative nutrition and multimodal prehabilitation on functional capacity and postoperative complications in surgical lung cancer patients: a systematic review. Support Care Cancer. 2021 Oct;29(10):5597-5610. doi: 10.1007/s00520-021-06161-5

7. Molenaar CJ, van Rooijen SJ, Fokkenrood HJ, Roumen RM, Janssen L, et al. Prehabilitation versus no prehabilitation to improve functional capacity, reduce postoperative complications and improve quality of life in colorectal cancer surgery. Cochrane Database Syst Rev. 2022 May 19;5(5):CD013259. doi: 10.1002/14651858.CD013259.pub2

8. Yang A, Sokolof J, Gulati A. The effect of preoperative exercise on upper extremity recovery following breast cancer surgery: a systematic review. Int J Rehabil Res. 2018 Sep;41(3):189-196. doi: 10.1097/MRR.0000000000000288

9. Driessen EJ, Peeters ME, Bongers BC, Maas HA, Bootsma GP, et al. Effects of prehabilitation and rehabilitation including a home-based component on physical fitness, adherence, treatment tolerance, and recovery in patients with non-small cell lung cancer: A systematic review. Crit Rev Oncol Hematol. 2017 Jun;114:63-76. doi: 10.1016/j.critrevonc.2017.03.031

10. Tsimopoulou I, Pasquali S, Howard R, Desai A, Gourevitch D, Tolosa I, Vohra R. Psychological Prehabilitation Before Cancer Surgery: A Systematic Review. Ann Surg Oncol. 2015 Dec;22(13):4117-23. doi: 10.1245/s10434-015-4550-z

11. Michael CM, Lehrer EJ, Schmitz KH, Zaorsky NG. Prehabilitation exercise therapy for cancer: A systematic review and meta-analysis. Cancer Med. 2021 Jul;10(13):4195-4205. doi: 10.1002/cam4.4021

12. Loewen I, Jeffery CC, Rieger J, Constantinescu G. Prehabilitation in head and neck cancer patients: a literature review. J Otolaryngol Head Neck Surg. 2021 Jan 6;50(1):2. doi: 10.1186/s40463-020-00486-7

13. Goldsmith I, Chesterfield-Thomas G, Toghill H. Pre-treatment optimization with pulmonary rehabilitation in lung cancer: Making the inoperable patients operable. EClinicalMedicine. 2020 Nov 30;31:100663. doi: 10.1016/j.eclinm.2020.100663

14. Paterson C, Roberts C, Toohey K, McKie A. Prostate Cancer Prehabilitation and the Importance of Multimodal Interventions for Person-centered Care and Recovery. Semin Oncol Nurs (2020) Aug;36(4):151048. doi: 10.1016/j.soncn.2020.151048

15. Santa Mina D, Brahmbhatt P, Lopez C, Baima J, Gillis C, et al. The Case for Prehabilitation Prior to Breast Cancer Treatment. PM R. 2017 Sep;9(9S2):S305-S316. doi: 10.1016/j.pmrj.2017.08.402

16. Palma S, Hasenoehrl T, Jordakieva G, Ramazanova D, Crevenna R. High-intensity interval training in the prehabilitation of cancer patients-a systematic review and meta-analysis. Support Care Cancer. 2021 Apr;29(4):1781-1794. doi: 10.1007/s00520-020-05834-x

17. van Rooijen S, Carli F, Dalton S, Thomas G, Bojesen R, Le Guen M, et al. Multimodal prehabilitation in colorectal cancer patients to improve functional capacity and reduce postoperative complications: the first international randomized controlled trial for multimodal prehabilitation. BMC Cancer (2019) Jan 22;19(1):98. doi: 10.1186/s12885-018-5232-6

18. Ferreira V, Minnella EM, Awasthi R, Gamsa A, Ferri L, Mulder D, Sirois C, Spicer J, Schmid S, Carli F. Multimodal Prehabilitation for Lung Cancer Surgery: A Randomized Controlled Trial. Ann Thorac Surg (2021) Nov;112(5):1600-1608. doi: 10.1016/j.athoracsur.2020.11.022

19. Santa Mina D, Hilton WJ, Matthew AG, Awasthi R, Bousquet-Dion G, Alibhai SMH, et al. Prehabilitation for radical prostatectomy: A multicenter randomized controlled trial. Surg Oncol (2018) Jun;27(2):289-298. doi: 10.1016/j.suronc.2018.05.010

20. Mikami Y, Kouda K, Kawasaki S, Okada KI, Kawai M, Kitahata Y, et al. Preoperative In-Hospital Rehabilitation Improves Physical Function in Patients with Pancreatic Cancer Scheduled for Surgery. Tohoku J Exp Med (2020) Aug;251(4):279-285. doi: 10.1620/tjem.251.279

21. Giles C, Cummins S. Prehabilitation before cancer treatment. BMJ (2019) Aug 14;366: l5120. doi: 10.1136/bmj. l5120

22. Guckenberger M, Belka C, Bezjak A, Bradley J, Daly ME, DeRuysscher D, et al. Practice Recommendations for Lung Cancer Radiotherapy During the COVID-19 Pandemic: An ESTRO-ASTRO Consensus Statement. Int J Radiat Oncol Biol Phys (2020) Jul 15;107(4):631-640. doi: 10.1016/j.ijrobp.2020.05.012

23. Coles CE, Aristei C, Bliss J, Boersma L, Brunt AM, Chatterjee S, et al. International Guidelines on Radiation Therapy for Breast Cancer During the COVID-19 Pandemic. Clin Oncol (R Coll Radiol) (2020) May;32(5):279-281. doi: 10.1016/j.clon.2020.03.006

24. Minnella EM, Awasthi R, Loiselle SE, Agnihotram RV, Ferri LE, et al. Effect of Exercise and Nutrition Prehabilitation on Functional Capacity in Esophagogastric Cancer Surgery: A Randomized Clinical Trial. JAMA Surg. 2018 Dec 1;153(12):1081-1089. doi: 10.1001/jamasurg.2018.1645

25. Janssen THJB, Fransen LFC, Heesakkers FFBM, Dolmans-Zwartjes ACP, Moorthy K, et al. Effect of a multimodal prehabilitation program on postoperative recovery and morbidity in patients undergoing a totally minimally invasive esophagectomy. Dis Esophagus. 2022 Jul 12;35(7): doab082. doi: 10.1093/dote/doab082

26. Liu Z, Qiu T, Pei L, Zhang Y, Xu L, et al. Two-Week Multimodal Prehabilitation Program Improves Perioperative Functional Capability in Patients Undergoing Thoracoscopic

Lobectomy for Lung Cancer: A Randomized Controlled Trial. Anesth Analg. 2020 Sep;131(3):840-849. doi: 10.1213/ANE.0000000000004342

27. Minnella EM, Baldini G, Quang ATL, Bessissow A, Spicer J, et al. Prehabilitation in Thoracic Cancer Surgery: From Research to Standard of Care. J Cardiothorac Vasc Anesth. 2021 Nov;35(11):3255-3264. doi: 10.1053/j.jvca.2021.02.049

28. Wu F, Laza-Cagigas R, Pagarkar A, Olaoke A, El Gammal M, et al. The Feasibility of Prehabilitation as Part of the Breast Cancer Treatment Pathway. PM R. 2021 Nov;13(11):1237-1246. doi: 10.1002/pmrj.12543

29. Chabot K, Gillis C, Minnella EM, Ferreira V, Awasthi R, et al. Functional capacity of prediabetic patients: effect of multimodal prehabilitation in patients undergoing colorectal cancer resection. Acta Oncol. 2021 Aug;60(8):1025-1031. doi: 10.1080/0284186X.2021.1937307

30. Awasthi R, Minnella EM, Ferreira V, Ramanakumar AV, Scheede-Bergdahl C, Carli F. Supervised exercise training with multimodal pre-habilitation leads to earlier functional recovery following colorectal cancer resection. Acta Anaesthesiol Scand (2019) Apr;63(4):461-467. doi: 10.1111/aas.13292

31. Moore J, Merchant Z, Rowlinson K, McEwan K, Evison M, Faulkner G, et al. Implementing a system-wide cancer prehabilitation programme: The journey of Greater Manchester's 'Prehab4cancer'. Eur J Surg Oncol (2021) Mar;47(3 Pt A):524-532. doi: 10.1016/j.ejso.2020.04.042

32. Sheill G, Guinan E, O'Neill L, Normand C, Doyle SL, Moore S, Newell J, McDermott G, Ryan R, Reynolds JV, Hussey J. Preoperative exercise to improve fitness in patients undergoing complex surgery for cancer of the lung or oesophagus (PRE-HIIT): protocol for a randomized controlled trial. BMC Cancer. 2020 Apr 15;20(1):321. doi: 10.1186/s12885-020-06795-4

33. Ngo-Huang A, Parker NH, Bruera E, Lee RE, Simpson R, O'Connor DP, et al. Home-Based Exercise Prehabilitation During Preoperative Treatment for Pancreatic Cancer Is Associated With Improvement in Physical Function and Quality of Life. Integr Cancer Ther (2019) Jan-Dec; 18:1534735419894061. doi: 10.1177/1534735419894061

34. Halliday LJ, Doganay E, Wynter-Blyth V, Osborn H, Buckley J, Moorthy K. Adherence to Pre-operative Exercise and the Response to Prehabilitation in Oesophageal Cancer Patients. J Gastrointest Surg. 2021 Apr;25(4):890-899. doi: 10.1007/s11605-020-04561-2

35. van Gestel T, Groen LCB, Puik JR, van Rooijen SJ, van der Zaag-Loonen HJ, Schoonmade LJ, Danjoux G, Daams F, Schreurs WH, Bruns ERJ. Fit4Surgery for cancer patients during covid-19 lockdown - A systematic review and meta-analysis. Eur J Surg Oncol. 2022 Feb 9: S0748-7983(22)00085-3. doi: 10.1016/j.ejso.2022.02.010

36. Akiyama Y, Sasaki A, Fujii Y, Fujisawa R, Sasaki N, et al. Efficacy of enhanced prehabilitation for patients with esophageal cancer undergoing esophagectomy. Esophagus. 2021 Jan;18(1):56-64. doi: 10.1007/s10388-020-00757-2

37. Barberan-Garcia A, Navarro-Ripoll R, Sánchez-Lorente D, Moisés-Lafuente J, Boada M, Messaggi-Sartor M, et al. Cost-effectiveness of a technology-supported multimodal prehabilitation program in moderate-to-high risk patients undergoing lung cancer resection: randomized controlled trial protocol. BMC Health Serv Res (2020) Mar 12;20(1):207. doi: 10.1186/s12913-020-05078-9

38. Piraux E, Caty G, Reychler G, Forget P, Deswysen Y. Feasibility and Preliminary Effectiveness of a Tele-Prehabilitation Program in Esophagogastric Cancer Patients. J Clin Med (2020) Jul 9;9(7):2176. doi: 10.3390/jcm9072176

39. Berkel AEM, Bongers BC, Kotte H, Weltevreden P, de Jongh FHC, et al. Effects of Community-based Exercise Prehabilitation for Patients Scheduled for Colorectal Surgery With High Risk for Postoperative Complications: Results of a Randomized Clinical Trial. Ann Surg. 2022 Feb 1;275(2): e299-e306. doi: 10.1097/SLA.0000000000004702

40. Santa Mina D, Sellers D, Au D, Alibhai SMH, Clarke H, Cuthbertson BH, Darling G, El Danab A, Govindarajan A, Ladha K, Matthew AG, McCluskey S, Ng KA, Quereshy F, Karkouti K, Randall IM. A Pragmatic Non-Randomized Trial of Prehabilitation Prior to Cancer Surgery: Study Protocol and COVID-19-Related Adaptations. Front Oncol (2021) Mar 10; 11:629207. doi: 10.3389/fonc.2021.629207

41. Gonella F, Massucco P, Perotti S, Monasterolo S, Vassallo D, Laezza A, et al. Telemedicine prehabilitation as a result of COVID-19: disruptive technological solutions. Br J Surg (2021) Jun 22;108(6): e215-e216. doi: 10.1093/bjs/znab066

42. López-Rodríguez-Arias F, Sánchez-Guillén L, Aranaz-Ostáriz V, Triguero-Cánovas D, Lario-Pérez S, Barber-Valles X, et al. Effect of home-based prehabilitation in an enhanced recovery after surgery program for patients undergoing colorectal cancer surgery during the COVID-19 pandemic. Support Care Cancer (2021) Dec;29(12):7785-7791. doi: 10.1007/s00520-021-06343-1

43. European Institute of Innovation and Technology. Patient Empowerment for Major Surgery Preparation at Home (2022). https://eithealth.eu/product-service/paprika/ [Accessed 9 August 2022].

44. ClinicalTrials.gov. PAPRIKA - Patients Empowerment for Major Surgery Preparation @Home (PAPRIKA) (2022). https://www.clinicaltrials.gov/ct2/show/NCT04295668 [Accessed April 25, 2022].

45. Barberan-Garcia A, Cano I, Bongers BC, Seyfried S, Ganslandt T, Herrle F, et al. Digital Support to Multimodal Community-Based Prehabilitation: Looking for Optimization of Health Value Generation. Front Oncol (2021) Jun 17; 11:662013. doi: 10.3389/fonc.2021.662013

46. Active Against Cancer. Who we are (2022) http://activeagainstcancer.org [Accessed January 17, 2022].

47. Macmillan Cancer Support. Safefit (2021). https://www.macmillan.org.uk/cancer-information-and-support/get-help/physical-help/safefit [Accessed January 21, 2022].

48. Wu F, Rotimi O, Laza-Cagigas R, Rampal T. The Feasibility and Effects of a Telehealth-Delivered Home-Based Prehabilitation Program for Cancer Patients during the Pandemic. Curr Oncol (2021) Jun 17;28(3):2248-2259. doi: 10.3390/curroncol28030207

49. Sell NM, Silver JK, Rando S, Draviam AC, Mina DS, Qadan M. Prehabilitation Telemedicine in Neoadjuvant Surgical Oncology Patients During the Novel COVID-19 Coronavirus Pandemic. Ann Surg (2020) Aug;272(2): e81-e83. doi: 10.1097/SLA.0000000000004002

50. Verduzco-Gutierrez M, Bean AC, Tenforde AS, Tapia RN, Silver JK. How to Conduct an Outpatient Telemedicine Rehabilitation or Prehabilitation Visit. PM R (2020) Jul;12(7):714-720. doi: 10.1002/pmrj.12380

51. Tay SS, Kwok KM. Setting Up A Cancer Prehabilitation Framework in Singapore. J Cancer Rehabil (2021) 4:1-6. doi: 10.48252/JCR5

52. Falz R, Bischoff C, Thieme R, Lässing J, Mehdorn M, et al. Effects and duration of exercise-based prehabilitation in surgical therapy of colon and rectal cancer: a systematic review and meta-analysis. J Cancer Res Clin Oncol. 2022 Sep;148(9):2187-2213. doi: 10.1007/s00432-022-04088-w

53. Strous MTA, Janssen-Heijnen MLG, Vogelaar FJ. Impact of therapeutic delay in colorectal cancer on overall survival and cancer recurrence - is there a safe timeframe for prehabilitation? Eur J Surg Oncol. 2019 Dec;45(12):2295-2301. doi: 10.1016/j.ejso.2019.07.009

54. Hangaard Hansen C, Gögenur M, Tvilling Madsen M, Gögenur I. The effect of time from diagnosis to surgery on oncological outcomes in patients undergoing surgery for colon cancer: A systematic review. Eur J Surg Oncol. 2018 Oct;44(10):1479-1485. doi: 10.1016/j.ejso.2018.06.015

55. Trépanier M, Minnella EM, Paradis T, Awasthi R, Kaneva P, Schwartzman K, et al. Improved Disease-free Survival After Prehabilitation for Colorectal Cancer Surgery. Ann Surg (2019) Sep;270(3):493-501. doi: 10.1097/SLA.0000000000003465

56. SingHealth Group. Health Buddy App (2021). https://www.singhealth.com.sg/patient-care/patient-visitor-info/health-buddy-app [Accessed April 25, 2022].

57. Silver JK. Cancer prehabilitation and its role in improving health outcomes and reducing health care costs. Semin Oncol Nurs (2015) Feb;31(1):13-30. doi: 10.1016/j.soncn.2014.11.003

58. Dholakia J, Cohn DE, Straughn JM, Dilley SE. Prehabilitation for medically frail patients undergoing surgery for epithelial ovarian cancer: a cost-effectiveness analysis. J Gynecol Oncol (2021) Nov;32(6): e92. doi: 10.3802/jgo.2021.32. e92

59. Cormie P, Zopf EM, Zhang X, Schmitz KH. The Impact of Exercise on Cancer Mortality, Recurrence, and Treatment-Related Adverse Effects. Epidemiol Rev (2017) Jan 1;39(1):71-92. doi: 10.1093/epirev/mxx007

60. Cormie P, Atkinson M, Bucci L, Cust A, Eakin E, Hayes S, et al. Clinical Oncology Society of Australia position statement on exercise in cancer care. Med J Aust (2018) Aug 20;209(4):184-187. doi: 10.5694/mja18.00199

61. Jain R, Gibson L, Coburn N. Prehabilitation for surgical oncology patients: empowering patient volition. Support Care Cancer (2018) Nov;26(11):3665-3667. doi: 10.1007/s00520-018-4300-4

62. Stout NL, Brown JC, Schwartz AL, Marshall TF, Campbell AM, Nekhlyudov L, et al. An exercise oncology clinical pathway: Screening and referral for personalized interventions. Cancer (2020) Jun 15;126(12):2750-2758. doi: 10.1002/cncr.32860

63. Waterland, JL, Chahal R, Ismail H, Sinton C, Riedel B, Francis JJ, et al. Implementing a telehealth prehabilitation education session for patients preparing for major cancer surgery. BMC Health Serv Res (2021) 21:443. doi: 10.1186/s12913-021-06437-w

64. Pew Research Center. Mobile fact sheet (2021). https://www.pewresearch.org/internet/fact-sheet/mobile [Accessed January 17, 2022].

65. UN Development Program. Digital Literacy opens up a new world during Covid-19 (2021). https://undp.medium.com/digital-literacy-opens-up-a-new-world-during-covid-19-2b0d11aafeb [Accessed January 17, 2022].

66. Infocomm Media Development Authority. Digital For Life (2021). https://www.imda.gov.sg/digitalforlife [Accessed January 15, 2022].

67. Silver JK, Santa Mina D, Bates A, Gillis C, Silver EM, Hunter TL, Jack S. Physical and Psychological Health Behavior Changes During the COVID-19 Pandemic that May Inform Surgical Prehabilitation: a Narrative Review. Curr Anesthesiol Rep. 2022 Feb 18:1-16. doi: 10.1007/s40140-022-00520-6

Figure Legend

Fig 1. Health Buddy phone application (a) Overview of functions (b) Exercise diary interface (c) YouTube videos (available in English and Mandarin).

Fig 1. Health Buddy phone application (a) overview of functions (b) exercise diary interface (c) YouTube videos (available in English and Mandarin).

No.	Diagnostic Gp	Author	Title	Journal	
1.	Gynecological	S Schneider	Prehabilitation Programs and ERAS protocols in gynaecological oncology: a comprehensive review	Arch Gynecol Obstet. 2020 Feb;301(2):315-326.	Prehab: 3 RCTs, 1 pilot, 1 study protocol. Study protocols are heterogenous but showed improvement in physical N psychological parameters. ERAS: 12 observational studies, 1 RCT. Shorter LOS, improvement in complications
2.	Various cancers HITT	Stefano Palma	High-intensity interval training in the prehabilitation of cancer patients-a systematic review and meta-analysis	Supportive Care Cancer.2021 Apr;29(4):1781-1794	Systematic review and meta-analysis of comparative studies on HITT in cancer prehab. 8 studies. 896 patients. Heterogeneous. Sig improvement in peak O2 consumption. (VO2 peak). Feasible and safe, low risk of adverse events, positive

					outcomes on health related events in prehab settings.
3.	Head & neck cancer	Irene Loewen	Prehabilitation in head and neck cancer patients: a literature review	J Otolaryngol Head Neck Surg. 2021 Jan 66;50(1):2	29 original research 2006-2020. On dysphagia Range from stretching to ROM, trismus, swallowing specific exercises Variability in prehab timing, exercise type, dose, duration, outcomes, Makes selection of optimal program difficult.
4.	Various cancers Exercise	Christina M. Michael	Prehabilitation Exercise Therapy for Cancer: A systematic review and meta-analysis	Cancer Medicine. 2021 Jul;10(13):4195-4205.	21 studies, 1564 patients enrolled. Meta-analysis of 5 studies showed statistically significant improvement in the 6MWT in the prehab group. Prehab was found to be safe, acceptable and feasible
5.	Colorectal, hepatbiliary, Upper GI	Lambert JE	The Impact of Prehabilitation on Patient Outcomes in Hepatobiliary, Colorectal, and Upper Gastrointestinal Cancer Surgery: A PRISMA-Accordant Meta-Analysis	Ann Surg 2021 Jul 1;274(1): 70-77.	15 studies: RCT 9, uncontrolled 6 Prehab reduced LOS. No significant difference in functional capacity(6MWT), reduction in post-op complications, mortality rates Prehab recommended to accelerate recovery from cancer surgery
6.	Various cancers	Ioanna Tsimopoulou	Psychological Prehabilittaion Before Cabcer Surgery: A Systematic Review	Ann Surg Oncol. 2015. Dec;22(13): 4117-23	7 studies. 6 RCT. Breast, colorectal, prostate cancer No change in LOS, complications, mortality. Positively affected immunologic function. Impacted PROM eg QOL
7.	NSCLC	Elisabeth J. Driessen	Effects of prehabilitation and rehabilitation including a home-based componenet on physical fitness, adherence, treatment tolerance and recovery in patients with non-small cell lung cancer: A Systematic review	Crit Rev Oncol Hematol. 2017 jun;114:63-76	9 rehab and 1 prehab showed sig or clinically relevant improved physical fitness. 3 home-based, 8 combined training. Adherence varied strongly. Studies on home based rehab or prehab not adequately powered.

8.	Urologic cancers	Logan G Briggs	Prehabilitation Exercise Before Urologica Cancer Surgery: A Systematic and Interdisciplinary Review	Eur Urol. 2022 Feb;81(2): 157-167	12 studies. 7 demonstrated therapeutic validity. All demonstrated sig improvement in cardiorespiratory fitness. 4 had sig improvement in QOL. None demonstrated reduction in postsurgical com[plications, mortality, LOS, readmission rates
9.	Lung cancer	Vanessa Ferreira	Effects if preoperative nutrition and multimodal prehabilitation on functional capacity and postoperative complications in surgical lung cancer patients: A systematic review	Support Care Cancer. 2021 Oct;29(10): 5597-5610	5 studies : 1 nutrition and 4 multimodal Multimodal: improvements in functional walking capacity n pulmonary function during pre-operative period. No effects on postoperative outcomes. Lower rates of postoperative complications unique to nutrition-only study.
10.	Colorectal cancer	Charlotte Jl Molenaar	Prehabilitation versus no prehabilitation to improve functional capacity reduce postoperative complications and improve quality of life in colorectal cancer surgery	Cochrane Database Syst Rev 2022 May 19;5(5):CD013259	3 RCTs, 250 participants with non-metastatic colorectal cancer, Improved functional capacity, may result in fewer complications, fewer ED visits, possibly higher readmission rates
11.	Breast	Ajax Yang	The effect of preoperative exercise on upper extremity recovery following breast cancer surgery: a systematic review	Int J Rehabil Res . 2018 Sep;41(3):189-196.	6 studies. Implementing exercise program and optimizing preoperative fitness, especially shoulder ROM, before breast cancer surgery in conjunction with individualized rehabilitation program may benefit postmastectomy ipsilateral upper extremity recovery.

Table 1 Systematic Reviews and Meta-analysis of Cancer Prehabilitation

No.	Author	Title	Diagnostic Gp	Remarks
Hospital based				
1	Akiyama (2021) Japan	Efficacy of enhanced prehabilitation for patients with esophageal cancer undergoing esophagectomy	Esophageal cancer	Inpatient setting : 7 days pre-operative. Preoperative 6MWD (Enhanced Prehab(EP) vs. control group, 492.9 ± 79.7 vs. 418.9 ± 71.8 m, p < 0.001) and postoperative (EP vs. control group, 431.5 ± 80 vs. 378 ± 68.7 m, p < 0.001). Respiratory complications rate lower in EP (4.3%) than control group (36%) (p = 0.007). Incidence of atelectasis lower in EP (0%) than control group (24%) (p = 0.012).
2	Minnella (2021) Canada	Prehabilitation in Thoracic Cancer Surgery: From Research to Standard of Care	Thoracic cancer	Centre-based, involving multiple healthcare providers, including anesthesiologists, kiensiologists, dietician, nurse 45 high-risk patients received one-month personalized prehabilitation program: 16 in trimodal program (exercise, nutrition, psychological), 22 received a program with both nutrition and exercise. After prehab, 6-minute waking distance improved by 29.9 meters (standard deviation 47.3 m) (n = 35; p = 0.001) and oxygen uptake at anaerobic threshold improved by 1.6 (1.7) mL/kg/min (n = 13; p = 0.004). Length of hospital stay was two (interquartile range one-four) days in prehabilitated patients versus three (two-seven) days in the usual care group (p = 0.101).
3	van Rooijen (2019) International	Multimodal prehabilitation in colorectal cancer patients to improve functional capacity and reduce postoperative complications: the first international randomized controlled trial for multimodal prehabilitation.	Colorectal	Multicentre RCT. Supervised in-hospital training, 3x/week x 4 weeks Intervention group receives 4 weeks of prehabilitation, control group, which will receive no prehabilitation. Both groups receive perioperative care in accordance with the enhanced recovery after surgery (ERAS) guidelines. Primary outcomes are functional capacity (six-minute walk test (6MWT)) and postoperative status determined with the Comprehensive Complication Index (CCI). Secondary outcomes include HRQoL, length of hospital stay (LOS) and a cost-effectiveness analysis.
4	Sheill (2020) Ireland	Preoperative exercise to improve fitness in patients undergoing complex surgery for cancer of the	Lung or esophagus cancer	Protocol. 2 weeks HITT programme . 78 participants. Medical clearance from primary physician. Performed on an electromagnetically braked cycle ergometer in St James Hospital, under direct supervision

		lung or oesophagus (PRE-HITT): protocol for a randomized controlled trial		
5	Chabot (2021) Canada	Functional Capacity of prediabetic patients; effect of multimodal prehabilitation in patients undergoing colorectal cancer resection	Colorectal cancer	RCT, data pooled from 2 published RCTs. 4 weeks supervised prehab clinic, Multimodal prehab Protective effect against loss of functional capacity after surgery was stronger in pre-diabetic patients
6	Wu (2021) UK	The Feasibility of Prehabilitation as part of the Breast Cancer Treatment Pathway	Breast	Multi-modal, face to face advisory interventions on nutrition, smoking cessation and psychosocial support. On-site supervised exercise 24 patients were able to partake and return questionnaires. 25 (93%) prehabilitation patients recorded high satisfaction with the program. Significant reduction in anxiety among prehabilitation patients. No significant improvements in the other PROs. No changes to hospital length of stay, readmissions, and complications.
Community based				
7	Berkel (2022) Netherlands	Effects of Community-based Exercise Prehabilitation for Patients scheduled for Colorectal Surgery with High Risk for Postoperative Complications: Results of a Randomized Clinical Trial	Colorectal Surgery	Single blind randomized clinical study. 3 week(3 sessions per week) personalized, supervised exercise program in community physical therapy practices Postoperative complication rates were lower in the prehab group
8	Moore (2021) UK	Implementing a system-wide cancer prehabilitation programme: The journey of Greater Manchester's "prehab4cancer"	Various cancers	Centre-based, anaesthesiologist led, multi-disciplinary. "Surgery School" for education and then community-based exercise gyms 3x/week . (prehab 3-6 weeks, rehab 12 weeks) Phone calls Classes went online during pandemic as centres were closed implementation of the Prehab4Cancer pathway

Home based				
9	Janssen (2022) UK	Effect of a multimodal prehabilitation program on postoperative recovery and morbidity in patients undergoing a totally minimally invasive esophagectomy	Esophageal	Multimodal home-based Prehab (n=52) vs control group (n=43): Median time to functional recovery 6 vs 7 days (P = 0.074), LOHS 7 vs 8 days (P = 0.039), Hospital readmission rate 9.6 vs. 14.3% (P = 0.484). 17% reduction in 30-day overall postoperative complication rate in Prehab group (P = 0.106). Reduction of 14% in CPC rate was observed (P = 0.190). Despite no difference in severity (Clavien-Dindo) of complications (P = 0.311), ICU readmission rate was lower in Prehab group (3.8 vs. 16.3%, P = 0.039).
10	Liu (2020) China	Two-week multimodal prehabilitation program improves perioperative functional capability in patients undergoing thoracoscopic lobectomy for lung cancer: A randomized controlled trial	Lung	Multimodal home-based Median duration of prehabilitation was 15 days. Average 6MWD was 60.9 m higher perioperatively in prehabilitation vs control group (95% CI, 32.4-89.5; P < .001). No differences in lung function, disability and psychological assessment, LOS, short-term recovery quality, postoperative complications, and mortality, except for forced vital capacity (FVC; 0.35 L higher in the prehabilitation group, 95% CI, 0.05-0.66; P = .021).
11	Minnella (2018) Canada	Effect of Exercise and Nutrition Prehabilitation on Functional Capacity in Esophagogastric Cancer Surgery: A Randomized Clinical Trial	Upper GI	Individualised, home-based (EMM) prescribed. Multimodal 68 randomized, 51 included in primary analysis. Prehabilitation vs control group had improved functional capacity both before (mean [SD] 6MWD change, 36.9 [51.4] vs -22.8 [52.5] m; P < .001) and after surgery (mean [SD] 6MWD change, 15.4 [65.6] vs -81.8 [87.0] m; P < .001).
12	Ngo-Huang (2019) USA	Home-based Exercise Prehabilitation During Preoperative Treatment for Pancreatic Cancer is Associated with Improvement in Physical Function and Quality of Life.	Pancreatic cancer	Home-based program with moderate-intensity aerobic exercise, strengthening. Improved physical function and QOL 50 participants enrolled. 6MWT, 5×STS, and GS significantly improved from baseline to restaging follow-up (P=.001, P=.049, and P=.009, respectively). Increases in self-reported aerobic exercise, weekly MVPA, and LPA were associated with improvement in 6MWT (β=.19, P=.048; β=.18, P=.03; and β=.08, P=.03, respectively) and self-reported physical functioning (β=.02, P=.03; β=.03, P=.005; and β=.01, P=.02, respectively). Increased weekly LPA was associated with increased HRQOL

Table 2. Cancer Prehabilitation Studies Based on Models of Care and Diagnostic Groups

				(β=.03, P=.02). Increased SA was associated with decreased HRQOL (β=-.02,P=.01)
13	Halliday (2021) UK	Adherence to pre-operative exercise and the Response to Prehabilitation in Oesophageal Cancer Patients	Esophageal cancer	Personalized home-based pre-operative exercise program 67 patients. Jan 2016-Dec 2018.Greater exercise volume is associated with lower risk of post-op pneumonia. Patients with high baseline fitness require less supervision to reach goals & completed more physical activity
14	Ferreira (2020) Canada	Multimodal Prehabilitation for Lung Cancer Surgery: A Randomized Controlled Trial	Lung cancer	Involves multiple healthcare workers eg kinesiologist, dietician, Psychology-trained personel. Home-based, unsupervised exercise program Multimodal prehab x 4 weeks prior to surgery is as effective in recovering functional capacity as multimodal rehabilitation
Technology				
15	Wu (2021) UK	The Feasibility and Effects of a Telehealth-Delivered Home-Based Prehabilitation Program for Cancer Patients during the Pandemic	Various cancers, surgical and non-surgical	Telehealth delivered prehab, includes personalized training exercises, dietary advice, medial optimization, psychological support 182 referred. 76% enrolled. Significant improvement in perceived health, fatigue Established during pandemic
16	Piraux (2020) Belgium	Feasibility and Preliminary Effectiveness of a Tele-Prehabilitation Program in Esophagogastric Cancer Patients	Esophagogastric Cancer Patients	Tele-prehabilitation program, including aerobic, resistance, inspiratory muscle training, 2 to 4 weeks. Main outcomes were recruitment, retention, attendance rate, satisfaction, adverse events. Secondary outcomes; functional capacity, fatigue, QOL, anxiety & depression. 15 completed out of 24Feasible with high recruitment, retention, good attendance
17	Barberan-Garcia (2020) Spain	Cost-effectiveness of a technology-supported multimodal prehabilitation program in moderate-to-high risk patients undergoing lung cancer resection: a randomized comtrolled trial protocol	Lung Cancer	Technology supported- exercise trackers. Inputs by various healthcare providers, supervised exercise program Study protocol.

18	Waterland (2021) Australia	Implementing a telehealth prehabilitation education session for patietns preparing for major cancer surgery	Various major cancer surgery	Telehealth prehabilitation education Online Surgical School- education only. 69% attendees reside in rural or regional areas. Well received

Table 3: Comparison between Baseline and Post-Prehab Outcome Measures

1. **Functional (Physical) Outcome Measures**

6 Minutes Walk Test	Baseline (metres)	Pre-Op (metres)	Improvement (metres)	p value
Mean (95% CI) Median (IQR)	303.94 (285.66, 322.22) 308 (234, 365)	325.46 (305.14, 345.77) 326 (251, 402)	21.52	<0.001

30-Seconds Sit-to-Stand Test	Baseline (reps)	Pre-Op (reps)	Improvement (reps)	p value
Mean (95% CI) Median (IQR)	10.99 (10.23, 11.76) 10 (9, 13)	12.07 (11.25, 12.90) 11 (9,14)	1.08	<0.001

Time-Up-And-Go Test	Baseline (sec)	Pre-Op (sec)	Improvement (sec)	p value
Mean (95% CI) Median (IQR)	12.07 (10.87, 13.27) 10.9 (8.35, 14.8)	11.24 (10.18, 12.29) 9.5 (8, 12.4)	0.83	0.014

2. <u>Psychological Outcome Measures</u>

HADS Depression Score	Baseline	Pre-Op	Improvement	p value
Mean (95% CI)	2.93 (2.41, 3.46)	1.94 (1.46, 2.43)	0.99 (34%)	<0.001
HADS Anxiety Score	**Baseline**	**Pre-Op**	**Improvement**	**p value**
Mean (95% CI)	3.24 (2.63, 3.86)	2.53 (1.93, 3.12)	0.71 (22%)	0.027
HADS Total Score	**Baseline**	**Pre-Op**	**Improvement**	**p value**
Mean (95% CI)	6.17 (5.17, 7.16)	4.40 (3.42, 5.37)	1.77 (29%)	<0.001

3. <u>Quality of Life (Health-Related) Outcome Measures</u>

EQ5D	Baseline	3-Month Post-Op	Improvement	p value
Mean (95% CI)	69.32 (65.96, 72.68)	76.36 (72.42, 80.29)	+ 7.04	0.001

HADS: Hospital Anxiety and Depression Scale

CI: Confidence Interval

IQR: Inter-Quartile Range

p value was obtained using Wilcoxon Signed Rank test