International Journal of Medical Toxicology & Legal Medicine Volume 27, No. 3S, 2024
e-ISSN: 0974-4614
p-ISSN: 0972-0448

Physical Exercise in the Prevention and Treatment of Colorectal Cancer: A Systematic Review

Stephanie Marie Cruz-Pierard[1], Samuel Olegario Iñiguez Jimenez[2], Fanny Cristina Guambo-Machado[3], Jonathan Luis Cruz-Pierard[4], Maybelin Samantha Iñiguez Jimenez[5]

[1]Pontificia Universidad Católica del Ecuador, Email: scruz586@puce.edu.ec
[2]Pontificia Universidad Católica del Ecuador, Centro de Investigación para la Salud en América Latina (CISeAL) , Email: soiniguez@puce.edu.ec
[3]Escuela Superior Politécnica de Chimborazo, Email: cristina.guambo@espoch.edu.ec
[4]Universidad Tecnológica Equinoccial (UTE) , Email: jonathan.cruz@ute.edu.ec
[5]Pontificia Universidad Católica del Ecuador, Email: soiniguez@puce.edu.ec

Received: 09.09.2024 Revised: 16.10.2024 Accepted: 22.11.2024

ABSTRACT
Colorectal cancer has become a major health risk worldwide. It has been shown that increasing physical activity in patients with this pathology can improve their condition and help in their treatment. This research sought to determine what types of exercises and what effects they have in the treatment of colorectal cancer. For this, a systematic review was carried out in accordance with the PRISMA guidelines. 14 randomized controlled trials from PubMed and Web of Science between 2018 and 2023 were included that met the inclusion and exclusion criteria. In all RCTs analyzed, it was determined that aerobic physical exercise performed 3-5 times a week with moderate to vigorous intensity for at least 30 minutes showed beneficial effects in CRC by improving quality of life, survival, and reducing anxiety and depression. Evidence shows that regular exercise can reduce the risk of CRC by improving predisposing factors such as overweight and inflammation, optimizing the function of the immune system. In addition, it can be a complementary treatment including aerobic activity combined with strength. More studies are needed to standardize dosing recommendations and the specific effects of exercise in the treatment of CRC.

Keywords: colorectal cancer; exercise; prevention; treatment.

1. INTRODUCTION

Colorectal cancer (CRC) is one of the pathologies that have been increasing in prevalence worldwide in recent years, being the third most diagnosed type of cancer [1]. In 2020, around 2 million people presented CRC, and its incidence among young people has also increased [1]. Regarding the 5-year survival rate of this pathology, it is 65%; however, it varies in relation to the stage of the cancer and other health factors [1].

The main causes of this type of cancer are genetic mutations that can be hereditary or acquired. Examples of the first case are familial adenomatous polyposis, Peutz-Jeghers or Lynch syndrome syndrome, while acquired genetic mutations are those that the person could develop during the course of his life [2] and are related to some risk factors such as being overweight or obese, physical inactivity, and the consumption of certain types of food, alcohol, or tobacco [3].

These acquired mutations are responsible for most CRC cases in the world [2]. Therefore, the suppression of the associated risk factors would be one of the best strategies to counteract the development of this pathology in the population. In this context, a sedentary lifestyle has been linked with colorectal cancer increased risk [4]. Also, it has been estimated that physical inactivity may contribute to 8% of the cases of this type of cancer worldwide [4].

According to the World Health Organization (WHO) [5], physical activity (PA) is any body movement that results from skeletal muscle contraction and significantly increases the body's energy use compared to the rest. This term applies to all the movements that the person performs [6]. On the other hand, a sedentary lifestyle is considered a continuous lack of exercise, which increases the risk of suffering up to 35 serious chronic diseases such as obesity, diabetes, hypertension, and other cardiovascular diseases. A direct relationship has even been shown between cardiovascular mortality and physical inactivity [7].

Around 1.4 billion adults in the world (1 in 3 women and 1 in 4 men) do not comply physical activity recommendations necessary to maintain health, according to the WHO [5]. In addition, levels of physical

activity have not improved since 2001, negatively impacting the health system, economy, environment, quality of life, and community well-being in all countries. Inactivity rates are twice as high in high-income countries as in low-income countries [5].

Physical inactivity can increase the risk of CRC for several reasons; for example, it can increase intestinal transit time, which increases the exposure of the colonic lining to carcinogens and toxic substances [4]. On the other hand, physical activity can help prevent overweight, obesity and reduce inflammation that contributes to the development of this cancer. It can also improve immune function, preventing the growth and spread of cancer cells [4, 8]. Therefore, people who have a sedentary lifestyle are recommended to increase their physical activity and avoid a sedentary lifestyle to reduce their risk of developing this pathology [9]. Current physical activity guidelines recommend at least 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity per week for adults [9].

Similarly, regular exercise combined with other medical treatments can be an important component of colorectal cancer treatment, as it can improve quality of life and reduce associated symptoms such as depression, fatigue, and anxiety [10]. It can also help maintain muscle strength, mobility, and flexibility, which may be particularly important during and after treatment for this pathology [10].

At the metabolic level, some pathways have also been determined, such as how exercise can benefit cancer patients; one way is the production of cysteine-rich acid protein (SPARC), which blocks the initiation and progression of colorectal tumors in humans [11]. Another pathway is the activation of sirtuins, which are cellular proteins involved in gene expression and cellular metabolism [11]. Specifically, the activation of certain 3 (SIRT3) by exercise, depending on the intensity of the exercise, has shown the potential therapeutic value in different types of cancer [11].

It has been observed that this protein can suppress the metabolism of cancer cells by increasing mitochondrial oxidative function, as well as the expression of PGC-1α and the enzymatic activity of isocitrate dehydrogenase 2 (IDH2) and succinate dehydrogenase (SDH), increasing the systems endogenous defense mechanisms that control the levels of free radicals [11]. Furthermore, SIRT3 can promote apoptosis by increasing the activity of the p53 protein [11].

Finally, there are several risk factors for developing CRC; however, it has been shown that one of the most common is a sedentary lifestyle and physical inactivity. Therefore, in the present study the objective was to determine, according to the existing updated evidence, the benefits of exercise in terms of the prevention and/or treatment of CRC. This is important since an exercise plan in these patients can be a strategy to reduce the incidence and mortality of this pathology, which has been increasing in recent years, especially in young people. Likewise, since physical inactivity is a modifiable risk factor, it is imperative to know what the impact of its improvement would be by promoting activity in patients. While it is true, some publications have been made on this topic, however, this study seeks to update knowledge with recent research results, therefore, it will help fill the knowledge gap in this area.

2. MATERIALS AND METHODS

2.1. Protocol

It was carried out a systematic review in accordance with PRISMA guidelines [12]. It was registered in the International Prospective Register for Systematic Reviews (PROSPERO) under the ID: CRD42023424991.

2.2. Search strategy

Two search chains were developed for PubMed and Web of Science databases, they were adapted with MeSH terms (Appendix A). The review was limited to those articles published in the last 5 years to specifically consider the most up-to-date information on the topic. The last search was carried out in January 2024.

A total of 85 manuscripts in PubMed and 387 in Web of Sciencewere found to be possibly included in the present review.

2.3. Inclusion and exclusion criteria

Characteristics of the PICO format (population, intervention, comparison and outcome) were determined to prepare the inclusion and exclusion criteria. P: Research on colon, rectal or colorectal cancer patients, survivors and those healthy individuals at risk of developing it, I: who performed some type of exercise during the study were considered, C: with control group for comparison. O: In addition, studies that presented results related to the beneficial effects of exercise in the prevention or treatment of CRC were included. The same way, articles published between 2018 and 2023, manuscripts in Spanish, French or English and randomized controlled trials (RCTs) were included.

Observational studies, systematic reviews, meta-analyses, short communications, letters to the editor and other types of studies such as exploratory studies, reviews, plans, cell cultures, ancillary studies or non-randomized clinical trials and animal studies were excluded.

2.4. Methods to avoid risk of bias

Determination of risk of bias was made based on the Cochrane Handbook for Systematic Reviews of Interventions tool Version 1.0 [13], it was used to assess the risk of bias of each study included.

The certainty or quality of the evidence was also determined using the Grading, Development and Evaluation of Recommendations (GRADE) approach [14]. This tool helps establish the degree of confidence provided by the results of the article to be able to use them as a recommendation. It presents four levels of evaluation that are high, moderate, low and very low [14]. Likewise, the GRADE methodology reviews a series of domains to determine the level of evidence, those that increase it are large magnitude of the effect, dose response gradient and effect of potential confounding factors; those that reduce the level are risk of bias, inconsistency, indirect evidence, imprecision and publication bias [14].

2.5. Data extraction method

Regarding the process of collecting and selecting studies, it was carried out in duplicate by the 2 researchers. Each one applied the search strings in the databases and reviewed the articles to determine the most favorable ones. Selected studies were then compared and duplicates were removed.

A total of 472 investigations were found. After excluding duplicates and those that did not meet the inclusion criteria, 14 eligible articles were included (Figure 1). The specific detail information of each study (author, number of participants, year of publication, intervention, evaluation instruments and conclusions) is shown in Table 2. It is worth mentioning that data extraction was performed and reviewed by both authors, as well as the risk of bias and GRADE level of evidence.

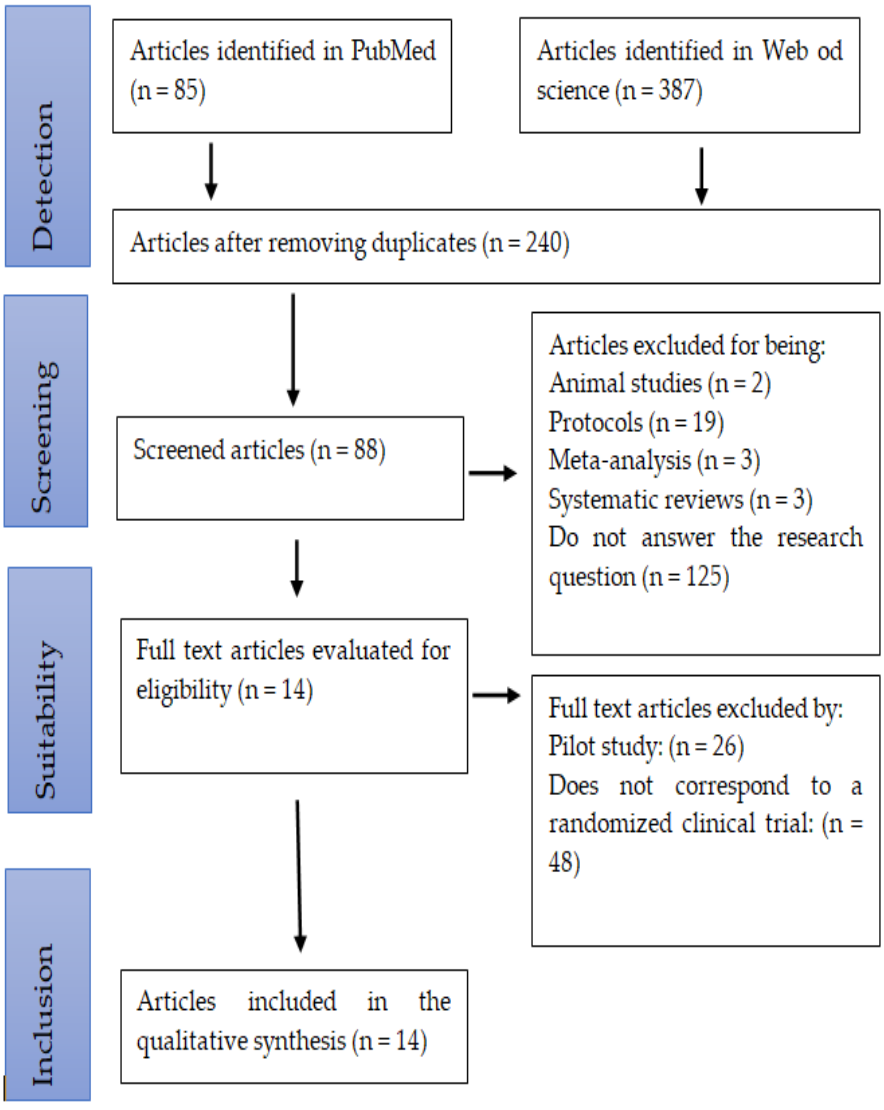

Figure 1. Article selection diagram

Table 1. Main characteristics of the studies included in the systematic review.

Author / year of publication	Number of participants	Intervention Prevention/treatment	Evaluation instruments	Conclusions
Golsteijn et al., 2018 [15]	Colorectal and prostate cancer patients and survivors. OncoActive intervention group: Prostate and colorectal cancer patients/survivors (n = 249). Control group: Patients on the usual care waiting list (n = 229).	Treatment OncoActive: Personalized physical activity advice at baseline, after 2 and 3 months, both online and by mail. Recommendations based on behavior change theories promoting pre-motivational, motivational, and post-motivational constructs. Use of pedometer. Patients had access to interactive content on the website (videos, instructions).	Self-report: PA monitoring by questionnaire (SQUASH) and accelerometers (ActiGraph GT3X-BT). CIS: fatigue. HADS: anguish. Quality of life questionnaire C30.	OncoActive participants significantly increased their PA. Physical functioning, depression and fatigue also improved. Patients with CRC and women obtained the best results.
Lu et al., 2019 [16]	Patients with CRC and CRF were treated with chemotherapy. Baduanjin exercise group: (n = 45). Routine care group: (n = 45).	Treatment The routine care group received general care for CRF, face-to-face health education about CRF, explanations about assessment methods, related symptoms, influencing factors, and CRF intervention measures. In the Baduanjin group, was carried out a routine CRF care too. Through WeChat, patients were motivated to watch videos of how to practice the exercises. Patients performed Ba-duanjin at least 5 sessions per week and 20-40 min per session.	BFI at 24 weeks. KPS and PSQI.	Baduanjin exercise improves CRF, physical activity level and sleep quality in CRC patients receiving chemotherapy.
Carli et al., 2020 [17]	Patients who underwent colorectal cancer resection. Prehabilitation group: (n = 55). Rehabilitation group: (n = 55).	Treatment Training supervised by a trained kinesiologist 1 time per week for 4 weeks: 30 minutes of moderate aerobic exercise on a recumbent climber, 25 min of resistance exercises with elastic band and 5 min of stretching. Personalized program of aerobic activities at home (walking daily for 30 min at moderate intensity) and resistance training (elastic band routine 3 times/week). Rehabilitation group, same program, but 4 weeks after discharge. Additionally, nutritional and	The Comprehensive Complication Index measured 30 days after surgery. General and serious complications after 30 days. Primary and total length of hospital stay, emergency department visits, 30-day hospital readmissions, recovery of walking ability, and patient-reported outcome measures.	The prehabilitation program that included exercise, nutritional and psychological interventions did not modify postoperative complications.

		psychological intervention		
Northgraves et al., 2020 [18]	Elective colorectal surgery patients. Prehabilitation group: (n = 11). Rehabilitation group: (n = 11).	Treatment 3 individualized 60-minute exercise sessions per week with a certified instructor. Aerobic and resistance training. Standard care participants maintain their normal exercise levels. Both groups fulfill diaries of physical activity.	Viability. Impact on length of postoperative hospital stay and complications. Preoperative physical functioning (TUG, FTSTS, SCT, HGD and 6MWT) and quality of life (Hospital Anxiety and Depression Scale and EORTC Quality of Life Questionnaire-C30).	Prehabilitation presented benefits in physical functioning, however, short surgical waiting times and patient participation were obstacles to its implementation.
Brown et al., 2020 [19]	Patients with breast cancer or CRC stage I-III. Exercise group: (n = 35). Metformin group: (n = 35). Exercise + metformin group: (n = 35). Control group: (n = 34).	Treatment Exercise: combination of supervised in-person and home activity. Aerobic exercise was the main one, with treadmill and walking outdoors. Exercise intensity: 65-80% of age-predicted heart rate. Home exercise was monitored by self-report using exercise logs that were provided to participants.	Fasting blood collection (≥10 hours) at baseline and week 12. Measures of inflammation: hs-CRP, sTNF-αR2 and IL-6.	Exercise reduced sTNF-αR2 concentrations of IL-6 and metformin over 12 weeks. The effect was consistent in all stratification variables (initial BMI, sex, type of cancer). Exercise reduced hs-CRP and IL-6, and the combination of metformin with exercise reduced sTNF-αR2 and IL-6.
Peng et al., 2021 [20]	Patients with CRC scheduled for surgery. Enhanced recovery group after S-ERAS surgery (n= 104). Improved recovery group after surgery based on PR-ERAS preoperative rehabilitation (n= 109).	Treatment Preoperative rehabilitation exercises (strengthening of extremities, abdominal muscle exercise, chest, and abdominal breathing exercises) + standardized protocol for improved recovery in the S-ERAS group. Patients that were not admitted to surgery performed exercises at home, upon admission, they exercised at their bedside. Exercises 2 times in the morning and in the evening, and 10-15 repetitions were suggested. The intensity of the exercise was written in a diary, including their time and types of exercise. Telephone tracking.	Early recovery of GI function, QOR-40 at three times, the day of surgery, 72 hours after surgery and 30 days later. Dominant handgrip strength was measured with a hydraulic dynamometer (Saehan Corporation, Korea).	Perioperative rehabilitation exercise helped improve both early GI recovery and quality of life and muscle strength after surgery.
Berkel et al., 2022 [21]	Elective colorectal surgery patients. Prehabilitation group: (n = 28). Usual care group: (n = 29).	Treatment Exercises performed and/or supervised by a group of physiotherapists trained in community practices. 60-minute training session: intervals of moderate to high intensity on a cycle ergometer (TechnoGym,	Rate of postoperative complications in the 30 days after, according to the Cla-vien-Dindo classification.	Postoperative complications were reduced. Prehabilitation should be considered routine care in high-risk patients scheduled for elective CRC surgery.

		Bike Med) for aerobic capacity (40 min) and resistance training for leg strength peripheral muscles (20 min).		
Onerup et al., 2022 [22]	Elective colorectal surgery patients. Intervention group: (n = 317). Control group: (n = 351).	Treatment Thirty minutes of daily aerobic activity added to the individual's normal exercise routine. Inspiratory muscle training (IMT). The physical therapist also instructed each participant on how to increase resistance, as needed.	Self-assessed physical recovery 4 weeks post-op: To what extent do you feel fully physically recovered?" Postoperative complications according to the rate of complications at 30 and 90 days.	No effect of physical activity intervention was found before and after CRC surgery on short-term self-assessed physical recovery.
Asnong et al., 2022 [23]	Patients with rectal cancer undergo total mesorectal excision (TME). Intervention group: (n = 50). Control group: (n = 54).	Treatment 12 weeks of PFMS: 1 session/week for the first 6 weeks and then 3 sessions the last 6 weeks with a specialized physiotherapist. It began with an evaluation of GI symptoms with a diary, health education, pelvic floor muscle exercises (endurance, strength relaxation, proprioception, and coordination), electromyography-biofeedback/electrical stimulation, and balloon rectal. The control group didn't receive any EMSP.	% of patients with LARS improved in 4 months.	Lower LARS ratios and faster recovery from intestinal symptoms up to 6 months after surgery/stoma closure.
Min et al., 2023 [24]	Postoperative patients with stage I-III colorectal cancer surgery. Intervention group: (n = 26). Usual care group: (n = 26).	Treatment 15 minutes of exercise supervised by exercise and oncology specialists, 2 times a day for the duration of the hospital stay. 3-phase exercise program: 1. Stretching and low-intensity resistance exercises, 2. Phase 1 exercises + central resistance exercises and 3. Phase 1 and 2 exercises + balance exercises. All movements were performed in a series of 10 repetitions. The usual care group didn't receive exercise program.	Duration of stay in the care center. Pt-RHDS. Anthropometry. Physical function.	Post-surgical exercise in hospitalized patients accelerates recovery and discharge after colorectal cancer surgery with curative intent. Improvement in muscle mass was also observed.
Liu et al. 2019 [25]	Patients with cancer of the middle and lower rectum with preoperative radiochemotherapy. Blank control group: (n = 38).	The 3 groups received routine nursing. Pelvic floor muscle exercises performed functional exercises every day before the operation and 16 months later except for 1 week. Videos of the exercises were provided for	A total of 5 assessments was conducted using the Chinese version of the MSKCC.	Biofeedback training did not completely prevent intestinal dysfunction, but it may reduce the degree of intestinal dysfunction and promote recovery of intestinal function in patients with rectal cancer during

	Pelvic floor muscle exercise group: (n = 36). Biofeedback training group: (n = 35).	them to do at home. Insight PHNS-A Biofeedback: Training with High-Resolution Gastrointestinal Dynamics Test Equipment. The appropriate course was chosen according to the EMG change, patients were trained to identify their abnormal and normal EMG signals, and repeated anal contraction, relaxation, defecation and other actions. It was repeated 3 times a week, 20 minutes.		treatment. It is considered a safe, effective, economical method, with few side effects.
Piraux et al., 2022 [26]	Rectal cancer patients undergo neoadjuvant chemoradiotherapy. UC Group: (n=6) HIIT group: (n=6) RES Group: (n=6)	The exercise interventions were performed 3 times a week for 5 weeks with a trained physiotherapist. Participants received a training diary to record exercise attendance, intensity and session duration, the reason for missing, or any related adverse events. HIIT: cycle ergometer training with a recovery work ratio of 1:1, between 26 to 40 min. RES: resistance training in abdominal muscles, pectoral, deltoids, gastrocnemius, trapezius, hamstrings, latissimus dorsi, spinal erector, biceps, triceps, quadriceps, soleus and glutes 30 to 40 min.	Fatigue: FACIT-F). Quality of life: FACT-G. Depressive symptoms: CES-D. Drowsiness: ESS. Perception of insomnia symptoms: ISI. Sleep quality: PSQI. Functional exercise capacity: 6MWT. Cognitive function: TMT.	HIIT and RES are feasible in patients with rectal cancer. A high recruitment and adherence rate was demonstrated. Neither of the two exercise programs was superior to UC in improving physical and psychological disorders related to chemoradiotherapy.
Bousquet-Dion et al., 2018 [27]	Patients for resection of non-metastatic colorectal cancer. PREHAB+ group: (n = 41) REHAB group: (n = 39).	PREHAB+: exercise sessions supervised by a kinesiologist in the pre-surgical period 1 time per week + multimodal home exercise program after surgery for 8 weeks (3 or 4 days/week 30 min of moderate intensity aerobic activity such as walking, jogging). REHAB: preoperative information on walking, ankle rotation, breathing exercises, etc. After surgery, a home exercise program is indicated. In both groups nutritional intervention and strategies to reduce anxiety.	Functional walking capacity: 6MWD.	There was no further increase in preoperative functional capacity in patients with CRC. Despite this, patients considered more inactive significantly increased their level of physical activity before surgery and accelerated the recovery of functional capacity after surgery, especially women.
Mayer et al.,	Colon cancer	Control group: "Looking	Survivor-CHESS usage	Both groups increased

2019 [28]	survivors. Survi-vorCHESS Group: (n = 144) Control group: (n = 140)	Forward: Life After Cancer Treatment" brochure, a cancer survivorship toolbox, and a pedometer were given. SurvivorCHESS Group: materials delivered to the control group + smartphones with the SurvivorCHESS application (promotion of competencies, relationships and autonomy). Goal of 150 minutes of physical activity per week.	data: login, pages reviewed and messages. Demographic and medical information about cancer. Physical activity: GLTPAQ. Distress: NCCN Distress Tool. Quality of life: FACT-C, version 4.	their level of physical activity but did not maintain it after the study ended. The use of the eHealth intervention, SurvivorCHESS, was not significantly different and was not associated with physical activity. No significant differences were found for the quality of life or distress elements.

CIS: Checklist Individual Strength. HADS: Hospital Anxiety and Depression Scale. CRF: Cancer-related fatigue. BFI: Brief Fatigue Inventory. KPS: Karnofsky Performance Status. PSQI: Pittsburgh Sleep Quality Index. TUG: timed up and go test. FTSTS: five times sit to stand. SCT: stair climb test. HGD: handgrip dynamometry. 6MWT: 6-min walk test. hs-CRP: high sensitivity C-reactive protein. sTNF-αR2: soluble tumor necrosis factor alpha receptor two. IL-6: interleukin 6. BMI: body mass index. GI: gastrointestinal. QOR-40: quality of recovery score. PFMT: pelvic floor muscle training. LARS: low anterior resection syndrome. Pt-RHDS: patient-perceived readiness for hospital discharge. Insight PHNS-A: biofeedback training and treatment system, Sandhill's solid anorectal high resolution pressure measuring device. EMG: electromyography. MSKCC: questionnaire on intestinal function by the Memorial Sloan-Kettering Cancer Center. HIIT: high-intensity aerobic interval training. RES: resistance training. UC: usual care. FACIT-F: Functional Assessment of Chronic Illness Therapy–Fatigue. FACT-G: Functional Assessment of Cancer Therapy–General. CES-D: Center for Epidemiologic Studies Depression Scale. ESS: Epworth Sleepiness Scale. ISI: Insomnia Severity Index. TMT: trail-making test. PREHAB: supervised prehabilitation program. REHAB: standard rehabilitation. GLTPAQ: Godin Leisure-Time Physical Activity Questionnaire. NCCN: National Comprehensive Cancer Network. FACT-C: Functional Assessment of Cancer Therapy-Colon.

3. RESULTS

3.1 Main results

The fourteen studies included in this paper were double-blind randomized clinical trials [15-28]. The main results on exercise dosage specified in each investigation are detailed in Table 2. It should be noted that a meta-analysis could not be prepared due to the heterogeneity of the results of each study, so the effects could not be statistically compared.

Table 2. Exercise dosage

Author	Frequency	Intensity	Time	Type of exercise	Results
Golsteijn et al., 2018 [15]	D: 24 weeks D/W: 4 - 7 S/D: - D/R: -	Moderate, vigorous	≥ 30 minutes	Light (metabolic equivalent [MET] < 3.0), moderate (MET 3.0–5.9) and vigorous (MET > 6) aerobic exercise	Fatigue: decrease in women (B = − 12.70, p = .007, ES = − 0.76), but not in men (B = − 2.14, p = .21, ES = − 0.15) Physical Functioning: significant improvements (B = 4.27, p = .004, ES = − 0.37)
Lu et al., 2019 [16]	D: 24 weeks D/W: 5 -7 S/D: 1 D/R: 2	Light	20 – 40 minutes	Baduanjin flexibility exercises, 54% maximum HR Aerobic exercise	Fatigue: moderate to severe was significantly lower (23.2 vs. 59.1%, p<). ai=4><0.01) Functional status: exercise group compared to routine care group (89.3 ± 8.3 vs. 75.2 ± 11.5, <) at i=3>p < 0.01) Sleep quality: in the exercise group compared to the usual care group (4.1 ± 1.1 vs. 6.9 ± 2.0, <) at i=7>p < 0.01)

Carli et al., 2020 [17]	D: 4 weeks D/W: 3 - 7 S/D: 1 D/R: -	Moderate	30 minutes of aerobic exercise, 25 minutes of resistance exercise, and 5 minutes of stretching	Combined exercise (resistance exercises and aerobic exercises)	Postoperative complications in surgical resection of CRC: There were no differences between groups (adjusted mean difference, –3.2; 95% CI, –11.8 to 5.3; P = 0.45).
Northgraves et al., 2020 [18]	D: 8 weeks D/W: 3 S/D: 1 D/R: 4	Light, moderate	60 minutes	Combined exercises (resistance exercises and aerobic exercises)	Physical function: increased on average 17.0 ± 9.0% (min/max 3.9 to 31.2%)
Brown et al., 2020 [19]	D: 12 weeks D/W: 2 S/D: 1 D/R: 5	Moderate	220 minutes	Aerobic exercise	Inflammation biomarkers C-reactive protein: decreased [-30.2%; 95% confidence interval (CI), −50.3, −1.0] IL6: decreased (−30.9%; 95% CI, −47.3, −9.5) sTNFαR2: unchanged (1.0%; 95% CI, −10.4, 13.9).
Peng et al., 2021 [20]	D: 2 weeks D/W: 7 S/D: 4 D/R: -	To the patient's tolerance	10 – 15 repetitions	Strength exercises	Normal recovery after CRC surgery: was higher (79.0% vs. 64.3%, P < 0.050).
Berkel et al., 2022 [21]	D: 3 weeks D/W: 3 S/D: 1 D/R: 4	Moderate to vigorous	40 minutes of aerobics and 20 minutes of resistance	Combined exercises (resistance exercises and aerobic exercise)	Postoperative complications in surgical resection of CRC: were lower (n = 12, 42.9% vs n = 21, 72.4%, relative risk 0.59, 95% confidence interval 0.37–0.96, P = 0.024).
Onerup et al., 2022 [22]	D: 6 weeks D/W: 7 S/D: 1 D/R: -	Moderate	30 minutes of aerobic exercise, 30 × 2 of resistance exercise	Combined between breathing resistance exercises and aerobic exercise	Postoperative recovery in surgical resection of CRC: There was no effect of the intervention on the primary outcome (adjusted odds ratio 0.84, 95% confidence interval 0.62-1.15).
Asnong et al., 2022 [23]	D: 12 weeks D/W: 3 -6 S/D: 1 D/R: 4-5	Moderate	60 contractions of the pelvic floor muscles per day, divided into 2-3 sets of exercises and in different positions	Strength exercises	Postoperative intestinal symptoms in surgical resection of CRC: faster recovery of intestinal symptoms up to 6 months after surgery 47.8% vs 21.3%; P=0.0091)
Min et al., 2023 [24]	D: 1 week D/W: 7 S/D: 2 D/R: -	Light	15 minutes 10 repetitions	Combined exercises (resistance exercises and mobility exercises)	Postoperative recovery in surgical resection of CRC: greater preparation for hospital discharge (adjusted group difference = 14.4; 95% CI, 6.2 to 22.6; P< ai=6> = 0.03).

Liu et al. 2019 [25]	Group 1 D: 64 weeks D/W: 7 S/D: 5 D/R: just 1 week after surgery Group 2 D: 64 weeks D/W: 3 S/D: 1 D/R: 4	Light	10 repetitions of 5 to 10 seconds with 10 second rests 20 minutes 1 repetition	Strength exercises	Intestinal Function: Training with biofeedback was the best (P<0.05).
Piraux et al., 2022 [26]	D: 5 weeks D/W: 3 S/D: 1 D/R: 4	≥ 85 % THRmax Perceived exertion of 4 to 6 on the modified Borg scale	26 to 40 minutes at 90 to 100 revolutions 30 to 40 minutes of 8 to 12 repetitions of 1 to 3 sets	Aerobic high-intensity interval training (HIIT) Resistance training (RES)	HIIT and RES are achievable in rectal cancer patients. A high recruitment and adherence rate was demonstrated. Neither exercise program was superior to UC in improving physical and psychological disorders related to chemoradiotherapy.
Bousquet-Dion et al., 2018 [27]	D: 8 weeks D/W: 3-4 S/D: 1 D/R: 3-4	60-70% THRmax	30 minutes 2 sets of 8 to 15 repetitions	Combined exercises (resistance exercises and aerobic exercises)	It did not further increase preoperative functional capacity in patients with CRC. Despite this, patients considered as inactive increased their level of exercise significantly before surgery. Also, they accelerated the functional capacity recovery after surgery, especially women. Both groups were comparable in terms of initial walking capacity (PREHAB+: 448 m [IQR 375-525] vs. REHAB: 461 m [419-556], p = 0.775) and included a similar proportion of patients who improved walking capacity. of walking (>20 m) during the preoperative period (PREHAB+: 54% vs. REHAB: 38%, p = 0.222). After surgery, changes in 6MWD were also similar in both groups. In PREHAB+, however, there was a significant association between physical activity energy expenditure and 6MWD (p < 0.01). Previously inactive patients were more likely to improve their functional capacity thanks to PREHAB+ (OR 7.07 [95% CI 1.10–45.51]).
Mayer et al., 2019 [28]	D: 6 months D/W: - S/D: - D/R: -	–	150 minutes	Aerobic exercises	Both groups increased their level of physical activity but did not maintain it after the study ended.Participants using SurvivorCHESS (n=144) increased their moderate-to-vigorous physical activities from 19.4 min at

					baseline to 50 min compared to the control group (n=140), increasing from 15.5 to 40 min. .3 min at 6 months (p = 0.083), but was not maintained 3 months after completing the study. No significant differences were found between groups over time in terms of quality of life or distress elements. Reports of physical symptoms were higher than other categories for distress items. Patients who had a higher body mass index and a greater number of comorbid diseases were less likely to increase their physical activity. Self-determination theory, including autonomous and relatedness motivation, was not associated with outcomes.

D: duration. D/W: days per week. S/D: sessions per day. D/R: days of rest. THRmax: theoretical maximum heart rate.

Guidelines regarding exercise dosage are based on WHO recommendations [29]. In this way, exercise should be part of a person's life to reduce the incidence of chronic non-communicable diseases, including their mood. Looking at Table 2, we can normalize the exercise recommendations at a frequency of 3 to 5 times per week with a slow progression [15, 16, 18, 21, 23, 26, 27] of aerobic exercise with a moderate intensity of more than 30 minutes at least 150 minutes per week [15, 18, 19] or a vigorous intensity of more than 75 minutes per week [21, 24-28]. For combined activity, it is recommended to integrate strength exercises at least 60% of 1RM [19-24, 26]. The duration apparently varies between 2 weeks [20] and 16 months [25] independently, with positive effects.

Regarding the results, exercise guidelines for the different manifestations seem to improve CRC patients' functional capacity, depression, sleep quality and fatigue [15, 19, 25, 26]. Additionally, patients during treatment can reduce the degree of intestinal dysfunction and promote recovery [23, 25, 26].

Post-surgical exercise in hospitalized patients accelerates recovery and discharge after curative-intent colorectal cancer surgery. Improving postoperative complications, quality of life [17, 20, 21, 23, 24]

In some studies, no significant differences were found between exercise and quality of life, physical recovery, and distress [22, 28], possibly because they were interventions based on self-perception report or also on ehealth.

3.2 Publication bias and certainty of evidence

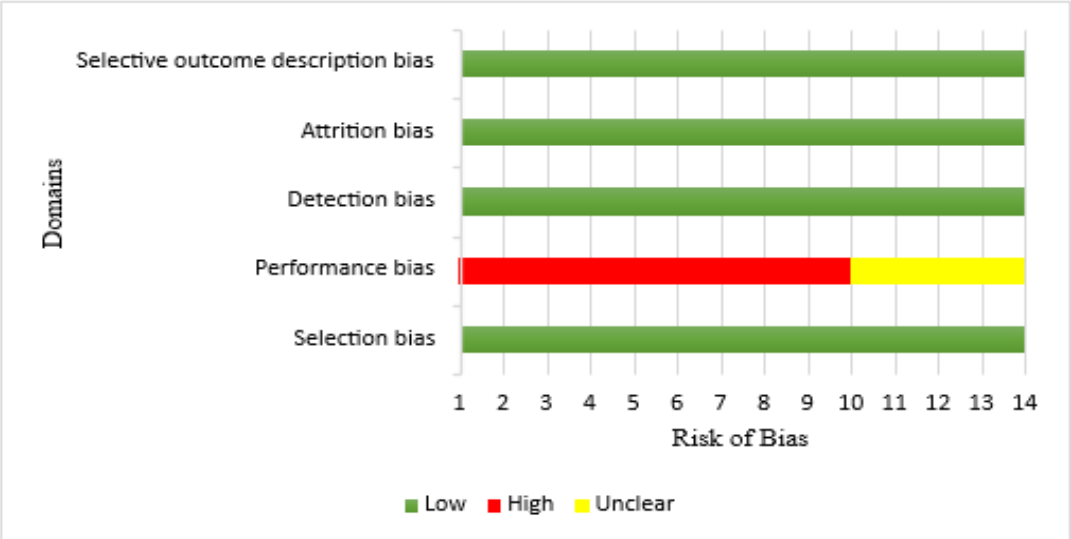

Figure 2. Risk of bias

Figure 2 shows the risk of bias found in the articles analyzed. All presented low risk in selection bias, detection bias, attrition bias, and selective description of the results. However, the articles by Golsteijn et al [15]., Carli et al [17]., Brown et al. [19], Berkel et al. [21], Onerup et al. [22], Asnong et al. [23], Min et al. [24], Piraux et al. [26], Bousquet-Dion et al. [27] and Mayer et al. [28] presented a high risk of performance bias by not blinding the participants or the researchers, the authors mention that it was not possible or necessary due to the type of intervention applied. Similarly, the unclear risk of bias was identified in the articles by Lu et al. [16], Northgraves et al. [18], Peng et al. [20] and Liu et al. [25] as they do not specify how blinding was performed.
Regarding the determination of the certainty of the evidence according to GRADE, eight of the articles analyzed were classified as high level of evidence [15, 16, 20, 21, 23-26] and the remaining six as moderate level [17-19 , 22, 27, 28], to establish these criteria, an evaluation of the domains that increase or decrease the level of evidence was carried out, they were detailed in the methodology [14, 29].

4. DISCUSSION

Physical activity can reduce the risk of CRC cancer. Furthermore, it has been associated as a protective and preventive factor for colon cancer [30, 31]. In this sense, physical activity is considered essential in treatment and recovery, making it necessary to provide an intervention based, among other treatments, on exercise in patients diagnosed with colorectal cancer [31, 33].
As mentioned above, moderate intensity physical activity between 150 to 300 minutes per week or 75 to 150 minutes of intense vigorous activity and strengthening activity more than 2 times per week is recommended preventively [20, 34]. Although there is no specific consensus recommendation as treatment, moderate and high intensity aerobic exercise can be specified more than 3 times per week and moderate intensity strength exercise at least 2 times per week [31, 34].
Regarding general recommendations for patients with colorectal cancer, the frequency should be 3 to 5 times per week, moderate aerobic exercise intensity between 40 - 60% of VO2max or HR, vigorous intensity between 60-85% of VO2max or HR. HR and strength exercise between 60 – 80% of the 1 repetition maximum (1RM), time 150 minutes of intense and vigorous activity, finally strength exercise at a moderate intensity of 60% to less than 70% of 1RM with a slow progression [31, 35, 36].
It has been shown in the majority of studies analyzed in this review that aerobic exercise at a frequency of 3 to 5 times per week, at least 30 minutes daily, offers benefits for patients with CRC such as a higher level of physical activity, functionality, a lower degree of fatigue and depression at 3 and 6 months of intervention, also improving their quality of sleep, reducing postoperative complications in high-risk patients, and reducing the appearance of gastrointestinal symptoms and help in recovery[15, 16, 18, 21, 23]. This coincides with what was stated by the NCI Team [37], who affirm that cancer survivors confirmed that half an hour of aerobic exercise three times a week was adequate to improve quality of life, dissipating symptoms such as anxiety, depression, fatigue and improving the functioning of the body [15, 19, 25, 26, 37].
Similarly, strength exercises, which are recommended at least twice a week, have also shown beneficial effects [20-25, 27]. In the research of Pereira-Rodríguez et al. [38], strength training in cancer patients or survivors managed to improve quality of life, increase strength, improve mobility, and reduce pain and fatigue, and it was also observed that it does not cause adverse effects or long-term complications.
In some of the articles reviewed, it was proven that, in patients during treatment, exercise can reduce intestinal dysfunction and improve recovery [23, 25, 26]. This is also evidenced in the study by Pino et al. [39] In which doing aerobic exercise at moderate intensity for 60 minutes or more can reduce the risk and better control gastrointestinal symptoms. However, the authors mention that, performing postprandial activities of long duration and vigorous intensity, linked to dehydration and high environmental temperature, could contribute to the development of exercise-induced gastrointestinal syndrome and, in turn, to the expression and/or worsening of symptomatology of pathologies of the gastrointestinal tract [39], a variable that should be taken into consideration for patients with CRC.
On the other hand, in terms of recovery, survival and postoperative quality of life in patients with this pathology, benefits were also found thanks to exercise programs [17, 20, 21, 23, 24] and these effects can be corroborated in other studies [39, 40]. Barroso [40] based on reviews and meta-analysis on the subject determined that CRC mortality is reduced by 21% associated with physical activity, it also reduces levels of anxiety, depression and improves quality of life and the social environment since performing physical exercise entails greater social interaction and communication with the environment.
One of the mechanisms by which exercise helps in the treatment of CRC could be the reduction of body inflammation [41]. When skeletal muscle contracts, interleukin 6 (IL-6) is produced independently of tumor necrosis factor, in addition to IL-1a and IL-10 receptor antagonists, generating an anti-inflammatory effect. It should be noted that the cytokine response during or after exercise is different from that produced by a severe infection; in addition, there are many other types of myosins that collaborate in the strengthening and proper functioning of the immune system [41].

Finally, in some studies no significant differences were found regarding the effects of exercise in the treatment of patients with CRC [22, 28], it is suggested that this could be due to the results of self-perception reports, in which patients can not having evidenced some aspects of their improvement, another reason may be that the exercise interventions were carried out in the ehealth modality, which has been proven to present some drawbacks such as a low participation rate and high abandonment by patients, for example. Which is important to find motivation strategies to improve adherence to this type of programs [42].
It is important to mention the strengths and weaknesses of the present review. As strengths, we could find several benefits of exercise in patients with CRC in various areas, such as improvement in their symptoms and fewer postoperative complications. On the other hand, the weaknesses were the diversity of interventions and measures used, which did not allow a meta-analysis to be prepared to determine the effect size of the results and to be able to make higher quality recommendations based on them. Likewise, the populations of each study were heterogeneous, which did not allow adequate measurement of the benefits to generalize them.

5. CONCLUSIONS

Evidence shows that regular exercise can reduce the risk of CRC by improving predisposing factors such as overweight and inflammation, optimizing the function of the immune system. However, physical activity can reduce the risk, but does not guarantee the prevention of CRC. In addition, it can be a complementary treatment including aerobic activity combined with strength. More studies are needed to standardize dosing recommendations and the specific effects of exercise in the treatment of CRC.

Author Contributions

All authors collaborated on every part of the article.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A

PubMed:
("exercise" OR "physical activity" OR "exercise therapy") AND ("colorectal cancer" OR "colorectal tumour" OR "colorectal carcinoma" OR "colorectal neoplasm" OR "colon cancer" OR "colon tumour" OR "colon carcinoma" OR "colon neoplasm" OR "rectum cancer" OR "rectum tumour" OR "rectum carcinoma" OR "rectum neoplasm" OR "rectal cancer" OR "rectal tumour" OR "rectal carcinoma" OR "rectal neoplasm")
Web of Science:
((((((((((ALL=(colorectal cancer)) OR ALL=(colorectal tumour)) OR ALL=(colorectal carcinoma)) OR ALL=(colorectal neoplasm)) OR ALL=(colon cancer)) OR ALL=(colon tumour)) OR ALL=(rectum cancer)) OR ALL=(rectum carcinoma)) OR ALL=(rectum neoplasm)) OR ALL=(rectal cancer)) OR ALL=(rectal carcinoma)) OR ALL=(rectal neoplasm)) AND ((ALL=(exercise)) OR ALL=(physical activity) OR ALL=(exercise therapy)) AND ALL = (Cross-sectional studies OR Clinical trials OR randomized controlled trials)

REFERENCES

1. American Society of Clinical Oncology. Colorectal cancer - Statistics [Internet]. Cancer.net. 2022 [cited 2023 Apr 28]. Available from: https://www.cancer.net/es/tipos-de-c%C3%A1ncer/c%C3%A1ncer-colorectal/estad%C3%ADsticas
2. American Cancer Society. Do we know what causes colorectal cancer? [Internet]. Cancer.org. 2018 [cited 2023 May 2]. Available from: https://www.cancer.org/es/cancer/cancer-de-colon-o-recto/causas-riesgos-prevencion/que-lo-causa.html
3. American Cancer Society. Risk factors for colorectal cancer [Internet]. Cancer.org. 2023 [cited 2023 May 2]. Available from: https://www.cancer.org/es/cancer/cancer-de-colon-o-recto/causas-riesgos-prevencion/factores-de-riesgo.html
4. Parra-Soto S, Martínez-Sanguinetti MA, Cigarroa I, Diaz-Martínez X, Matus-Castillo C, Garrido-Méndez A, et al. What is the association between physical activity, sedentary lifestyle and risk of developing cancer in the adult population? A review of the literature. Rev Chil Nutr [Internet]. 2021 [cited 2023 May 12];48(2):245–54. Available from: https://www.scielo.cl/scielo.php?pid=S0717-75182021000200245&script=sci_arttext
5. World Health Organization. Physical activity [Internet]. Who.int. 2022 [cited 2023 May 22]. Available from: https://www.who.int/es/news-room/fact-sheets/detail/physical-activity

6. Patiño Palma BE, Tabares Gutierrez M, Vélez Álvarez C, Vidarte Claros JA. Social determinants of health, predictors of physical condition in school adolescents. Investig Andina [Internet]. 2019 [cited 2023 May 22];21(39):117–31. Available from: https://revia.areandina.edu.co/index.php/IA/article/view/1559
7. Valle A. Lack of exercise - Sedentary lifestyle - Spanish Heart Foundation [Internet]. Spanish Heart Foundation. 2022 [cited 2023 May 22]. Available from: https://fundaciondelcorazon.com/prevencion/riesgo-cardiovascular/falta-ejercicio-sedentarismo.html.
8. Matsudo SMM. Physical Activity: Passport to Health. Medical reviewClín Las Condes [Internet]. 2012 [cited 2023 May 16];23(3):209–17. Available from: https://www.elsevier.es/es-revista-revista-medica-clinica-las-condes-202-articulo-activity-fisica-pasaporte-para-la-S0716864012703036
9. American Cancer Society. Physical activity and the cancer patient [Internet]. Cancer.org. [cited 2023 May 16]. Available from: https://www.cancer.org/es/cancer/supervivencia/bienestar-tras-el-tratamiento/activity-fisica-y-el-paciente-de-cancer.html
10. Rozano DB, Yuste CC. Effect Of Physical Exercise On Quality Of Life And Survival In Patients With Colorectal Cancer: Systematic Review [Internet]. Uca.es. [cited 2023 May 16]. Available from: https://rodin.uca.es/bitstream/handle/10498/27731/TFG_Dar%C3%ADoBR_C%C3%A1ncercolorrectal.pdf?sequence=1&isAllowed=y
11. Bórquez JC, Montes N, Díaz E. Combating tumor cells through SIRT3 activation and exercise. Rev Med Chil [Internet]. 2018 [cited 2023 May 24];146(6):762–9. Available from: https://www.scielo.cl/scielo.php?pid=S0034-98872018000600762&script=sci_abstract&tlng=pt
12. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., & Hoffmann, T. C. Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg,88, 105906. [Internet]. 2021. [cited 2023 May 16].
13. Higgins JPT, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ [Internet]. 2011 [cited 2023 Dec 8];343(oct18 2):d5928–d5928. Available from: https://www.bmj.com/content/343/bmj.d5928
14. Kirmayr M, Quilodrán C, Valente B, Loezar C, Garegnani L, Franco JVA. Metodología GRADE, parte 1: cómo evaluar la certeza de la evidencia [Internet]. Medwave.cl. 2021 [cited 2023 Dec 8]. Available from: http://dx.doi.org/10.5867/medwave.2021.02.8109
15. Golsteijn RHJ, Bolman C, Volders E, Peels DA, de Vries H, Lechner L. Short-term efficacy of a computer-tailored physical activity intervention for prostate and colorectal cancer patients and survivors: a randomized controlled trial. Int J BehavNutr Phys Act [Internet]. 2018 [cited 2023 Jun 1];15(1):106. Available from: http://dx.doi.org/10.1186/s12966-018-0734-9
16. Lu Y, Qu H-Q, Chen F-Y, Li X-T, Cai L, Chen S, et al. The effect of Baduanjin qigong exercise on cancer-related fatigue in patients with colorectal cancer undergoing chemotherapy: A randomized controlled trial. Oncol Res Treat [Internet]. 2019 [cited 2023 Jun 1];42(9):431–9. Available from: http://dx.doi.org/10.1159/000501127
17. Carli F, Bousquet-Dion G, Awasthi R, Elsherbini N, Liberman S, Boutros M, et al. Effect of multimodal prehabilitation vs postoperative rehabilitation on 30-day postoperative complications for frail patients undergoing resection of colorectal cancer: A randomized clinical trial: A randomized clinical trial. JAMA Surg [Internet]. 2020 [cited 2023 Jun 1];155(3):233–42. Available from: http://dx.doi.org/10.1001/jamasurg.2019.5474
18. Northgraves MJ, Arunachalam L, Madden LA, Marshall P, Hartley JE, MacFie J, et al. The feasibility of a novel exercise rehabilitation programme in patients scheduled for elective colorectal surgery: a feasibility randomised controlled trial. Support Care Cancer [Internet]. 2020 [cited 2023 Jun 1];28(7):3197–206. Available from: http://dx.doi.org/10.1007/s00520-019-05098-0
19. Brown JC, Zhang S, Ligibel JA, Irwin ML, Jones LW, Campbell N, et al. Effect of exercise or metformin on biomarkers of inflammation in breast and colorectal cancer: A randomized trial. Cancer Prev Res (Phila) [Internet]. 2020 [cited 2023 Jun 1];13(12):1055–62. Available from: http://dx.doi.org/10.1158/1940-6207.CAPR-20-0188
20. Peng L-H, Wang W-J, Chen J, Jin J-Y, Min S, Qin P-P. Implementation of the pre-operative rehabilitation recovery protocol and its effect on the quality of recovery after colorectal surgeries. Chin Med J (Engl) [Internet]. 2021 [cited 2023 Jun 1];134(23):2865–73. Available from: http://dx.doi.org/10.1097/CM9.0000000000001709
21. Berkel AEM, Bongers BC, Kotte H, Weltevreden P, de Jongh FHC, Eijsvogel MMM, 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: Results of a randomized clinical trial. Ann Surg [Internet]. 2022 [cited 2023 Jun 1];275(2):e299–306. Available from: http://dx.doi.org/10.1097/SLA.0000000000004702
22. Onerup A, Andersson J, Angenete E, Bock D, Börjesson M, Ehrencrona C, et al. Effect of short-term homebased pre- and postoperative exercise on recovery after colorectal cancer surgery (PHYSSURG-C): A

randomized clinical trial. Ann Surg [Internet]. 2022 [cited 2023 Jun 1];275(3):448–55. Available from: http://dx.doi.org/10.1097/sla.0000000000004901
23. Asnong A, D'Hoore A, Van Kampen M, Wolthuis A, Van Molhem Y, Van Geluwe B, et al. The role of pelvic floor muscle training on low anterior resection syndrome: A multicenter randomized controlled trial: A multicenter randomized controlled trial. Ann Surg [Internet]. 2022 [cited 2023 Jun 1];276(5):761–8. Available from: http://dx.doi.org/10.1097/SLA.0000000000005632
24. Min J, An K-Y, Park H, Cho W, Jung HJ, Chu SH, et al. Postoperative inpatient exercise facilitates recovery after laparoscopic surgery in colorectal cancer patients: a randomized controlled trial. BMC Gastroenterol [Internet]. 2023 [cited 2023 Jun 1];23(1):127. Available from: http://dx.doi.org/10.1186/s12876-023-02755-x
25. Liu L, Wu X, Liu Q, Tang C, Luo B, Fang Y, et al. The effect of biofeedback training on intestinal function among patients with middle and low rectal cancer: a randomized controlled study. Ann Transl Med [Internet]. 2019 [cited 2023 Jun 1];7(21):605–605. Available from: http://dx.doi.org/10.21037/atm.2019.09.62
26. Piraux E, Reychler G, Vancraeynest D, Geets X, Léonard D, Caty G. High-intensity aerobic interval training and resistance training are feasible in rectal cancer patients undergoing chemoradiotherapy: a feasibility randomized controlled study. Rep Pract Oncol Radiother [Internet]. 2022 [cited 2023 Jun 1];27(2):198–208. Available from: http://dx.doi.org/10.5603/RPOR.a2022.0036
27. Bousquet-Dion G, Awasthi R, Loiselle S-È, Minnella EM, Agnihotram RV, Bergdahl A, et al. Evaluation of supervised multimodal prehabilitation programme in cancer patients undergoing colorectal resection: a randomized control trial. Acta Oncol [Internet]. 2018;57(6):1–11. Available from: http://dx.doi.org/10.1080/0284186X.2017.1423180
28. Mayer DK, Landucci G, Awoyinka L, Atwood AK, Carmack CL, Demark-Wahnefried W, et al. SurvivorCHESS to increase physical activity in colon cancer survivors: can we get them moving? J Cancer Surviv [Internet]. 2018 [cited 2023 Jun 1];12(1):82–94. Available from: http://dx.doi.org/10.1007/s11764-017-0647-7
29. Aguayo-Albasini JL, Flores-Pastor B, Soria-Aledo V. Sistema GRADE: clasificación de la calidad de la evidencia y graduación de la fuerza de la recomendación. Cir Esp [Internet]. 2014 [cited 2023 Dec 11];92(2):82–8. Available from: https://www.elsevier.es/es-revista-cirugia-espanola-36-articulo-sistema-grade-clasificacion-calidad-evidencia-S0009739X13003394
30. WHO Guidelines on Physical Activity and Sedentary Behaviour [Internet]. Available from: https://iris.who.int/bitstream/handle/10665/336656/9789240015128-eng.pdf
31. Hidrobo Coello J. Physical Activity For Patients Diagnosed With Cancer. Sports Prescription Guide For Ecuador. Revista ibero-americana de ciencias de la actividad física y el deporte [Internet]. 2020;9(3):18–41. Disponible en: https://dialnet.unirioja.es/servlet/articulo?codigo=7724426
32. Lugo D, Pulido AL, Mihos CG, Issa O, Cusnir M, Horvath SA, et al. The effects of physical activity on cancer prevention, treatment and prognosis: A review of the literature. Complementary Therapies in Medicine [Internet]. 2019 Jun 1 [cited 2023 Sep 24];44:9–13. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0965229918309646.
33. Roberts A, Potts HWW, Koutoukidis DA, Smith L, Fisher A. Breast, Prostate, and Colorectal Cancer Survivors' Experiences of Using Publicly Available Physical Activity Mobile Apps: Qualitative Study. Jmirmhealth and uhealth [Internet]. 2019 Jan 4 [cited 2023 Sep 24];7(1):e10918–8. Available from: https://mhealth.jmir.org/2019/1/e10918/
34. Rubén López-Bueno, Ahmadi M, Stamatakis E, Yang L, Pozo del. Prospective Associations of Different Combinations of Aerobic and Muscle-Strengthening Activity With All-Cause, Cardiovascular, and Cancer Mortality. JAMA Internal Medicine [Internet]. 2023 Sep 1 [cited 2023 Sep 24];183(9):982–2. Available from: https://jamanetwork.com/journals/jamainternalmedicine/article-abstract/2807854
35. Squires RW, Shultz AM, Herrmann J. Exercise Training and Cardiovascular Health in Cancer Patients. Current Oncology Reports [Internet]. 2018 Mar 1 [cited 2023 Sep 24];20(3). Available from: https://link.springer.com/article/10.1007/s11912-018-0681-2
36. Steele J, Plotkin D, Van DW, Rosa A, Zambrano H, BenjimanMendelovits, et al. How hard should you train? A meta-analysis of studies comparing body composition changes between interval training and moderate intensity continuous training. 2021 Jul 1 [cited 2023 Sep 24]; Available from: https://sportrxiv.org/index.php/server/preprint/view/66
37. Prescribing exercise as a cancer treatment [Internet]. National Cancer Institute. 2020 [cited September 24, 2023]. Available at: https://www.cancer.gov/espanol/noticias/temas-y-relatos-blog/2020/pautas-sobre-ejercicio-sobrevivientes-cancer-schmitz
38. Pereira-Rodriguez JE, Mercado-Arrieta MA, Quintero-Gómez JC, Lopez-Flores O, Díaz-Bravo M, Juárez-Vilchis R. Effects and benefits of strength training in cancer patients: systematic review of the literature.

Pinareña Medical University [Internet]. 2020 [cited 2023 Sep 24];16(3):498. Available at: http://www.revgaleno.sld.cu/index.php/ump/article/view/498
39. Pino J, Gómez S, Olivares M, Quera R, Simian D, Escaffi MJ, et al. Effects Of Exercise On Diseases Of The Digestive Tract. Medical review Clín Las Condes [Internet]. 2020;31(5–6):472–80. Available at: https://www.sciencedirect.com/science/article/pii/S0716864020300729
40. Barroso Rozano D. Effect of physical exercise on quality of life and survival in patients with colorectal cancer: systematic review. Cadiz University; 2022.
41. Covers A. Exercise As An Anti-Inflammatory Treatment [Internet]. Binasss.sa.cr. 2016 [cited 24 Sep 2023]. Available at: https://www.binasss.sa.cr/revistas/rmcc/619/art14.pdf
42. Bonet Garreta J. Planning and online supervision of a combined physical exercise and healthy diet program. Autonomous University of Barcelona; 2016.