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Opinion Article

EXERCISE AS PART OF CANCER CARE: SCIENTIFIC EVIDENCE WITHIN THE BRAZILIAN CONTEXT

EXERCÍCIO FÍSICO PARA O TRATAMENTO DO CÂNCER: EVIDÊNCIAS CIENTÍFICAS E O CONTEXTO BRASILEIRO

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ABSTRACT

It is now well-known that physical activity and exercise are both able to prevent the appearance of different types of cancer, increase survival, improve quality of life and attenuate the adverse effects caused by cancer and its treatment. Therefore, the current recommendation is that every cancer survivor must be encouraged to stay active, begin or keep exercising after the cancer diagnosis, contrary to the recommendation of 20 years ago to "rest and avoid physical efforts". In fact, physical exercise is now recognized as a reliable, inexpensive, adverse effect-free, safe and relatively simple tool to be incorporated into the context of cancer treatment. However, Brazil has not contributed and is not part of the agenda to make exercise as a standard in cancer care. This literature review aims to present the scientific evidence of the use of physical exercise in the different stages of cancer treatment and the most recent contributions to the development of exercise prescription for people with cancer. In addition, I will discuss the main challenges and future perspectives for the area of exercise oncology, considering the Brazilian context.

Key-words. Oncology, survival, exercise prescription, adverse effects

RESUMO

Sabe-se hoje que a atividade e o exercício físico são capazes de prevenir o aparecimento de diferentes tipos de câncer, aumentar a sobrevida e a qualidade de vida, além de amenizar os efeitos adversos causados pelo câncer e seu tratamento. Assim, a recomendação atual é que todo indivíduo com câncer deve ser encorajado a manter-se ativo, iniciar a prática de exercícios ou continuar se exercitando após o diagnóstico da doença, ao contrário da recomendação de 20 anos atrás de "descansar e evitar esforços físicos". De fato, o exercício físico é considerado hoje, uma ferramenta completa, barata, isenta de efeitos colaterais, segura e relativamente simples de ser incorporada no contexto do tratamento do câncer. Entretanto, o Brasil não tem contribuído e não está inserido na agenda para transformar o exercício físico como parte do tratamento oncológico. Esta revisão de literatura tem o objetivo de apresentar as principais evidências científicas sobre uso do exercício físico nas diversas fases do tratamento do câncer e as mais recentes contribuições para o desenvolvimento da prescrição do exercício físico em pacientes oncológicos, além de discutir os principais desafios e perspectivas futuras para a área de exercício físico em oncologia, considerando o contexto brasileiro.

Palavras-chave: Oncologia, sobrevivência, prescrição de exercício, efeitos adversos

Introduction

Cancer is the second most common cause of death worldwide, a disease with a growing incidence rate. The World Health Organization predicts 29.5 million cases in the world by 2040, an increase of approximately 64% compared to 2018[1]. In Brazil, an estimated 625,000 new cases of cancer were reported in 2020, a 27% increase in the past 10 years[2].

In addition to the increase in the number of cases, research studies demonstrate a significant increase in the number of cancer survivals in recent years. Because of technological advances in cancer detection and treatment, along with the identification of modifiable behaviors associated with cancer (smoking, drinking, and lack of physical activity), the number of cancer survivors has increased in recent years[1]. An estimate calculated in 2019 in the United States shows that the number of cancer survivors has increased by 28% in the last 20 years[3]. This number is expected to increase to approximately 35% in the next decade[4]. However, cancer survivors suffer a number of adverse effects caused by the cancer and its treatment, such as cardiovascular dysfunction, neuromuscular issues, reduced physical function, metabolic syndrome, and other problems that increase the morbidity and mortality related to cancer in general[5]. This means that despite improvements in cancer screening and treatment and in the

ensuing increased survival rates, cancer survivors experience significant physical and psychological effects that require long-term health care.

In this context, exercise has been recognized as a promising strategy not only in prevention but also as an adjuvant therapy in cancer treatment. Growing evidence from the past three decades demonstrates that exercise attenuates morbidities and cancer treatment side effects and increases the survival rate of people with cancer[6]. In fact, the international scientific positions and guidelines from researchers and societies published in the past decade recommend that all people with cancer keep as active as possible and/or get involved in exercise programs in all phases during and after their treatment, regardless of the type and the stage of their disease[6-8]. Unfortunately, Brazil does not seem to be participating in the international agenda to make exercise a part of oncological treatment. Indeed, many challenges to incorporating exercise as an adjuvant therapy against cancer and its complications are seen in Brazil.

This review aims to present the primary scientific evidence regarding exercise as an adjuvant in the cancer treatment continuum, along with the major recent contributions to the prescription of exercise to cancer survivors. Finally, the review briefly discusses the main challenges and the prospects of the field of exercise oncology within the Brazilian context.

Evidence on the role of exercise in oncology

Evidence from the past three decades demonstrates that exercise may prevent some types of cancer as well as decrease mortality and protect against the toxicity associated with cancer treatment in cancer survivors. I will use an adaptation of the setup proposed by Courneya *et al*.[9] to present the main findings on the protective effect of exercise throughout the three main phases of the cancer treatment continuum*:* 1) pre-habilitation, 2) during treatment, and 3) post-treatment (Figure 1). It is important to note that although exercise plays an important preventive role against cancer (engaged in before the diagnosis of the disease), its effects are beyond of the scope of this review; I suggest that those interested in these effects read studies from the American College of Sports Medicine[10] and the World Cancer Research Foundation[11].

Exercise in cancer pre-habilitation

Cancer pre-habilitation denotes the period between the diagnosis and the start of cancer treatment. This period may last days or weeks, depending on the number of exams, access to the laboratory exams required for the disease, and access to health care services. In Brazil, the median time between diagnosis and treatment onset in women with breast cancer who use the public health system (Sistema Único de Saúde, or SUS) was 43 days in 2018[13]; approximately 40% of the breast and prostate cancer treatments through the SUS started 60 days after the diagnosis[4]. The main aim of exercise in pre-habilitation is to condition or prepare the person for the enormous stress imposed by cancer treatment, in the hopes of mitigating its deleterious physiological and psychological effects. Therefore, it is crucial to establish a baseline and identify a commitment to physical function, as well as to propose an exercise intervention program to minimize the severity of the adverse effects of the cancer treatment and to decrease the incidence of physical dysfunctions in the post-treatment stage[14].

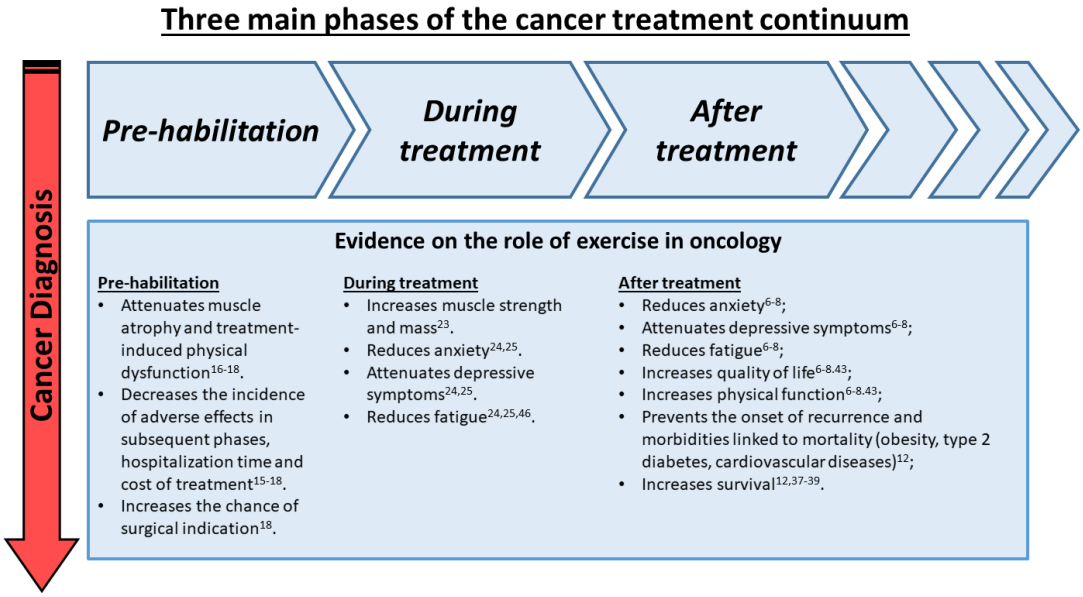

Figure 1. Benefits of exercise on complications and adverse effects of cancer treatment in the three phases of the cancer treatment continuum: 1) pre-habilitation, 2) during treatment, and 3) after treatment

Source: author

Studies have been conducted on the use of exercise in cancer pre-habilitation, using various exercise modalities and protocols for different types of cancer[15-18]. A study assessing pre-surgery interventions using exercise for people with lung, prostate, and colorectal cancer reviewed 18 studies with a total of 966 participants who performed resistance, aerobic, and combined exercises (resistance and aerobic) for a median period of 21 days (7–52 days). The authors demonstrated that exercising before surgery led to a significant improvement in urinary (in)continence in people with prostate cancer and enhanced functional walking capacity, cardiorespiratory aptitude, and quality of life in people with all types of cancer studied[16]. Recently, Stout *et al.*[18] conducted an extensive review of cancer pre-habilitation and found improved cardiorespiratory capacity as a result of exercise, which in turn contributed to improved chances of surgical referral for advanced cancer patients and diminished surgical risk; in addition, it prevented a reduction in their cardiorespiratory capacity and ambulation, which consequently accelerated surgery recovery. In fact, studies have demonstrated that the greater the frequency and duration of the exercise before treatment, the greater the benefits and the lower the treatment cost, since exercise attenuates the occurrence and severity of adverse effects as well as reduces the length of use of health care services[15-18]. These data demonstrate that pre-habilitation is critical to successful treatment for cancer survivors.

It is important to note that a diagnosis of cancer results in a significant reduction in physical activity, especially due to the psychological stress arising from the diagnosis and the need to reorganize one's routine and finances in preparation for treatment[19]. This decrease in physical activity levels contributes to reduced physical capacity and muscle loss, which are major predictors of mortality during the treatment of various types of cancer[20,21]. Thus, exercise can improve the physical condition, strength, and muscle mass of individuals diagnosed with cancer, in addition to building up the confidence that may help them psychologically face the major life challenge of cancer treatment. However, involving people in exercise programs shortly after their cancer diagnosis seems to be a major challenge in oncology-related exercise[18].

Some scientific limitations to pre-habilitation must also be highlighted. The strong results listed above were attained in a limited group of cancer types, and many researchers did not use or did not report a standardized exercise frequency and intensity, which makes

comparison and reproducibility difficult. The lack of standardization in the initial evaluation also hinders the proper determination of patient evolution in the exercise program; many studies do not ensure that an initial evaluation is carried out close to the diagnosis. Thus, future studies should aim to develop exercise programs that are specific to each type of cancer in order to prevent or minimize individual dysfunctions. For example, people with breast cancer should develop pectoral, arm, and shoulder muscles, along with neck mobility and strength, since many breast cancer survivors feel pain and have reduced local function as a result of a mastectomy[18].

Exercise during cancer treatment

The main cancer treatments are surgery, chemotherapy, radiotherapy, immunotherapy, and hormonal therapy, with chemotherapy and radiotherapy being the most frequently used. In brief, chemotherapy involves the use of one or a set of drugs that prevent or interrupt the proliferation of tumor cells. Radiotherapy uses high-energy particles or waves (such as X-ray, gamma-ray, or a beam of electrons or protons) to destroy or damage cancer cells, with the same objective as chemotherapy. In many cases, a combination of both chemotherapy and radiotherapy is necessary, and they are performed in cycles to be efficiently administered in a time interval that enables people with cancer to adequately recover physically. In initial-stage or locally-advanced cancer, chemotherapy and/or radiotherapy are used as a treatment known as a neoadjuvant strategy in order to shrink tumors before surgery. After surgery, these treatments—known as adjuvant therapy—are used to help prevent cancer recurrence (further information on this and other subjects are presented well in Vieira[22]).

Although neoadjuvant and adjuvant treatments are effective against cancer, they may cause numerous side effects, including nausea and diarrhea, reduced immune function, fatigue and discomfort, hair loss, lack of appetite, and more. The side effects generally start in the early weeks of treatment, and they negatively affect peoples' engagement in exercise programs. Some of these effects (such as nausea, diarrhea, hair loss) may disappear shortly after the treatment is completed, while others may remain for weeks or years, including cardiovascular diseases and musculoskeletal and metabolic dysfunctions, such as sarcopenia, neuropathies, and weight gain[22] (the persistent effects of exercise on such symptoms will be discussed next). Importantly, as surgery is the primary cancer treatment in many cases, the period referred as "during treatment" can be a post-surgery period. Surgery may produce significant anatomical changes and pain, compromising full movement and the individual's independence. Thus, numerous systematic reviews and meta-analyses have demonstrated that exercise is tolerable and safe, and when it is performed during cancer treatment, it may partially minimize treatment side effects, in addition to preserving physical function and quality of life[23-26].

Muscle mass, strength, and physical function are three of the most studied physical capacities in cancer survivors who participate in exercise programs. This is particularly relevant given the high mortality of people with cancer cachexia, a syndrome characterized by a quick loss of weight, strength, and muscle mass. A meta-analysis has shown that resistance exercise is effective in increasing muscle mass and strength as well as in reducing body fat in people undergoing neoadjuvant and adjuvant therapy, regardless of the type of treatment[23]. However, we highlight that unsupervised guided exercises performed at home have shown little or no effect on muscle mass and strength in people with breast and prostate cancer[27], in contrast to supervised exercise[28,29]. These data show the importance of supervised exercise programs to increase and/or maintain muscle mass and strength in cancer survivors during their treatment.

Exercise is also beneficial during treatment because it reduces fatigue and improves psychological aspects, such as anxiety, depression, and health-related quality of life[24,25]. A meta-analysis by Kessels *et al*.[24] demonstrated a clear improvement in cancer-related fatigue indexes as a result of exercise intervention during treatment, especially aerobic and combined exercises, for different types of cancer. They also reported that adherence to any kind of

intervention is more important than the intensity of the exercise and that high adherence resulted in greater effects on the reduction of cancer-related fatigue.

The role of exercise in preventing and/or attenuating cardiac dysfunction resulting from cancer treatment has also been reported, especially when the cancer is treated with anthracyclines (a class of chemotherapeutic drug) or with mediastinal irradiation—treatment methods with great cardiotoxicity potential. However, the evidence that exercise minimizes or prevents cancer treatment-induced cardiotoxicity and/or loss of cardiorespiratory function is moderate. One study has demonstrated only a moderate increase in oxygen peak (~2.8 ml/kg/min) in cancer survivors who participated in aerobic training[26]. However, the numbers and quality of these data are still nascent; for this reason, the protective action of exercise against chemo-/radiotherapy-induced cardiotoxicity is still under debate.

Data on the possible benefits of exercise in response to cancer treatment are also scarce: in a meta-analysis, Bland *et al*.[30] demonstrated that only two studies out of eight reported a beneficial effect of exercise on the chemotherapy completion rate—a relevant indicator, given that receiving the planned chemotherapy doses is related to a greater efficacy of the treatment and survival people with cancer. These data suggest that exercise does not seem to improve tolerability to chemotherapy; however, a thorough interpretation of such findings is limited by the small number of studies and their high heterogeneity.

Perhaps one of the main difficulties reported by researchers with regard to exercise prescription and instruction in individuals undergoing cancer treatment is the relatively low adherence to exercise programs (40–60%)[31-33]. The side effects of the treatment and the lack of experience of the professionals who prescribe exercises and follow up with people with cancer are significant barriers to adherence to the exercise program[34]. Kirkham *et al*.[32] propose planning exercise intensity and volume individually (a practice called periodization) based on the chemotherapy program of each pearson; the "chemotherapy-periodization" succeeded in raising adherence to the exercise program by nearly 25%.

A major limitation is that most of the studies presented above were carried out with people with two of the most common types of cancer: breast and prostate. It is unknown whether these results apply to other types of cancer. Furthermore, the effects of exercise on other aspects related to cancer and its treatment—such as peripheral neuropathy induced by chemotherapy, cognitive function, nausea and alteration of the digestive system health, bone health, and other aspects—remain unclear. Thus, it is possible to state that despite great advances in recent years, there is still a long way to go to identifying the main protective effects of exercise in individuals undergoing cancer treatment and to defining protocols.

Exercise after cancer treatment

The end of primary treatment (surgery, chemotherapy, and radiotherapy) is characterized by a significant reduction in the risk and some of the main symptoms of the cancer and its acute side effects, and it is a victory for the medical team and the person with cancer. This phase is generally associated with successful treatment. However, it is important to consider that the end of cancer treatment is also the beginning of a new phase: post-treatment and cancer survivorship. This phase lasts from the end of primary treatment to the end of the people's life. It is important to consider that, depending on the type and the severity of the cancer, this phase can also be considered a period before the start of a new round of treatment, which is implemented either with the goal of curing and/or preventing progression of the disease or as a palliative aiming to improve the individual's quality of life by relieving the symptoms and side effects related to the disease.

While some cancer survivors will have a life free of symptoms, most will experience some symptoms and adverse effects as a consequence of the disease and its treatment. Some of the effects appear during treatment and can disappear afterwards, while others may remain for

the individual's entire life. In the period immediately after treatment, from the end of the primary adjuvant treatment up to the first year of recovery, the survivor is generally susceptible to the acute effects of the treatment (chemotherapy, radiotherapy, anti-hormone treatment), which are characterized by the occurrence of fatigue, weakness, lymphedemas (edemas resulting from poor drainage of body fluids, generally due to the removal of lymph nodes during surgery to treat the cancer), and other issues[35]. As mentioned in the previous section, in some cases the surgical treatment can lead to lasting anatomical changes that may compromise the full range of motion and the individual's independence. For these reasons, this period is associated with high levels of stress, anxiety, and/or depression[5].

Some symptoms and adverse effects do not decrease or disappear over time without specific care. Many cancer survivors live with symptoms such as weakness, cognitive difficulties, sexual dysfunction, loss of sleep quality, loss of muscle mass and strength, and psychological dysfunctions (such as depression), with the effects lasting many years after the treatment ends[35]. These effects are known as long-term adverse effects. Some of these effects are 'silent', such as cardiovascular and hormonal dysfunctions and bone health effects[36]. Notably, in many cases the survivor will continue to use additional anti-hormone therapy or immunotherapy in the post-treatment period, which can cause new side effects or potentiate the side effects of the anti-cancer treatment.

The main benefits of exercise in the post-treatment phase are summarized in recommendation documents, guidelines, and statements on exercise for cancer survivors that have issued by societies and associations, including the American College of Sports Medicine[6], the Australian Association for Exercise and Sports Science[7], and the Spanish Society of Oncology[8]. It is relevant to note that all these documents state that exercise is feasible, safe, and tolerable for cancer survivors. In brief, these documents demonstrate that exercise facilitates physical and mental recovery, prevents and/or mitigates many short- and long-term side effects and associated morbidities, and extends survival and improves quality of life in cancer survivors. Furthermore, such benefits have been found for a variety of cancers, including breast, prostate, colorectal, lung, hematological, head and neck, and gynecological cancers, as well as less common cancer types such as brain, testicle, and pancreas cancers[7]. In fact, exercise has been considered a complete, inexpensive, side effect-free strategy to help cancer survivors resume their normal routines in the post-treatment period[6]. Exercise in this phase also plays a preventive role, since it reduces the risk of recurrence, which would lead to a new diagnosis and going through the whole treatment continuum again.

Campbell *et al*.[6] reported strong evidence that specific levels of resistance and combined exercises reduce anxiety, depression, and fatigue symptoms related to cancer and its treatment, as well as reducing lymphedemas and improving the physical function and quality of life in cancer survivors. Exercise can also recover the full range and quality of joint movement and the independence that may be compromised in many cancer survivors. Their study also demonstrated moderate evidence that exercise improves quality of sleep and bone health. Despite poor scientific evidence that exercise prevents cardiotoxicity, peripheral neuropathy, and nausea induced by chemotherapy, as well as improves cognitive function, pain, and sexual function and reduces the risk of falls, investigations have corroborated these findings.

In addition to the benefits described above, cohort studies have reported that individuals who are more active in the post-treatment period have a longer survival rate than less active individuals[37]. These data corroborate the preliminary results of Phase 2 exploratory studies showing that leukemia and lymphoma cancer survivors engaged in exercise programs have longer survival rates than less-active cancer survivors[38,39].

The practice: when, how, how much, and where individuals with cancer and cancer survivors should exercise

Although consistent evidence shows the importance of exercise in the different phases of cancer treatment, developing practical recommendations for and methods of exercise prescription for people with cancer and survivors remains a major challenge. The first difficulty is determining when people with cancer must start exercising. As discussed above, people with cancer can benefit from exercising by themselves as soon as they are diagnosed[15-18] and throughout the cancer treatment continuum (Figure 1). Although many doctors and specialists also propose resting during cancer treatment, studies have demonstrated that early adherence to exercise programs leads to significant improvements in bone health and muscle mass compared to people who join an exercise program later[40]. Such evidence has led the American College of Sports Medicine to recommend that people with cancer join exercise programs as early as possible[6]. However, an early initiation must also take people' interests and availabilities into consideration in order to ensure their mental health. Disregarding this aspect may considerably reduce adherence to exercise programs[31]. It must also be kept in mind that many people with cancer will undergo a post-surgery period, when rest may be an important measure.

Various conditions will determine the indication of the type, the most appropriate place, and the level of supervision of exercise for each people with cancer/survivor. Figure 2 summarizes the most important steps in referring people with cancer/survivors to exercise programs (Figure 2). First, it is strongly recommended that cancer survivors have the support of their doctors before engaging in any exercise program. Although some studies and guidelines suggest that medical consent for the practice of exercise is unnecessary[7,8]—due to claims that the need for consent might become a barrier to its promotion—the interaction between the doctor, the exercise professional, and the person with cancer may increase the safety of, confidence in, and people adherence to the exercise program. In the next step, a general evaluation must be carried out to identify the people's with cancer and survivor's health profile and the possible risks involved[7,41]. The initial evaluation may also include a set of physical tests, such as for cardiorespiratory capacity, physical function, strength, body mass composition, and bone health. These tests will be useful in establishing the exercise program conditions and objectives, as well as the baseline of the person's physical capacity, which is central to determining the program's success and to reassessments of program objectives. Later, decisions around prescription and level of supervision of exercises must be made in view of the severity of the disease, the adverse effects of the cancer treatment, the presence or absence of morbidity and physical dysfunctions, and the phase of the cancer treatment continuum (Figure 2). These steps can help in the design of an exercise program that will be safe, viable, and effective.

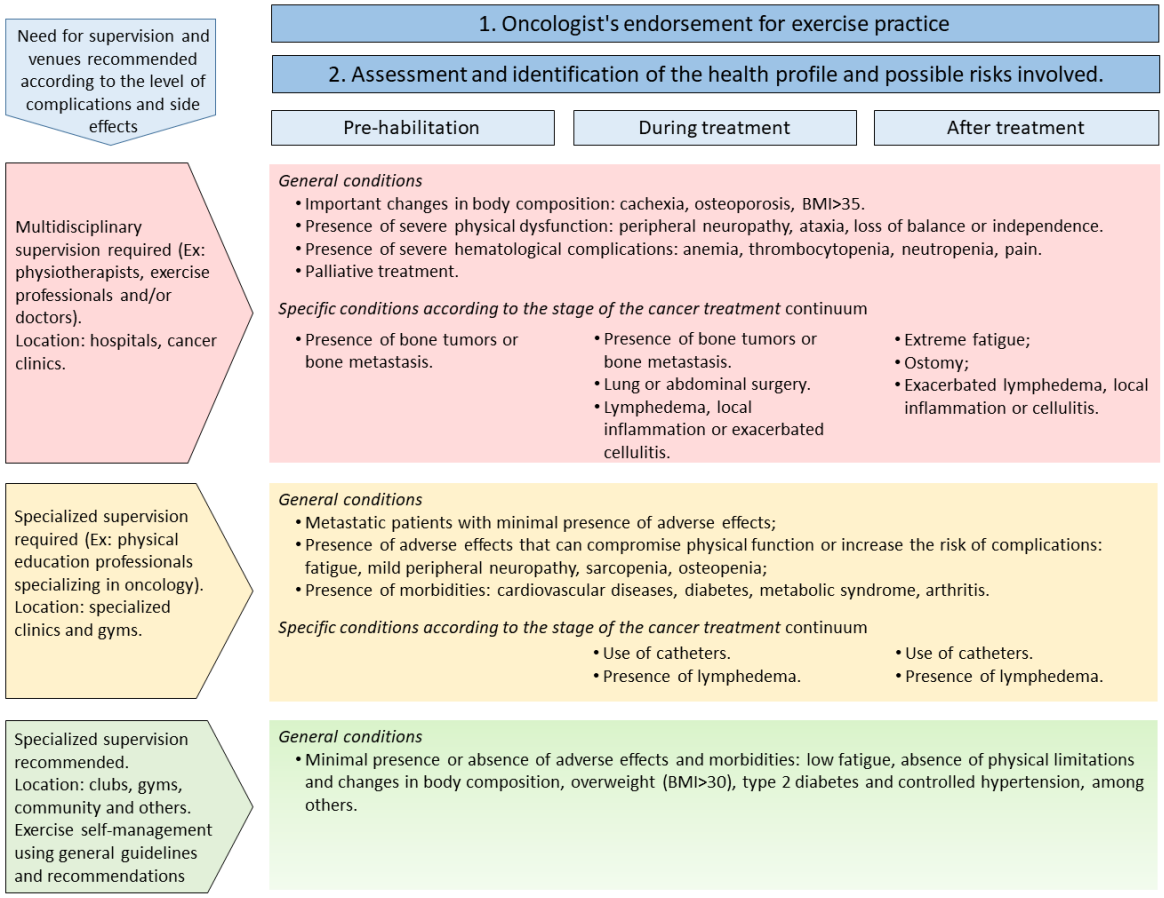

Figure 2. The most important steps in the referral of people with cancer and survivors to exercise programs, considering the need for supervision, and venues recommended according to the level of complications and side effects present

Source: author

Some guidelines and authors[6,8] discuss the need for supervision the exercise of people with cancer or survivors who experience little or no cancer treatment adverse effects (e.g., some fatigue, sleep disorder). Although people with cancer and survivors may benefit from general exercise guideline recommendations, studies have demonstrated that those who perform supervised exercises have greater adherence and better results than those who perform self-monitored exercises[29,42]. For this reason, although it is unnecessary, I nevertheless recommend that, when possible, people with cancer and survivors practice professionally supervised exercises, even with no or minimal adverse effects and morbidities (Figure 2).

After the identification of a person health profile, the possible risks involved, and the objectives of the exercise program, professionals and patients must address all the components of the prescription of the exercise program in cancer treatment: modality, intensity, frequency, duration, and progression/periodization. Box 1 summarizes the main general recommendations for each of these components.

Box 1. General recommendations and considerations around the five key elements of an exercise program for cancer survivors

General Recommendation	Join a supervised exercise program as soon as possible; if not possible, remain as active as possible during all phases of treatment and for one's whole life[6-8,41,43]. Avoid prolonged sedentary behavior (e.g., sitting for long periods)[41].
Modalities	Priority must be given to aerobic and strength exercises[6-8,42]. Flexibility and balance exercises are also recommended. Recent studies have shown that Eastern movement practices (Yoga, Tai-chi, Qigong) improve many of the adverse effects of cancer and its treatment (quality of life, quality of sleep, reduction of fatigue, anxiety, and depression symptoms)[44,45].
Intensity	At least moderate[7], when possible, and as the program evolves, more intense sessions should be included[6,7].
Frequency	Three to five weekly sessions of aerobic exercises and one or two sessions of strength exercises[6,43]. When exercise sessions are multimodal, they should occur every other day, avoiding consecutive days[7]. Each people's conditions and objectives must be taken into consideration.
Duration/volume	Weekly exercise sessions lasting 150–300 min at moderate intensity[6,41], and a minimum of 70 min of high-intensity exercises[6]. Each people's condition and objectives must be taken into account[7]. Take 10,000 steps a day[8,41].
Progression/periodization	Exercise load progression and volume must follow the recommendations for the general population[7]. Aerobic exercises of moderate intensity must last a minimum of 20 min and evolve in modality, duration, and intensity to optimize aerobic aptitude. Aerobic exercises can be broken down for beginners who cannot manage to perform 20 uninterrupted minutes. Walking is a good option, but aerobic exercises must not be limited to that. When low/moderate intensity is preferred, duration and frequency must increase gradually. Strength exercises performed at least twice a week with moderate-to-high intensity must initially aim at large muscle groups and be graded by modifying load, number of repetitions, and types of exercises seeking to optimize muscle mass gain. The people's general condition must be taken into account, as well as the possible risks and the stage of the disease (See Figure 1 and Table 2).

Source: author

Generally, and whenever possible, all exercise programs should include aerobic and strength exercises, with the priority and focus determined according to the objectives proposed. The exercise should be at least of moderate intensity, when possible, and as the program evolves, more intense sessions should be included. Schwartz *et al*.[47] pointed out that exercises for people with cancer who are still weak or debilitated by cancer and its treatment must start at the minimum volume and intensity and gradually increase according to the people's tolerance to effort increases. The initial sessions serve to develop aerobic capacity, strength, and motivation, as well as build up engagement for longer exercise periods. Unlike some guidelines[6,41], which propose three to five weekly sessions of aerobic exercises and one or two sessions of strength exercises, new studies[7] propose adopting a multimodal exercise program with aerobic, strength, and flexibility exercises in the same session every other day, avoiding

consecutive days. I also indicate here that recent studies have demonstrated that some Eastern movement practices (Yoga, Tai-chi, Qigong) and balance and flexibility exercises improve quality of life and quality of sleep as well as reduce fatigue and anxiety associated with cancer and its treatment[44,45]; thus, these can be included in the exercise program. When it is not possible to participate in an exercise program, people with cancer and survivors must nevertheless remain as active as possible[6-8]. The recommendation to walk over 10,000 steps a day is also widely shared as being beneficial to the health of members of this population[8]: it is cited in several documents and studies, including the latest version of the World Health Organization Guidelines on Physical Activity and Sedentary Bahavior[41], which for the first time highlights the importance of remaining active when having cancer.

In addition to the recommendations and general considerations on health and physical capacity presented in Table 1, it is crucial that the prescription of exercises to people with cancer and survivors also takes into consideration the particularities of each type of cancer and the side effects caused by the treatment. For example, a mastectomy may result in the removal of parts of muscle tissues important in arm and shoulder movement, resulting in pain and limitation of movement, which must be taken into account during exercise planning[42]. Likewise, the tempo of exercise progression and the degree of overload between exercise sessions must be guided by the appearance and worsening (or not) of side effects and their symptoms. Some of the conditions and specificities related to cancer, as well as contraindications, risks, and reasons pertinent to interrupting the exercise program, are summarized in Box 2.

Box 2. Conditions and specificities related to the prescription of exercise for individuals with cancer and cancer survivors, as well as care, reasons to interrupt exercise, and contraindications

Exercise is contraindicated	
	In the presence of severe lymphedema and infections, including cellulite, hernia, or infection related to ostomy, fever, severe pain, or chest pain[48]. People with poor balance symptoms must also avoid street exercises (running, cycling, etc.). People with melanomas must avoid exercising under exposure to sunlight. People with bone metastasis, osteoporosis, or ostomy must avoid contact sports[7].
Care and conditions specific to different types of cancer	
Breast	People who have undergone a mastectomy must pay special attention to exercises that demand ample arm and shoulder movements and strength[42]. Exercises for the upper limbs must be avoided when there is arm and shoulder swelling and pain[48]. The use of compressive clothing may improve comfort and safety while exercising[7].
Prostate	Exercises for the pelvic region may reduce urinary incontinence and sexual dysfunction caused by prostatectomy. Special attention must be paid to patients with osteoporosis or bone metastasis who are undergoing Androgen Deprivation Therapy[5].
Lung	Continued aerobic exercises may be uncomfortable at first, causing fatigue, dizziness, and risk of falls. Intermittent aerobic exercises with slower volume and intensity progressions should be performed[7,46].
Colorectal	Exercise must be interrupted when there is a hernia or infection related to ostomy[46,48].
Care and conditions specific to adverse effects and morbidities	
Anemia	Continued aerobic exercises can be uncomfortable. Volume and intensity should be increased according to the symptoms[7].
Cachexia/sarcopenia	Strength exercises targeting the large muscle groups should be emphasized in individuals with cachexia and sarcopenia[23,46]. Tolerance must be taken

	into account for training progression. Food intake before and after training must receive special attention.
Fatigue	Exercise is one of the main treatments for fatigue related to cancer and its treatment. Moderate-intensity exercise can be better tolerated, especially in the beginning of the exercise program[49]. Fatigue can be closely related to emotional factors, and motivation is essential for good adherence[49].
Lymphedema	Aerobic and strength exercises with initial intensities at low to moderate are recommended. Weight control must be emphasized, since being overweight is a contributing factor to lymphedemas[50]. The use of compressive clothing can improve exercise comfort and safety. Water exercises are recommended[50].
Peripheral neuropathy	Exercises targeting stability and balance are strongly recommended[46,48]. It is advisable to give preference to the use of equipment instead of free weights and to cycloergometers instead of treadmills. Attention must be paid to the risk of falls and accidents with weights and exercise equipment[7].
Osteoporosis and metastasis	Attention must be paid to the risk of fractures and falls. Contact exercises are contraindicated; water exercises may promote marginal bone health benefits. Strength exercises and the gradual introduction of impact exercises should be considered[7,48].
Morbidities	Specific care and recommendations for each co-morbidity (obesity, type-2 diabetes, cardiovascular diseases, arthritis) following guidelines and consensus must be taken[48].

Source: author

Finally, it is fundamental to make the people with cancer and cancer survivor the main element in designing and implementing the exercise program. People with cancer and survivors must learn to evaluate and manage the intensity of their efforts and monitor their symptoms; this will enhance the efficiency and safety of the training program[46]. They should also participate in defining the objectives and designing the exercise program. Their exercise and sports history, preferences, motivations, and sensitivity to effort must also be considered when proposing an exercise program. The most efficient and beneficial exercise program is one that the people with cancer and survivors is both able and willing to do[47].

Prospects and trends in the exercise oncology field in the Brazilian context

Despite the scientific development in this field and the exponential increase in the amount of information available on the safety and effectiveness of exercise in promoting health in people with cancer and survivors all over the world, in general, the exercise oncology field seems to be lagging behind in Brazil. This conclusion is based on: 1) the lack of data on the physical activity levels of people with cancer and survivors in Brazil and on oncology professionals' knowledge of and attitudes toward exercise; 2) the absence of Brazilian clinical trials and cohort studies in the international meta-analyses and the standings of scientific associations on this issue in the world; 3) the lack of guidelines or standings issued by Brazilian medical and scientific associations and societies; 4) the scarcity of professional training courses on exercise oncology; and 5) the small number of programs promoting physical activity and exercise among people with cancer and survivors in Brazil. Thus, necessary actions include those promoting the production of information targeted at cancer survivors and their relatives, the training of health professionals, and the dissemination of physical activity and exercise among people with cancer and survivors.

I argue that the scarcity of training courses and, consequently, of professionals specialized in exercise oncology are the main barriers to the development of this field in Brazil. Thus, training professionals to work with exercise oncology may be one of the field's main challenges in Brazil in the near future. The training of exercise physiologists, physical therapists, and oncology doctors in exercise oncology should ideally start in undergraduate,

specialization, and graduate courses. This measure would have a direct impact on the dissemination of the knowledge and the creation of venues dedicated to people with cancer who need specialized services. Although most cancer survivors may exercise safely in fitness centers and clubs or follow exercise programs by themselves based on guidelines and recommendations, supervised exercise programs are needed for those who suffer treatment side effects and limited physical function, who are weak or debilitated, who have acute associated diseases (cardiopathy, diabetes, bone frailty, etc.), or who do not feel sufficiently secure or motivated. However, such programs are scarce in Brazil and limited to university research projects, university hospitals, and philanthropic entities. In a study conducted in Italy, Avancini *et al*.[34] observed that poor professional training and lack of experience were the main obstacles to the adherence of cancer survivors to exercise programs.

Another challenge is introducing exercise to the context of cancer treatment in Brazil. Programs that popularize science and disseminate information on the safety and benefits of exercise throughout the cancer treatment continuum, especially those targeting oncologist doctors, must be created and implemented. For example, an Australian group has developed implementation plans to bring scientific research and practice closer together[51,52]. Schmitz *et al*.[53] and a group of specialists with the initiative Moving Through Cancer published a schedule up to 2029 to make the practice of exercise a part of oncology by promoting informative campaigns, action policies, and health professional training. Unfortunately, Brazil and Latin America do not take part in this initiative and lack measures for introducing exercise to the oncology field.

I envision the creation of environments that are favorable to promoting the well-being and health of people with cancer and survivors; these have increased in developed countries, but are still mostly lacking in emerging countries like Brazil. This includes production of knowledge in universities and hospitals, the training of health care professionals, and the dissemination of specialized knowledge to people with cancer, cancer survivors and their relatives in order to stimulate the practice of exercise as soon as the diagnosis is confirmed.

Conclusions

The exercise oncology field has evolved quickly in the last 30 years; since the first clinical studies published in the late 1980s, numerous studies have tested various types of exercise and effort intensity levels before, during, and after cancer treatment. These studies have resulted in a significant number of systematic reviews, which have supported the drafting of guidelines and recommendations by multiple scientific associations in various countries. These studies and positions clearly show that physical activity and exercise prevent the development of different types of cancer, increase survival, improve quality of life, and minimize the adverse effects of cancer and its treatment in people with cancer and survivors. Thus, contrary to the recommendation 20 years ago to "rest and avoid physical effort", the current recommendation is that every individual with cancer must be encouraged to remain active and to start or continue exercising[6]. The exercise oncology field has advanced to the point that we no longer ask *whether* people with cancer should exercise but *how*, *how much*, *when*, and *where* they must exercise. Nevertheless, many gaps remain to be bridged, which keep the recommendations of exercise in oncology at a generic level. New studies and guidelines published in the last five years have made great progress toward individualized exercise prescriptions in oncology.

Unfortunately, Brazil and South America do not seem to be included in the international agenda to make the practice of exercise a part of oncological treatment. Numerous random clinical trials, meta-analyses, and scientific positions from various countries have been published in the last 10 years; however, Brazil's participation is negligible. Therefore, I consider it urgent to mobilize scientists and society—through scientific associations, medical

societies, and philanthropic associations—with the goal of obtaining data (e.g., on the level of physical activity and sedentary behavior in people with cancer and survivors, as well as the level of knowledge), promoting the practice of physical activity among people with cancer and cancer survivors, and developing the exercise oncology field in Brazil.

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