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Training, Performance & Rehabilitation

Review

Physical activity and cancer

R Laszlo*, P Hartveg, S Laszlo, S Otto, D Prokopchuk, JM Steinacker

Abstract

Introduction

Literature indicates that physical activity has significant primary-preventive effects concerning various cancer entities. An entity-specific approach is needed to study the mechanisms for these effects. Numerous studies showed that physical activity during tumour therapy can result in a reduction in fatigue, increase in quality of life and exercise capacity and a reduction in treatment-associated disorders such as fatigue, nausea, insomnia and pain. Therefore, physical activity during ongoing cancer treatment is considered to be an effective support therapy without any negative effects, if relevant contraindications are considered. Prognosis of some malignant diseases may be modulated by physical activity during follow-up care. Furthermore, due to its other multi-dimensional effects, physical activity plays an increasing role in follow-up care even independent of the influence on prognosis. Significance of physical activity in all phases of cancer disease is delineated in this review.

Conclusion

Physical activity can be recommended during all stages of cancer disease if contraindications are followed.

Introduction

Physical activity (PA) is defined by a motion-caused increase in metabolic rate above the basal rate. Competition, muscular effort and enjoyment of motion are basic principles of sports[1]. In contrast, humans are classified as inactive if they are precisely not or at best a little physically active in all areas of everyday life[1].

PA can be objectified by load-dependent oxygen uptake of the organism. The ratio between oxygen uptake during exercise and during rest is called 'metabolic equivalent' (MET). For example, taking a walk is up to 3 MET, bicycling 6 MET or jogging (11 km/h) 11 MET[2].

There is a close relationship between PA and, respectively, exercise capacity and all-cause mortality. For example, in a large study with 15,000 male subjects (60 ± 11 years old), ergometry-determined exercise capacity at baseline was the strongest predictor of all-cause mortality during follow-up: adjusted risk was reduced by 13% for every 1-MET increase in exercise capacity[3].

Not only due to positive influence of PA on mortality, but also due to manifold positive effects on physical and mental health, at least 150 min of moderate- (3–6 MET) or, respectively, 75 min of high- (>6 MET) intensity PA are recommended by world health organization (WHO). However, these recommendations are insufficiently implemented by a large portion of human population of many countries[4,5]. There is a negative correlation between physical activity and obesity[6]. In parallel, obese people are not as physically active as people who are of a normal weight[7]. Therefore, insufficient PA of large parts of the population of many countries is probably responsible for increasing prevalence of overweight and obesity in these countries[8].

During the past years, as a consequence of the generally positive effects of PA[9] and of the benefits in primary and secondary prevention of cardiovascular diseases[10], PA of cancer patients attracted more clinical and scientific interest. Significance of PA in all phases of cancer disease is delineated in this review.

Discussion

Physical activity and primary prevention of malignant diseases

Based on the close relationship between PA, bodyweight and all-cause mortality, one can wonder whether the risk of affection of a malignant disease also depends on body weight or, respectively, PA. As shown in a meta-analysis of 282, 317 cancer cases, increased body mass index (BMI) is associated with an increased risk of cancer. For example, compared with people of normal body weight, there is a 1.5-fold increase in risk for oesophagus-carcinoma with every 5 kg/m^2-increment of BMI[11].

A weak point of many studies concerning the issue 'PA and cancer' is due to methodical reasons – it may be difficult to acquire PA in proper style during everyday life[12]. However, there is epidemiological evidence that cancer-protective effects of PA are rather under, than overestimated by common methods of acquisition of PA (questionnaire, accelerometer)[13].

An inverse association between PA and cancer incidence was found in a large cohort study of 40,700 men[14]. Currently, largest evidence for primary-preventive effects of PA on cancer risk can be found for colon carcinoma[15]. In summary, between 9% and 19% of the most common tumours seems to be attributed to deficit PA[16]. As especially the risk for the most common tumours (e.g. cancer of breast and colon) seems to be reduced, increase in PA in terms of behaviour-oriented prevention offers an enormous potential for general population health care.

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FOR CITATION PURPOSES: *Laszlo R, Hartveg P, Laszlo S, Otto S, Prokopchuk D, Steinacker JM.* Physical activity and cancer. OA Sports Medicine 2014 Jan 18;2(1):1.

Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to conception and design, manuscript preparation, read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

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Compared with cardiovascular diseases[17], there is equivocality concerning the mechanisms of primary-preventive effects of PA on risk of cancer. On the one hand, this may be due to the fact that 'cancer' summarises many heterogeneous diseases of different aetiology, and on the other hand, 'PA' is also only a superordinate concept of a complex behaviour which elicits various physical and psychic reactions of the organism. As a multiplicity of biological modes of action can be taken into account, an entity-specific approach is needed. Generally[18–21], increase in muscle mass and, accordingly, reduction in body fat as a consequence of PA result in positive endocrinological alterations (sex/ steroid hormones, growth factors, insulin/insulin resistance) which finally inhibit carcinogenesis. Positive influence of PA on 'oxidative stress', inflammation and DNA repair mechanisms as well as its induction of specific gene expression patterns and, respectively, extensive effects of PA on the immune system are discussed as further possible unspecific mechanisms (Figure 1). Accelerated gastro-intestinal transition time and – as a consequence – reduced contact time of carcinogen substances with the mucosa also seems to be responsible that of all things, primary-preventive effects of PA on risk of colon carcinoma are especially high[22].

Physical activity as cancer-support therapy

As a residue of former therapeutic standards, the thought that cancer patients should rest and do not bear or are even marred by PA still haunts some people's mind[23]. Typical consequence of cancer disease and therapy such as surgery-induced limitation of flexibility or even immobility, side-effects of drugs (anaemia, cardiotoxicity, pulmonary toxicity), sarcopaenia, myopathy, susceptibility to infection, pain, anxiety, mental stress, depression, insomnia, nutritional disturbance (malnutrition, cachexia) may result in breathlessness, tachycardia and fatigue[24]. Therefore, at first glance it may be traceable that PA in terms of a cancer-support therapy is considered to be an unreasonable demand for cancer patients. However, physical protection/inactivity may end up in a vicious circle (Figure 2): muscle mass is reduced as well as cardiac and, respectively, pulmonary exercise capacity and – as consequence – endurance capacity and muscular strength. Former activities of daily living are getting more and more difficult for the patients and are thus avoided whereupon inactivity and physical protection are further increased.

Thus, breakthrough of this vicious circle is an important aim of PA within the scope of tumour therapy. For that matter, numerous studies showed that PA during tumour therapy results in a reduction in fatigue[24,25], an increase in quality of life and exercise capacity[26] and a reduction in treatment-associated disorders such as nausea, fatigue, insomnia and pain[27]. Therefore, PA during ongoing cancer treatment is considered to be an effective cancer-support therapy without any negative effects if relevant

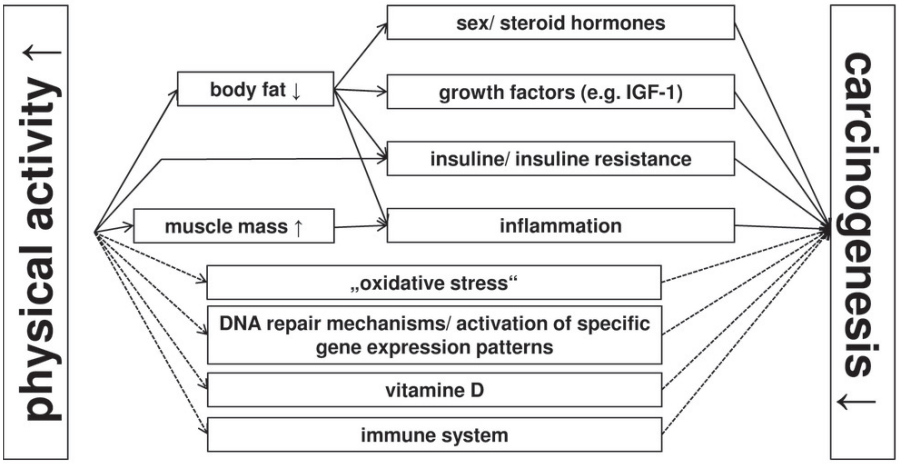

Figure 1: Potential mechanisms of primary-preventive effects of physical activity on risk of cancer.

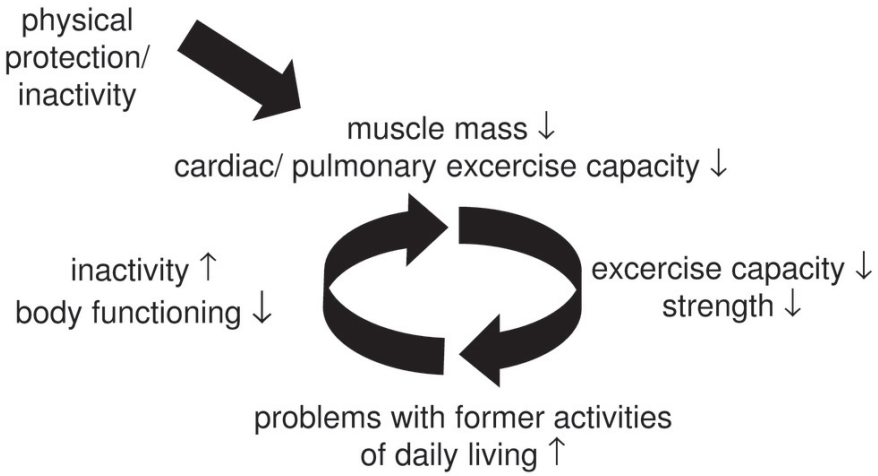

Figure 2: Vicious circle of physical protection and inactivity.

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Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to conception and design, manuscript preparation, read and approved the final manuscript.
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contraindications are considered. Contraindications for participation are similar to those of healthy people and, respectively, patients with chronic diseases[28]. Specific characteristics of cancer- or therapy-related alterations of the patient have to be considered. Table 1 gives an overview of general contraindications of sport participation, whereupon attention of the specific situation of a patient is always a necessity[28,29].

Preliminary assessment of cancer patients includes clinical status, laboratory parameters and exclusion of skeletal instability. Cardiological examination is essential for older patients, patients at risk for coronary heart disease and after high-dose chemotherapy or treatment with cytostatic drugs with cardiotoxicity or pulmonary toxicity. Examination should include resting- and stress-ECG, echocardiography and pulmonary function test for assessment of exercise capacity, additional (e.g. invasive) diagnostics may be necessary in certain clinical situations[28,30].

Training programme[29–35] should respect the patient's affinity for certain sports. Very often, cancer patients exhibit a severely reduced exercise capacity. Therefore, a frequent and individual monitoring is important. A combination of resistance and endurance training, for example, jogging, walking, bicycling, gymnastics or (under consideration of general state of health and immune state) rowing and swimming is recommended for cancer patients. Ball games or contact sports may be dangerous for patients with impaired blood coagulation. Endurance training (30–45 min/day) should be performed with 70%–80% of maximal exercise capacity, a modulation of intensity due to concomitant disease (coronary heart disease, arterial occlusive disease, diabetes, osteoarthritis) may be needed but with possibly consecutive reduction in effectiveness of training. Reduction in intensity due to a generally reduced state of health of the patient to offer sports participation results in a disproportional increase in training time and is therefore not generally recommended. However, training with reduced intensity may be focused on muscle coordination to improve motor deficits in some of these patients. If hygiene factors for immunosuppressed patients are considered, sports participation is also possible for patients with leukopaenia/neutropaenia.

Physical activity in follow-up care

Negative influence of overweight/obesity and, respectively, positive effects of PA concerning risk of cancer disease have been already discussed. Hence, the question comes up whether factors such as bodyweight and PA are able to modulate prognosis of malign diseases. The correlation between BMI at baseline and risk of cancer-related death during follow-up was examined in a large cohort study with 900,000 subjects who did not have cancer diagnosis at baseline[36]. During follow-up (16 years), there was a 52% (♂) and accordingly 62% (♀) increase in risk of cancer-related death of the most obese (BMI > 40 kg/m^2) compared with subjects with normal body weight. An association between BMI and increased mortality was also found for cancer of the colon and rectum, oesophagus, liver, gallbladder, pancreas and kidney and for death due to non-Hodgkin's lymphoma and multiple myeloma. Significant trends were observed for death from stomach cancer and prostate in men and for death from breast, uterus, cervix and ovary cancers in women. Based on these associations, it was calculated that overweight and obesity in the United States could account for 14%–20% of all deaths from cancer.

Concerning positive effects of PA on prognosis, there is good evidence for colon carcinoma. For example, in a prospective study by Meyerhardt et al.[37] with 573 patients suffering from colon carcinoma (I–III), dependency of cancer-related and accordingly all-cause mortality on PA before and after diagnosis and, respectively, changing of PA after diagnosis was examined. Cancer-related and all-cause mortality was not influenced by degree of PA before diagnosis but was modulated – the more, the better – by magnitude of PA after diagnosis, whereupon it did not play a role whether the patients were physically active at a defined level already before or as recently as after diagnosis. Similar results became apparent at patients with breast cancer wherein exact entity (e.g. receptors) plays an important role[38]. At other cancer entities, there is no or at most minor evidence for a prognosis-modulation effect of PA[39].

However, due to its multi-dimensional effects, PA plays an important role in follow-up care of cancer patients even independent of the

Table 1 Contraindications of sport participation of cancer patients

Absolute contraindication	Relative contraindications
Acute disease	Thrombopaenia < 50,000/µL
Decompensation of disease	Bone metastasis
Acute episode of chronic disease	Anaemia
Fever	Chronic pain
New-onset pain	
Thrombopaenia < 10,000/µL	
Pronounced cachexia	

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Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to conception and design, manuscript preparation, read and approved the final manuscript.
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influence on prognosis. PA is effective concerning improvement of exercise capacity, acts as antidepressant and enhances mental health and body functioning[40]. At the moment, there is no acceptably data if these effects can be observed also in a palliative situation[41]. Finally, PA promotes social re-integration and results in a better quality of life[12,42].

Conclusion

Positive effects of PA concerning primary prevention of certain cancer entities are assured or are at least highly probable. Under consideration of important contraindications, PA acts as an effective cancer support therapy and does not harm patients. Positive influence of PA on prognosis of certain cancer entities can be assumed. In addition, further multi-dimensional effects on physiological (exercise capacity), psychological (depression) and social (re-integration) levels and concomitant increase in quality of life underline the importance of sports/PA in follow-up care of cancer patients. Summarised, PA can be recommended during all stages of cancer disease if contraindications are followed.

Abbreviations list

BMI, body mass index; MET, metabolic equivalent; PA, physical activity; WHO, World Health Organization.

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Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to conception and design, manuscript preparation, read and approved the final manuscript.
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Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to conception and design, manuscript preparation, read and approved the final manuscript.
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