Advocating physical activity for the enhancement of cancer prevention and treatment

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The term 'Cancer' encompasses a large group of related disease processes that affect the healthy replication of cells (Dishman et al., 2004). Worldwide, cancers of the lung and airways alone were the fifth highest cause of mortality in 2015 (WHO, 2015). The same cancers were the fourth leading cause of mortality in high-income economy countries (WHO, 2015). While some cancers arise from non-epithelial cells, and are more attributable to pre-disposition and heredity, these cases form the minority of reported cancer incidence (Smith et al., 2016). The majority of cancers occur in epithelial tissues, which separate body cavities from the outside environment, and have a large number of modifiable lifestyle and environmental risk factors (Smith et al., 2016). There is a growing body of evidence linking physical activity and fitness with improved functional outcomes in cancer patients (Giovannucci et al., 2012). This improvement may be two fold. First, where activity and fitness have a direct improvement on risk factors for the development of certain cancers, such as diabetes. Secondly, it may also improve health and quality of life indices during cancer treatment (Giovannucci et al., 2012).

Cancer was the leading cause of death in Canada in 2011, accounting for 30% of all deaths (Statistics Canada, 2014), and was the second leading cause of death in the United States in 2003 at 23% (Dishman et al., 2004; Bouchard, Blair & Haskell, 2006). In the United States, the estimated financial burden from Cancer was $170 billion in 2002, accumulated from medical services, loss of productivity, and loss of life (Dishman et al., 2004).

In Canada, it was estimated that there would be 191, 300 new incidences and 76, 600 deaths from cancer in 2014 (Canadian Cancer Society, 2014). It is also

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estimated that 45% of men and 41% of women, or two out of every five Canadians, will develop cancer in their lifetimes (Canadian Cancer Society, 2014). Furthermore, it is expected that one in four Canadians will die from cancer, though that number is slightly higher for men at 29% and lower for women at 24% (Canadian Cancer Society, 2014). Excluding non-melanoma skin cancer, the most commonly diagnosed cancers in Canada are lung, colorectal, prostate, and breast cancer, which account for 52% of all new cancer cases (Canadian Cancer Society, 2014). Lung cancer has the lowest survival rates for Canadians, with a five-year survival rate of only 17% (Canadian Cancer Society, 2014).

Aetiology

Cancer is a large group of related diseases that arise from the uncontrolled division and spread of abnormal cells (Dishman, Washburne & Heath, 2004; Mayo Clinic, 2014). These cells also have the ability to infiltrate and destroy normal body tissue, and can spread and form tumours throughout the body (Mayo Clinic, 2014). Death from cancer results either when vital organs become so compromised by cancerous cells that they cannot support life or from complications arising from the disease or treatment, such as thromboembolisms or heart failure (Khorana et al., 2007; Smith et al., 2016).

The two phases in the pathology of cancer are initiation, where normal cells are turned into cancerous cells by damage from mutagens, and promotion, where tumour growth may be stimulated by other agents (Dishman et al., 2004). In healthy cells, telomeres shrink after every cell division until they become too small, thus preventing further division. Between 80% and 90% of cancer cells produce telomerase, which prevents telomeres from shrinking and results in uncontrolled cell growth and tumour formation (Dishman et al., 2004). Occasionally, as tumours grow, some cells may enter circulation and be deposited in other areas of the body where they continue to grow and form new tumours. This process is known as metastasis and only occurs because of cancerous tumours (Dishman et al., 2004).

Primary Prevention

The association between physical activity and reduced cancer risk is dependent on the site that the cancer originates in and the mutagens most often associated with it. For example, smoking is a recognized risk factor for the genesis of cancer in the lungs, throat, mouth and larynx whereas alcohol abuse is more commonly associated with liver cancer (Dishman et al., 2004; McKillop & Schrum, 2005). Strong evidence exists that physical activity has an inverse relationship with incidences of certain types of cancer. These include colon, breast, endometrial, prostate, gastric and ovarian cancers (Steindorf, 2013). For these cancers, subjects who participate in physical activity demonstrated fewer incidences of cancer. The

average relative risk reduction associated with physical activity is generally between 10% and 30%, indicating that physical activity can play an active role in primary cancer prevention (Steindorf, 2013).

For colon cancer specifically, a meta-analysis of 52 studies concluded that there is strong evidence that physical activity decreases it's associated risks (Wolin, Yan, Colditz & Lee, 2009). Overall, physical activity was associated with a 24% risk reduction, which may be achieved with sufficient durations of moderate-intensity activity, though more specific studies are required to draw conclusions. This may be supported by the findings that occupational physical activity provides greater reductions than leisure-time physical activity, since occupational physical activity usually lasts for a longer duration and generally has a lower oxygen demand (Dishman et al., 2004). The most widely accepted pathological theory is that physical activity reduces bowel transit time, effectively reducing the amount of time that the colon is exposed to carcinogens (Dishman et al., 2004).

There is also strong evidence that physical activity is associated with reductions in both the incidence and risk of death from breast cancer (Montaruli et al., 2012). Women who regularly participate in moderate-intensity physical activity had a 20% lower overall risk of developing breast cancer, and those who participated in physical activity both before and after their diagnosis demonstrated a 50% lower risk of death (Montaruli et al., 2012). Furthermore, women who increased their activity level after diagnosis had a 45% decrease in risk of death, while those who decreased their activity after diagnosis had a four-fold increase in risk of death (Monatruli et al., 2012).

Breast cancer risk is reduced through maintaining a lower body mass and BMI, delay of menarche, earlier onset of menopause, reductions in endogenous sex hormones and insulin resistance, and circulating insulin-like growth factors (Dishman et al., 2004; Montaruli et al., 2012). Physical activity is positively associated with reductions in overall body weight, lipid stores, insulin-like growth factor, and insulin sensitivity. Insulin-like growth factor is a growth hormone mediator that is positively correlated with the growth of cancerous cells (Baserga, Peruzzi & Reiss, 2003).

The evidence on physical activity's role in the prevention of prostate cancer is still controversial. While many studies seem to indicate between a 10% and 30% risk reduction, the benefits may be more associated with activity's effects on other risk factors, such as obesity, rather than on the direct prevention of cancer itself (Dishman et al., 2004; Young-McCaughan, 2012). Other possible mechanisms include improvements to diet, body composition and temporary reductions in serum testosterone that accompany bouts of physical activity (Dishman et al., 2004).

Several studies have reported a lower risk of lung cancer in patients who participate in regular leisure-time physical activity, with a stronger inverse association in subjects who smoke as compared to non-smokers (Koutsokera et

al., 2013). However, given that 85% of incidences of lung cancer are associated with tobacco smoking and no association was found between occupational physical activity and lung cancer, more investigation is required (Koutsokera et al., 2013).

Secondary Prevention and Management

In the mid to late 20th century, the prevailing idea was that a cancer patient undergoing cytotoxic, chemo, or radiation therapies should avoid physical exertion (Lemanne, Cassileth & Gubili, 2013). However, it has been shown that aerobic physical activity can help improve functional capacity and body composition, and can help to reduce chemotherapy-induced nausea (Lemanne et al., 2013). Physical activity may also have a direct effect on tumours in some types of cancer (Giovannucci, 2012). Exercise demonstrably decreases endogenous hormones such as androgens, insulin, insulin-like growth factor 1, and others. Many of these hormones are associated with tumour promotion in different types of cancer, so any decrease may inhibit or slow tumour proliferation (Giovannucci, 2012).

Elderly patients who participated in activity while undergoing treatment demonstrated improved self-report health, less memory loss, reduced shortness of breath, and reduced fatigue at the end of treatment (Lemanne et al. 2013).

Physical activity of moderate to vigorous intensity, eliciting greater than 55% of maximum heart rate, has been associated with greater health benefits than low intensity activity (Lemanne et al., 2013). There is, however, some debate as to the benefits of vigorous activity in cancer patients, as vigorous activity has also been linked to immunosuppression and increases in circulating reactive oxygen species, a risk factor that increases cancer (Montaruli et al., 2012). High intensity aerobic activity is contra-indicated for patients whose haemoglobin levels have been reduced by treatment (Hayes et al., 2009). Therefore, patients undergoing radiation or chemotherapy should avoid strenuous activity.

Special Considerations for Physical Activity

Most cancer patients undergo some form of surgery, which may be as minor as the removal of a mole or as major as having parts of an internal organ removed (Schmitz et al., 2010). Approximately half of all patients receive ionizing radiation therapy, which may be concomitant with chemotherapy and may occur at any point surrounding surgeries (Schmitz et al., 2010). Furthermore, the scheduling of these treatments, and the degree to which they affect the subjects should be considered on an individual basis (Schmitz et al. 2010). A physician should clear all cancer patients before beginning exercise testing to identify any specific risks to the individual. The attending physician should evaluate for any peripheral neuropathies, musculoskeletal morbidities, and risk of fractures and cardiotoxicity

(Schmitz et al., 2010). With physician clearance, submaximal aerobic testing and moderate intensity activity should be as safe for cancer patients and survivors as it is for the general population (Schmitz et al. 2010).

Physical activity has been shown to have important effects on physical, social, and psychological outcomes of cancer patients (Montaruli, 2012) and, as such, should have the objective of improving a subject's general health and quality of life (Hayes et al., 2013). As such, prescriptions should be individualized according to a subject's pre-treatment fitness, comorbidities, and any persistent negative effects from their treatment (Schmitz et al., 2010).

Ideally, an exercise program should incorporate both aerobic and resistance activities, to promote functional capacity and maintain bone density (Montaruli, 2012). In contrast to earlier beliefs, the majority of cancer patients tolerate vigorous-intensity and impact activities well (Hayes et al., 2013).

Unless contraindicated by symptoms or treatment, physical activity recommendations for cancer patients are substantially similar to those for the general population (Hayes et al., 2013). Those recommendations are: moderate-intensity aerobic activity on most days of the week, adding up to 150 minutes, and two resistance training sessions weekly (Hayes et al., 2013). The benefits of physical activity in the prevention and care of cancer far outweigh the risks, and for that reason physical activity should be included in cancer care regimens.

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