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The dangers of inactivity; exercise and inactivity physiology for the manual therapist

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ABSTRACT

Physiotherapists should take a primary role in relation to the prevention and management of all diseases that are associated with low levels of physical activity. The benefits of regular physical activity on health, longevity, and well being easily surpass the effectiveness of any drugs or other medical treatment. Physical activity has many beneficial effects on the body, helps prevent the development of many chronic diseases and is a useful complement to drug treatment in many diseases. As the importance of physical activity for health might well be underrated and undervalued even by manual therapists we describe the physiological consequences and health dangers of being inactive in this paper.

1. Introduction

Physical inactivity has become the biggest public health problem of the 21st century (Blair, 2009), with at least 60% of the global population failing to achieve the minimum recommendation of 30 min moderate-intensity physical activity daily (World Health Organisation, 2010).

Numerous well-conducted prospective observational studies have demonstrated that the least active and unfit people are at the greatest risk of developing a variety of chronic diseases, such as heart disease, diabetes and obesity, and all-cause mortality. This increased risk occurs independent of ethnicity, income, education, or body size and shape, and there is a dose–response across a wide range of activity and fitness levels (US Department of Health and Human Services, 2008; Haskell et al., 2009).

At the same time we see an increase in the strong evidence for the health benefits of physical activity and physical fitness. Physical activity protects against many chronic health conditions by improving glucose uptake and insulin sensitivity, improving blood lipid profiles, lowering blood pressure, improving the health of blood vessels, and protecting against obesity (Chakravarthy et al., 2002; Pedersen and Saltin, 2006). The evidence suggests the benefits of regular physical activity on health, longevity, and well being easily surpass the effectiveness of any drugs or other medical treatment (Chief Medical Officer, 2010; Pedersen and Saltin, 2006). Then, how come the silence on these health benefits in the physiotherapy community?

The paucity of research on the impact that physiotherapists can make in promoting physical activity for prevention of chronic diseases, suggests that the importance of physical activity for health might well be underrated and undervalued even by physiotherapists. Although studies on health promotion by physiotherapists are scarce, an American study reported that only 54% of physiotherapists assisted patients with increasing physical activity (Rea et al., 2004). Only one controlled trial assessed a behavioural intervention by physiotherapists to promote exercise among outpatients (Sheedy et al., 2000). The effect of the intervention was not clear, as both control and intervention subjects improved their physical activity participation from baseline to follow-up. This may not be surprising, considering the use of exercise therapy as treatment for many conditions to increase performance.

Physiotherapists should take a primary role in relation to the prevention and management of all conditions that are associated with low levels of physical activity. As experts in functional ability, in which movement and exercise are cornerstones, and with a thorough knowledge of pathophysiology of inactivity and its

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effects on all systems, physiotherapists may be the ideal professionals to promote, guide, prescribe and manage exercise activities that enable people living with chronic musculoskeletal, neurological or cardiopulmonary conditions or inactivity related disease (e.g. obesity and Diabetes type II (DM II)) to maintain or improve their level of physical activity.

Insight into the physiological impact of inactivity on physical fitness may eventually help us to design therapeutic strategies to minimize the loss of health-related fitness in people who are in situations associated with inactivity, due to prolonged hospitalization, ageing, and/or chronic disorders.

2. Physical activity and physical fitness

Physical activity is defined as “any bodily movement produced by contraction of skeletal muscles and resulting in energy expenditure above the basal level”. Exercise (therapy) is defined as a subcategory of physical activity in which planned, structured, and repetitive bodily movements are performed to maintain or improve one or more attributes of physical fitness. Physical fitness refers to the ability to carry out daily tasks with vigor and alertness without undue fatigue and with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies (Caspersen et al., 1985). Physical fitness includes body composition, muscle strength and endurance, flexibility, motor control and aerobic capacity. Physical activity and physical fitness are thus interrelated.

Physical fitness provides the capacity to perform physical activities. With increasing fitness, people tend to become more active, and the fittest persons tend to be the most active. The association between fitness and health is also reciprocal. Fitness influences health, but health status also influences both physical activity and fitness (Bouchard and Shephard, 1994). One aspect of physical fitness is aerobic capacity or VO_{2max}. VO_{2max} is a measure of the ability and efficiency of the body to take up oxygen and use it to convert fat and carbohydrates into energy (adenosine triphosphate or ATP). Factors influencing the VO_{2max} are described by the Fick equation:

$$VO_2 = Q \times \Delta a - v O_2,$$

where Q is cardiac output (cardiac stroke volume × heart rate) and Δ a-v O_2 is the mixed arterio-venous O_2 content difference. VO_{2max} describes the maximal amount of energy available by aerobic metabolism per unit of time (Mezzani et al., 2009). Normal values of VO_{2max} depend on age and gender and are influenced by body size, level of physical activity and genetic endowment. VO_{2max} declines with age and accelerates from 3% to 6% per decade during the 20 s and 30 s to >20% per 10 years in the 70 s and beyond, regardless of physical activity habits (Fleg et al., 2005), because of decreasing maximal heart rate, stroke volume, blood flow to skeletal muscle and skeletal muscle aerobic potential with age (Betik and Hepple, 2008). VO_{2max} is 10–20% greater in males than in females of comparable age, because of the higher hemoglobin concentration, greater muscle mass and cardiac stroke volume in males (Mezzani et al., 2009).

Part of aerobic capacity is used for basal metabolic rate; the other part is available for physical activities (metabolic scope). Physical activities are coded in Metabolic Equivalent of Task (MET) intensity levels. One MET equals the resting metabolic rate obtained during quiet sitting and equals an approximate oxygen uptake of 3.5 ml/kg/min. The oxygen usage for physical activities ranges, for example, from 0.9 MET for sleeping to 16 METS running a 6 min mile (Ainsworth et al., 2000) (see Table 1).

A person’s aerobic capacity thus directly affects the amount and intensity of physical activity an individual is able to perform and determines exercise capacity. Higher aerobic capacity not only enables individuals to “do more”, but has also been shown to predict a lower risk of death in normal males and males with cardiovascular disease (Myers et al., 2002) and asymptomatic women (Gulati et al., 2003).

Table 1
Examples of metabolic equivalent of task (MET) cost (Ainsworth et al., 2000).

Activities	METS
Watching TV	1
Desk work	1.5
Standing	2
Walking the dog	3
Gardening -general	3–4
Cleaning windows	3–4
Cleaning floors	3–4
Mowing lawn	5–6
Carry 10–20 kg	4–5
Bicycling (slow)	6
Running (6 min/mile)	16

3. Deconditioning

Inactivity or disuse leads to deconditioning. Deconditioning is defined as the integrated physiological response of the body to a reduction in metabolic rate; that is, how the body reacts to a reduction in energy use or exercise levels (Greenleaf, 2004), such as in bed rest. Deconditioning is associated with a host of physiological changes. Muscle mass decreases, with loss of muscle strength. Muscle capillary density declines along with mitochondrial enzymatic activity and ATP production. This leads to loss of muscle oxidative potential (Δ a-v O_2) and increased fatigability of muscle. This, in combination with loss of cardiac output (Q) leads to a decrease of VO_{2max}. In response to unloading, bone strength decreases through a rapid and sustained increase in bone resorption and a more subtle decrease in bone formation (Zerwekh et al., 1998). The greatest bone loss occurs at weight-bearing skeletal sites. Disuse decreases the collagen turn-over in tendons and muscles (Kjaer, 2004), weakens the attachment of ligaments to bone and causes a disorganization of collagenous fibers. Proprioceptive mechanisms within the muscle and muscle-tendon junction degenerate and become less responsive (Simonson, 2004) potentially increasing risk of injury. Metabolic changes can lead to an increased risk of cardiovascular disease (CVD) and Diabetes type II (DM II) (see Fig. 1).

A result of deconditioning is a shift towards increased reliance on carbohydrate as an energy substrate at submaximal and maximal exercise intensities in exercising muscle and a corresponding decrease in the contribution from lipid metabolism. In addition, a decline in sensitivity to insulin-mediated glucose uptake occurs, which partly results in a reduction of whole-body glucose uptake. Due to the increased reliance on carbohydrate as an energy substrate with deconditioning, the blood lactate concentration during exercise increases at submaximal intensities and the lactate threshold is apparent at a lower percentage of VO_{2max} (Mujika and Padilla, 2001). Consequently, exercise performed at the same absolute intensity after disuse results in a higher heart rate, higher blood lactate accumulation, an increase in muscle glycogen utilization and carbohydrate oxidation, a reduction in exercise time to fatigue and increased dyspnoea. Activities demand a higher relative percentage of VO_{2max} and may cause shortness of breath and fatigue. As a result, activities may be reduced or avoided, causing physical functioning to decline. A vicious cycle develops where activity is reduced, walking speed is lowered, fitness levels decline

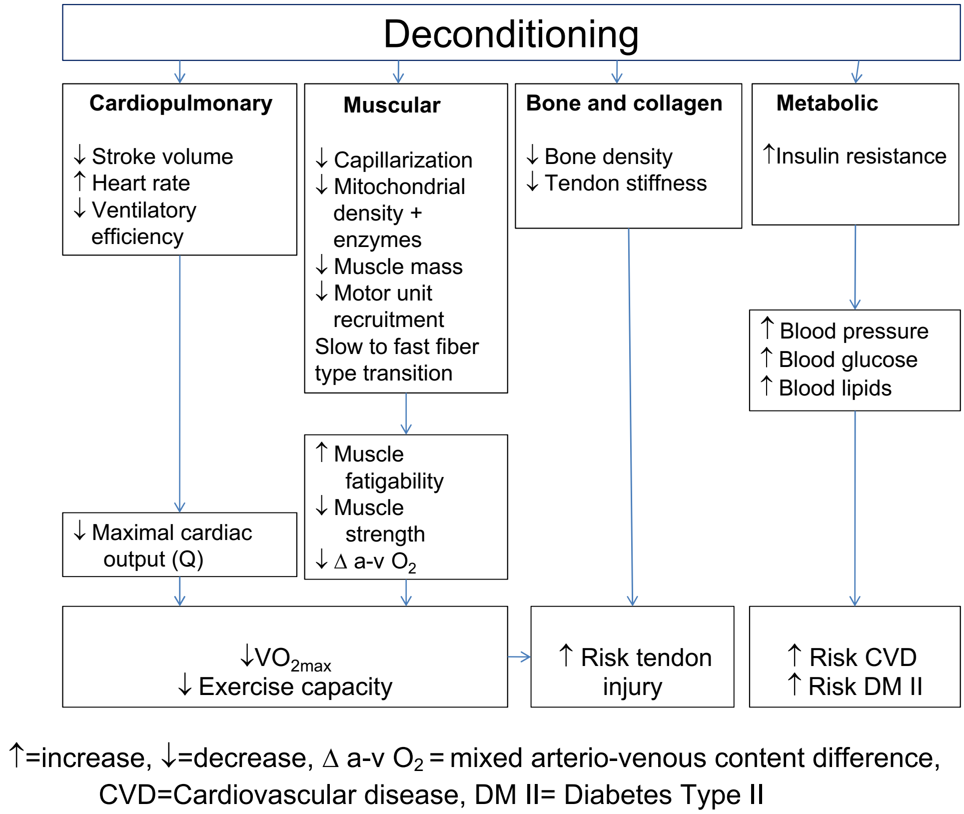

Fig. 1. Physiological consequences of deconditioning.

further and activities of daily living become too difficult to carry out, eventually resulting in disability and dependence (see Fig. 2).

In bed rest studies, the magnitude of reduction in VO_{2max} ml/kg/min varies according to the duration of bed rest and the initial level of aerobic capacity, but appears to be independent of age or gender. In general, fitter people appear to experience relatively greater losses in VO_{2max}, but retain a more efficient oxygen uptake system than people who are sedentary or who have not exercised for prolonged periods (Coyle et al., 1984; Saltin et al., 1968).

The decline in VO_{2max} during the first two to four weeks of deconditioning is related to a loss of cardiac output, mostly due to plasma volume loss, while further declines are associated with decreases in mixed arterio-venous O_2 content difference (Coyle et al., 1984). With longer prolongation of bed rest, the rate at which VO_{2max} decreases becomes progressively slower (Capelli et al., 2006).

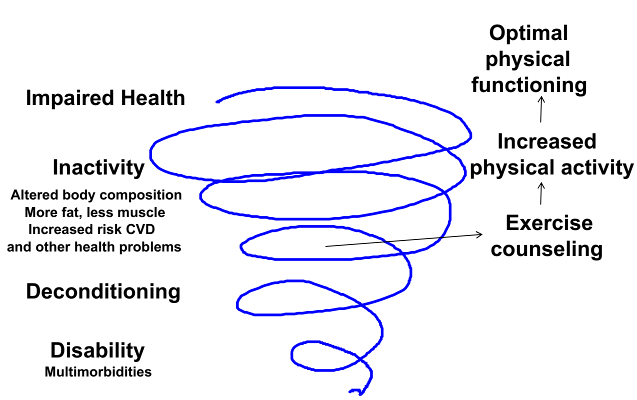

Fig. 2. Downward spiral of deconditioning (adapted from Painter (2003)).

A dose-dependent relationship between the duration of bed rest and the resulting reduction in muscle strength has been observed in a number of studies (MacDougall et al., 1977, 1980). Decreases of 6–40% in muscle strength have been observed within 4–6 weeks of bed rest (Bloomfield, 1997). Extensor groups experience greater decreases in strength than do the corresponding flexor muscles; the loss of strength in lower limb musculature is greater than in the upper musculature (Bloomfield, 1997).

An eight-week bed rest study in ten healthy males found that bed rest resulted in selective atrophy of the multifidus muscle. An increased cross-sectional area of the trunk flexor musculature (increases in psoas, anterolateral abdominal, and rectus abdominus muscles) was thought to reflect muscle shortening or possible overactivity during bed rest. According to the researchers, some of the changes resembled those seen in lower back pain and may partly explain the negative effects of bed rest seen in lower back pain sufferers (Hides et al., 2007). New research suggests that changes in the lumbar discs also occur with bed rest. Together with reduced muscle mass of the multifidi, these changes may be responsible for the occurrence of low back pain after bed rest (Belavy et al., 2010).

In healthy older men and women 10 days continuous bed rest resulted in a substantial loss of lower extremity strength, power, and aerobic capacity, and a reduction in physical activity (Kortebein et al., 2008). Changes such as these explain why 34%–50% of hospitalized elders experience decline in their functional status between hospital admission and discharge (Inouye et al., 2000).

4. Inactivity physiology

While exercise physiology concerns itself with the physiological responses caused by structured exercise, inactivity physiology concerns itself with the potentially unique molecular, physiologic and clinical effects of too much inactivity like sitting or lying down

(Hamilton et al., 2007). This new paradigm emphasizes the distinction between the health consequences of sedentary behaviour and that of not exercising (performing light-intensity activities only) (Bak et al., 2010). In this paradigm "sedentary time" is seen as muscular inactivity (such as in sitting). A number of studies, using both subjective and objective measures of physical activity, have now suggested that prolonged bouts of sitting time are strongly associated with chronic disease; obesity, abnormal glucose metabolism, diabetes, metabolic syndrome, CVD risk and cancer, independent of whether adults meet physical activity guidelines. (Aadahl et al., 2007; Dunstan et al., 2005; Dunstan et al., 2007; Fung et al., 2000; Healy et al., 2008b; Hu et al., 2003; Jakes et al., 2003; Katzmarzyk et al., 2009; Thorp et al., 2010). Dunstan et al. (2005) reported that each 1 h increase in sitting time watching television increased the prevalence of the metabolic syndrome in women by 26%, independently of the amount of moderate to vigorous physical exercise performed. This is approximately the same quantity of decreased risk (28%) of the metabolic syndrome caused by 30 min of extra physical exercise. One potential mechanism for the metabolic changes associated with prolonged sedentary time is the absence of muscle contractions, although further research is needed to confirm this. Both a Swedish and an Australian study showed that the majority of adult waking hours (>90%) were spent either in sedentary or in light-intensity activity (Hagstromer et al., 2007; Healy et al., 2008b). People already insufficiently physically active might increase their risk even further by prolonged sitting. Spending less time in sedentary activities and more time in light-intensity activity, might therefore yield metabolic benefits, as indeed was shown in a study investigating breaks in sedentary time (Healy et al., 2008a). Increased breaks were associated with less metabolic risk, independent of total sedentary time. Even activities as minimal as standing, rather than sitting, were shown to result in substantial increases in total daily energy expenditure and resistance to fat gain.

Especially for people who do not exercise, it is important to reduce their sitting time and attempt to maintain a high level of daily low intensity activity (such as standing, walking and walking stairs) to reduce their metabolic risk. Several of the guidelines recommend for children to reduce TV viewing to a maximum of 2 h/day to avoid negative effects on body weight and other health outcomes (American Academy of Pediatrics, 2001).

5. Metabolic syndrome

Even a short period of inactivity can induce metabolic changes. Numerous studies have shown that bed rest reduces the muscles' sensitivity to insulin (Pavy-Le Traon et al., 2007). Other metabolic and functional changes occur as well. In a study, 10 healthy young men decreased their daily activity level from a mean of 10,501 (±808) to 1344 (±33) steps/day for 2 weeks. After these two weeks peripheral insulin sensitivity was significantly reduced, as was cardiovascular fitness (−7%), and lean leg mass (Krogh-Madsen et al., 2009). Five days of bed rest was associated with the development of insulin resistance, dyslipidemia, increased blood pressure, and impaired microvascular function in 20 healthy volunteers (Hamburg et al., 2007).

Insulin stimulates uptake of glucose from the blood to the cells in the body. A sedentary lifestyle is associated with insulin resistance, which results in a reduced uptake of glucose into the cells (and thus elevated blood glucose levels), an abnormal response of fat, muscle and liver cells and subsequent elevated plasma levels of insulin. The insulin resistance syndrome or metabolic syndrome is characterized by 3 out of the 5 following metabolic derangements: high serum levels of triglycerides, low high-density lipoprotein (HDL) or "good" cholesterol, hypertension, elevated fasting blood glucose and increased waist circumference (>102 cm for men and >88 cm for women) (NCEP, 2001). Although insulin-resistant individuals need not be clinically obese, they nevertheless commonly have an abnormal fat distribution that is characterized by predominant upper-body fat. Upper-body obesity correlates strongly with insulin resistance (Grundy et al., 2005). Waist circumference is a measure of visceral fat, which actively contributes to an adverse inflammatory response and thus to disordered insulin signalling and endothelial dysfunction (Potenza and Mechanick, 2009). Endothelial dysfunction contributes to the initiation and progression of atherosclerotic disease and could be considered an independent vascular risk factor (Esper et al., 2006) (see Fig. 3).

The metabolic syndrome is associated with a marked risk of CVD and DM II, myocardial infarction and stroke. Mortality from any cause is increased 2.26 fold in men and 2.78 fold in women with metabolic syndrome, independent of age, body mass index, cholesterol levels and smoking (Potenza and Mechanick, 2009).

6. Physical activity and exercise

Physical activity has many beneficial effects on the body, helps prevent the development of many chronic diseases and is a useful complement to drug treatment in many diseases (Eyre et al., 2004).

A single session of physical activity (at intensity 50–80% VO_{2max}) results in the lowering of serum triglycerides and an increase in serum high-density lipoprotein (HDL = "good") cholesterol, decreases blood pressure (at intensity 50–100% VO_{2max}) and lowers blood glucose concentration (Kesaniemi et al., 2001). Chronic inflammation is involved in the pathogenesis of insulin resistance, atherosclerosis, neurodegeneration, and tumour growth (Brandt and Pedersen, 2010). Regular physical activity has an inverse and generally linear relationship with the rates of all-cause mortality, total CVD, and the incidence of and mortalities due to coronary heart disease, and the incidence of type 2 diabetes mellitus. It is also associated with a reduction in the incidence of obesity, colon and breast cancer and an improvement in the metabolic control of individuals with chronic diseases as established in DM II. Evidence suggests that the protective effect of exercise may to some extent be ascribed to the anti-inflammatory effect of regular exercise (Brandt and Pedersen, 2010).

Further benefits of regular physical activity include improved physical function and independent living in the elderly. There is evidence that aerobic physical activities which improve

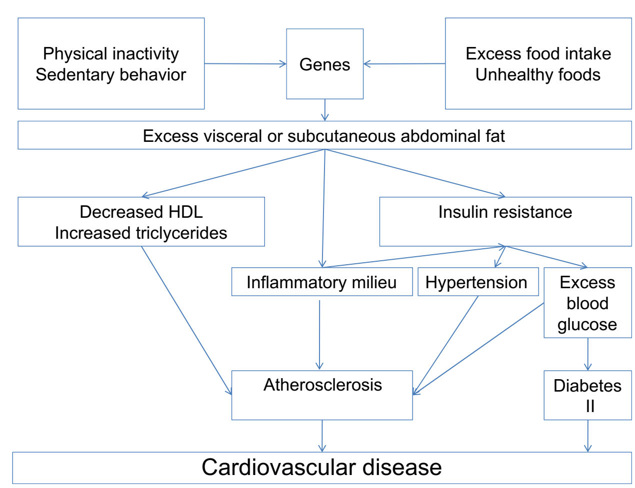

Fig. 3. The relationship between physical inactivity, obesity and cardiovascular disease.

Table 2
Physical activity guidelines for children, adults and older adults.

	Children and adolescents (aged 6–17)	Adults (aged 18–64)	Older adults (aged 65 and older)
US guidelines (US Department of Health and Human Services, 2008)	60 min or more of physical activity every day. Most of the 1 h or more a day should be either moderate- or vigorous-intensity aerobic physical activity. As part of their daily physical activity, children and adolescents should do vigorous-intensity activity on at least 3 days per week. They also should do muscle-strengthening and bone-strengthening activity on at least 3 days per week	Adults should do at least 150 min a week of moderate-intensity, or 75 min a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity. Aerobic activity should be performed in episodes of at least 10 min, preferably spread throughout the week. Additional health benefits are provided by increasing to 300 min a week of moderate-intensity aerobic physical activity, or 2 h and 30 min a week of vigorous-intensity physical activity, or an equivalent combination of both. Adults should also do muscle-strengthening activities that involve all major muscle groups performed on 2 or more days per week.	Older adults should follow the adult guidelines. If this is not possible due to limiting chronic conditions, older adults should be as physically active as their abilities allow. They should avoid inactivity. Older adults should do exercises that maintain or improve balance if they are at risk of falling.
Australian guidelines (Australian Government Department of Health and Ageing, 2005)	Children aged 5–12 A combination of moderate and vigorous activities for at least 60 min a day is recommended. Children shouldn't spend more than 2 h a day using electronic media for entertainment (eg computer games, TV, internet), particularly during daylight hours. Children aged 12–18 At least 60 min of physical activity every day is recommended. This can built up throughout the day with a variety of activities. Physical activity should be done at moderate to vigorous-intensity. For additional health benefits, include 20 min or more of vigorous activity at least three to four days a week.	At least 30 min of moderate-intensity physical activity on most, preferably all, day. Accumulate 30 min (or more) throughout the day by combining a few shorter sessions of activity of around 10–15 min each. If you can, also enjoy some regular, vigorous activity for extra health and fitness	Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities. Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility. Older people should accumulate at least 30 min of moderate-intensity physical activity on most, preferably all, days. Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up to the recommended amount, type and frequency of activity. Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.
Canadian guidelines (Kesaniemi et al., 2010)	At least 1 h and up to several hours of at least moderate-intensity PA (Physical Activity) on a daily basis to achieve most of the health benefits associated with PA (evidence: level 3, grade A). Some health benefits can be achieved through 30 min/day of moderate-intensity PA, and this should be used as a "stepping stone" for currently sedentary children (evidence: level 2, grade A). Vigorous-intensity activities should be incorporated or added when possible, including activities that strengthen muscle and bone (evidence: level 3, grade B). Aerobic activities should make up the majority of the daily PA. Muscle- and bone-strengthening activities should be incorporated on at least 3 days of the week (evidence: level 2, grade A). Although not reviewed, it is likely that reducing sedentary behaviour is important for health. The Canadian Paediatric Society recommends a maximum of 2 h/day of television-viewing time. We endorse that recommendation.	Accumulate 150 min/week of moderate-intensity PA or 90 min/week of vigorous-intensity PA in periods of at least 10 min each. Greater amounts of activity and more vigorous activity provide additional benefits (evidence: level 2, grade A). Engage in resistance activities on 2–4 days/week (evidence: level 2, grade A). Engage in flexibility activities on 4–7 days/week (evidence: level 3, grade A).	Older adults should participate in moderate-intensity aerobic activity for a total of 150 min/week, or in vigorous-intensity activity for a total of 90 min/week. Moderate- and vigorous-intensity activities are defined as approximately 50% and 60–70% of maximal aerobic capacity, respectively. For many older adults, walking at 3.0–3.5 mph is a good example of moderate-intensity activity. The dose of PA described here is *in addition* to the routine and light-intensity activities of daily living, and can be expected to reduce the risk of several chronic diseases and premature death by 20–30%. Regular PA is also important for maintaining a healthy body weight. The PA recommendation presented here will be sufficient for many people to prevent weight gain, while others may need to engage in more PA to achieve this benefit. Obviously, caloric intake also must be considered as a tool for managing body weight. Higher doses of PA, and more vigorous-intensity activity provide additional health benefits. The weekly dose of PA may be accumulated in sessions of at least 10 min of moderate-intensity activity (evidence: level 2, grade A). In addition to the aerobic PA recommendation, older adults should also engage in resistance exercises on 2 days/week. Resistance exercise should involve the major muscle groups of the body, and should consist of 8–12 repetitions at >60% of 1 repetition maximum (RM). Daily activities that involve lifting, carrying, and pushing tasks should be maintained because they can also benefit muscular and bone health (evidence: level 2, grade A). Good balance helps prevent falls, and older adults should participate in activities that improve and maintain balance. Such activities include dancing, walking on uneven surfaces such as a field or in a forest, and various exercises such as standing on one leg. Stretching exercises should be done regularly to maintain good flexibility. Inflexibility can interfere with routine daily tasks and in participation in leisure time PA (evidence: level 2, grade A).

cardiorespiratory fitness are beneficial for cognitive function in healthy older adults, with effects observed for motor function, cognitive speed, auditory and visual attention (Angevaren et al., 2008) and that aerobic fitness reduces brain tissue loss in ageing adults (Colcombe et al., 2003). Individuals with higher levels of physical activity are less likely to develop depressive illness than those with lower levels. Moreover, in those with mild-to-moderate depression and anxiety, prescribed physical activity is associated with an improvement in such symptoms (Strohle, 2009).

Although the beneficial effect of exercise is "dose related," increasing in proportion to the duration and amount of energy expended, even a modest increase in the level of moderate physical activity (3–6 METS), such as 30 min at least 5 days per week, has been found to reduce risk for cardiovascular events and all-cause mortality (Washburn et al., 2002). For sedentary and overweight people, evidence is emerging that "even a little is more" and half the recommended amount of activity can still produce health benefits (Church et al., 2007).

Current physical activity guidelines (see Table 2) recommend at least 30 min/day of moderate-intensity (3–6 METs) exercise or 75–90 min/week vigorous-intensity (>6 METs) exercise. At moderate-intensity exercise a person can still talk but no longer sing, and at vigorous-intensity talking is no longer possible. Vigorous-intensity exercise will contribute to $VO_{2max.}$ The Canadian guidelines have recently been updated and contain the most rigorous evidence (Kesaniemi et al., 2010) of all physical activity guidelines.

7. Exercise therapy

Lack of physical activity may cause deconditioning with loss of functional capacity, thus further limiting an individual's ability to perform physical activities, eventually resulting in disability and dependence. Inactivity is associated with an increased risk of a number of chronic conditions that place the individual's health further at risk. Exercise therapy may break this vicious cycle of inactivity, deconditioning, further inactivity and potential (multi)-morbidity.

One of the major questions in health research is whether it is physical activity or physical fitness that is more important in determining health outcomes. So far, there seems to be a stronger dose–response gradient for physical fitness, but the explanation may be that physical fitness is measured objectively while physical activity is usually assessed by self-report, which inevitably leads to misclassification (Blair et al., 2001).

Our knowledge of the impact of exercise in the treatment of a number of diseases has grown considerably over the past decades. Today, exercise therapy is indicated in the treatment of a large number of medical disorders.

There is a high level of evidence that therapeutic exercise is beneficial for patients across broad areas of physiotherapy practice, including people with conditions such as multiple sclerosis, osteoarthritis of the knee, chronic low back pain, coronary heart disease, chronic heart failure, chronic obstructive pulmonary disease, cystic fibrosis, chronic and intermittent claudication. Furthermore, there are indications that exercise therapy is effective in reducing symptoms, increasing physical fitness and physical and social functioning for patients with ankylosing spondylitis, hip osteoarthritis, Parkinson's disease, and for patients who have suffered a stroke (Kujala, 2004, 2009; Pedersen and Saltin, 2006; Smidt et al., 2005; Taylor et al., 2007). Therapeutic exercise is more likely to be effective if it is relatively intense and there are indications that more targeted and individualized exercise programs might be more beneficial than standardized programs (Taylor et al., 2007). Aerobic capacity and muscle strength can be improved by exercise training among patients with different diseases without having detrimental effects on disease progression (Kujala, 2004, 2009). The finding that aerobic exercise training consistently increases physical performance capacity and maximal oxygen uptake in patients with chronic diseases (Kujala, 2009) is important, as aerobic capacity is inversely related to the clustering of CVD risk factors associated with the metabolic syndrome (Sassen et al., 2009). There is strong evidence of the positive effect of exercise therapy on the pathogenesis, symptoms, physical fitness and quality of life in patients with insulin resistance, hypertension, obesity and dyslipidemia (Pedersen and Saltin, 2006). Few adverse events are reported for exercise therapy (Kujala, 2009; Taylor et al., 2007). In many areas of practice, however, there was no evidence that one type of exercise was more beneficial than another, indicating a clear need for scientifically sound preventive and rehabilitative exercise programs with clear parameters for frequency, intensity, duration and type of exercise therapy. These exercise programs should be designed, supervised and conducted by qualified personnel, such as physiotherapists (See Case Study, submitted as Appendix).

8. Conclusion

The optimal evaluation and treatment of many conditions continues to require particular attention and many questions remain unanswered regarding physical activity patterns in people with impaired health and their adherence to exercise therapy. Given the health benefits of physical activity, we should routinely measure our patients' physical activity levels in our clinical practice and set goals that include meeting the daily recommended amount of physical activity (or more). We need to educate our patients on the health benefits of exercise and the dangers of sitting too much. Pedometers may be helpful to patients to achieve their daily goals. It has been shown that the use of a pedometer is associated with significant increases in physical activity and significant decreases in body mass index and blood pressure (Bravata et al., 2007). An important predictor of increased physical activity was having a step goal such as 10,000 steps per day. For many patients, this is a good start. A next step could be to pick up the pace (walk faster). Tailored individual care is advocated. Individual and disease-related risk profiles should be developed and studied to predict which patient with what disease benefits from which customized program. We have an important role to play in the prevention of chronic diseases. As experts in movement and exercise, we may be the ideal professionals to promote, guide, prescribe and manage exercise activities that enable people living with chronic conditions or inactivity related disease to maintain or improve their level of physical activity.

Supplementary data

Supplementary data associated with this article can be found in the online version at 10.1016/j.math.2011.01.006.

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