Physical activity

Recommended minimum physical activity in addition to normal active living		
	Minutes per week	*Intensity*
Adults	150 or	Moderate*
	75	Vigorous
	Minutes per day	
Children and adolescents	60	Moderate to vigorous
All	Reduce and minimise periods of sedentary behaviour	

* Somewhat less if the intensity of the activity also is vigorous

Introduction

There is paucity of data allowing a direct comparison of population levels of past and present levels of energy expenditure and physical activity. Furthermore, differences in definitions of physical activity across studies usually preclude meta analyses of existing data. However, the impression that our habitual physical activity level has gradually decreased is supported by studies showing that both average weight and the percentage of women and men in the Nordic countries who are overweight/obese have increased over recent decades [1-4], while results from nutritional surveys imply that the energy intake in the adult population remained relatively stable from the mid-1970s until 1997 [5, 6]. However, many nutritional studies are affected by under-reporting of energy dense food high in fat and sugar. Furthermore, Church et al estimated that daily occupational-related energy expenditure had decreased more than 100 kcal (420 kJ) over the last 50 years, which can account for a significant proportion of the concurrent weight gain [7]. This trend is likely due to structural changes in society, which may have resulted in a decrease in overall physical activity in daily life. As a result, large segments of the population can be characterized as physically inactive. Indeed, objective measurement of physical activity in both Sweden and Norway show that adults and older people spend the vast majority of their time being physically inactive, and that adherence to physical activity recommendations is low [8]. However, trend data from high income countries indicate that leisure time physical activity has increased among adults while occupational physical activity has decreased [9].

The knowledge about physical activity/physical inactivity and its associations with health outcomes has increased considerably during the past decades. Epidemiologic research, clinical interventions and mechanistic studies have contributed to the evidence that physical activity is essential to improve health, prevent disease as well as quality of life. The reference list in this chapter includes some key references and do not intend to cover all literature.

Box 1. Definitions

Physical activity is a comprehensive concept that encompasses many terms related to movement of the body. It is defined as any bodily movement achieved by contraction of skeletal muscles that increases energy expenditure (EE) above resting levels [10].

Physical inactivity may be defined as those who do not meet the current? recommendations.

Sedentary behaviour refers to any waking activity characterized by an energy expenditure ≤ 1.5 metabolic equivalents and a sitting or reclining posture [11] In general this means that any time a person is sitting or lying down, they are engaging in sedentary behavior. Common sedentary behaviors include TV viewing, video game playing, computer use (collective termed “screen time”), driving automobiles, and reading.

Exercise is planned, structured, and repetitive bodily movement carried out to improve or maintain one or more components of physical fitness.

Physical fitness is a set of attributes related to the ability to perform physical activity that people have or achieve [12]. The term includes cardiorespiratory fitness, strength, coordination, flexibility etc.

Cardiorespiratory fitness relates to the ability of the circulatory and respiratory systems to supply and utilize oxygen during sustained physical activity [12]. *MET* (metabolic equivalent) is a unit used to estimate the metabolic cost (oxygen consumption) of physical activity. One MET equals the resting metabolic rate which corresponds to approximately 3.5 ml O_2/kg/min.

Light activity is defined as activity corresponding to an EE below 3 METs, such as standing or walking slowly (< 3.5 km/h).

Moderate physical activity is defined as activity that requires three to six times as much energy as the energy needed in a resting state.

Vigorous physical activity is activity requiring more than 6 METs [8, 12]. *Resistance training* is exercise designed to increase strength and power.

Endurance training is repetitive, dynamic use of large muscles (e.g. swimming, walking, bicycling).

Physical activity in the prevention of various diseases

The effect of physical inactivity on the global burden of major communicable diseases has been quantified [13]. According to conservative assumptions physical inactivity causes 9% of premature mortality and more than 5 million deaths a year worldwide. The risk of being inactive is then similar to established risk factors like smoking and obesity[13]**.**

Cardiovascular disease, metabolic syndrome and type 2 diabetes

Several studies show an inverse relationship between physical activity [14-19] or physical fitness [20-23] and coronary heart disease (CHD) in both genders and different age groups. People who are sedentary run twice as great a risk of developing CHD as those who are physically active [24]. This is probably an underestimation due to dilution of relative risk [25]. A study from Norway [26, 27] observed that women and men below the median peak oxygen uptake (<35.1 mL/kg/min and <44.2 mL/kg/min, respectively) were five and eight times more likely to have a cluster of cardiovascular risk factors compared to those in the highest quartile of peak oxygen uptake (≥40.8 and ≥50.5 mL/kg/min in women and men, respectively). Each 5 mL/kg/min lower peak oxygen uptake corresponded to ~56% higher odds of cardiovascular risk factor clustering. Physical fitness is also related to a genetic profile that could prevent CVD without exercise.

A study by Stensvold and colleagues [28] showed that individuals with the metabolic syndrome (a clustering of risk factors for cardiovascular disease) was associated with increased risk of premature mortality from cardiovascular causes (hazard ratio 1.78, CI 1.39-2.29) compared with that observed in healthy counterparts. Additionally, those with metabolic syndrome that reported to be highly active had about 50% risk reduction compared to inactive individuals with metabolic syndrome. The study also showed that compared to inactivity even low levels of physical activity were associated with reduced cardiovascular mortality.

There is sufficient evidence to clearly establish a dose-response association between physical activity/fitness and CHD morbidity and mortality [29, 30]. Paffenbarger et al demonstrated that those who had an extra energy expenditure of approximately 500-1000 kcal per week had a 22 % lower mortality compared to a group who were sedentary [31]. Leon et al. showed that people who were regularly physically active for 30 minutes a day during their leisure time, corresponding to an energy expenditure of 150 kcal (630 kJ), had a 36 % lower risk of dying from CHD adjusted for other important CHD risk factors [17]. One study observed that a weekly energy expenditure of 2000 kcal may represent a threshold, at least for risk of heart attack in males [32]. Interestingly, Lee et al. [33] showed that apparently healthy elderly men who exercised one to two times per week (so-called weekend warriors), had a ~60% lower risk of all-cause mortality compared with sedentary, apparently healthy men. In addition, a dose-dependent association has been indicated, suggesting an additional benefit among those who attain an even higher activity level [29]. In a Norwegian study [34] it was observed that a single weekly bout of exercise of high intensity reduced the risk of cardiovascular death, both in men (~40%) and women (~50%), compared with those who reported no activity. In contrast to studies of male college alumni, in which mortality from ischaemic heart disease was gradually reduced with increasing energy expenditure from 500 to 3500 kcal per week [35], no additional benefits associated with as many as four high-intensity sessions per week compared with a single weekly bout were observed[34].

Some studies have suggested that physical activity and cardiovascular fitness have independent effects on overall mortality [36, 37], but the associations may appear somewhat complex. On one side, Lee et al [38] recently observed that the preventive effect of following the guidelines for physical activity was completely attenuated when adjusting for fitness, meaning that the protective effect was confounded by high or low fitness. In contrast, Hein and colleagues observed that among inactive men who were highly fit, the mortality rates from ischemic heart disease were similar to those who were inactive and unfit, while unfit but active men were protected in comparison to those that were inactive and unfit [20]. Further studies are needed to examine the combined effects of activity and fitness on morbidity and mortality and whether fitness modifies the association between activity and mortality, but the scientific evidence is consistent that being physical active induces protection against all-cause and cardiovascular disease regardless of fitness level.

Physical activity/physical fitness and metabolic risk factors

Regular physical activity and high levels of physical fitness is favourably associated with plasma lipids (triglycerides, HDL- and LDL-cholesterol) [39 40] blood pressure [41], insulin sensitivity [42] haemostasis/fibrinolysis [39, 43], and endothelial function [44]. Increased physical activity has the potential to influence all these factors in a favourable direction at the same time. The effect 'size' and the amount of physical activity needed to improve these factors are not fully outlined. However, data with respect to plasma lipids, blood pressure and insulin sensitivity are available.

The average expected changes in lipids and lipoproteins following exercise are: An increase in HDL cholesterol of 4.6 %, a reduction in LDL-cholesterol of 3.7 % and in triglycerides of 5 % [45]. There is also evidence of a beneficial effect on LDL sub-classes [40]. The baseline levels of these metabolic risk markers strongly influence the effect of physical activity in that greater beneficial effects are seen in those with poor lipoprotein profile. The improvements are probably more related to the amount of activity and not to the intensity or improvement in cardiorespiratory fitness [40].

A meta-analysis of randomised controlled trials has indicated that the effect of exercise on systolic/diastolic blood pressure reduction is on average 3/2 mm Hg in normotensive and 8/6 mmHg in hypertensive groups [41]. Moderate physical activity on three to five occasions per week with duration of 30-60 minutes seems to be effective in blood pressure reduction. There is strong scientific evidence that regular physical activity has a beneficial effect on insulin sensitivity [42, 46]. Prospective studies have shown that regular physical activity brings about a linear decrease in the age-adjusted risk of developing type 2 diabetes [47-49]. Importantly, the protective effect is also independent of general and central adiposity [50]. The decrease is in the magnitude of 6 % for each 500 kcal expended by physical activity in weekly leisure time [49]. It appears that those who are at greatest risk of developing type 2 diabetes benefit the most from regular physical activity [48].

Overweight and obesity

Physical activity has profound effects on body composition and metabolism. It increases EE and helps to maintain and increase muscle mass, which may result in an increased basal metabolism and an increased capacity for mobilising and burning fat both while using the muscles and in a resting state [54, 55]. Thus, regular physical activity is likely to be of importance in long-term regulation of body weight. However, there is limited evidence of a prospective association between physical activity and later body weight and the association may be bi-directional. Regular physical activity is important for obese people, as health benefits can be achieved through improved physical fitness, regardless of weight loss [56]. The mortality and morbidity related to overweight are substantially reduced in people who, despite being overweight, are physically fit [30, 57, 58]. However, in a systematic review by Fogelholm it was concluded that having high BMI even with high physical activity was a greater risk for the incidence of type 2 diabetes and the prevalence of cardiovascular and diabetes risk factors, compared with normal BMI with low physical activity [57]. Only in short-term studies (16 weeks or shorter duration) is it possible to find evidence of a linear dose-response relationship between the volume of physical activity and the amount of weight loss when diet is controlled. The amount of weight loss is consistent with the excess energy expended [59]. In practice, a weight loss of around 3 kg , however with large individual variations, might be expected following increased physical activity in obese persons [60]. Even though there is a lack of conclusive data, it seems that the amount of activity needed to avoid weight gain is about 60 minutes of moderate intensity or somewhat less of vigorous intensity activity [61, 62].

Cancer

Physical activity is an essential modifiable lifestyle risk factor that has the potential to reduce the risk of major cancers forms [13, 63]. The risk reduction for active individuals, though dependent on the intensity and duration, is 10-70% for colon cancer [64]. With respect to breast cancer regular physical activity corresponding to an intensity of 6 METs and with a duration of four hours per week may reduce the risk by 30-50% [65, 66]. Physical activity may also prevent the development of endometrial cancer [65-67]. The evidence is weaker for lung and prostate cancers and generally either null or insufficient for all remaining cancers [66, 67]

There are several possible biological mechanisms by which physical activity may prevent cancer. They include among others the effect of physical activity on body composition and energy metabolism, insulin resistance, sex steroid hormones, inflammation and immune function. In a review by Fridenreich and coworkers it is stated that between 9% and 19% of cancer cases in Europe could be attributed to lack of sufficient physical activity[67]. They also state that public health recommendations for physical activity and cancer prevention generally suggest 30–60 min of moderate or vigorous-intensity activity done at least 5 days per week. Recently, several observational studies as well as some randomised clinical trials have observed that physical activity may improve survival for breast and colon cancer. However, existing knowledge regarding effects on site-specific cancer survival is not yet clarified.

Musculo-skeletal disorders

Reversible risk factors for falls include lower limb? muscle strength, poor balance and a poor level of overall physical fitness, all which can be improved by regular physical activity. [68]-[69-71]. Muscle strength and muscle endurance diminish with increasing age and decreasing activity level [72]. Physical activity can counter and reverse this trend to a substantial degree and keep older people independent in daily life longer [69, 73].

Loss of calcium may lead to osteoporosis. This risk increases with age, particularly in post-menopausal women. Physical activity contributes to increased bone density and can thus counteract osteoporosis. Physical activity immediately before and during puberty seems to yields greater maximum bone density in adult life [74-77]. For adults and the elderly, physical activity retards bone loss [78]. To be beneficial for bone mass and structure, exercise should preferably be weight-bearing [79]. Repeated weight-bearing loading, such as walking and running, is more beneficial than e.g. swimming and cycling. Even better for bone health are activities with high- and odd impacts (e.g. tennis, squash, aerobics) or high volume loading (weight training). However, there is a lack of information about the dose-response relationship between activity/exercise and osteoporosis [79].

Strengthening exercises – targeting the muscles that stabilize the back – reduce the incidence of back problems, particularly in people with a history of back problems, but also to a certain degree among those who have not previously experienced such problems [80]. Regular physical activity may have a preventive effect on low back pain, although the type of the activity has yet to be determined [79].

Mental health and quality of life

A positive association is found between physical activity habits and self-esteem and psychological well-being in children and young and middle-aged adults [12]. Furthermore, observational studies have shown that those who are physically inactive are at greater risk of developing depression than those who are physically active [81, 82]. However there is no dose-response relationship between physical activity and depression and anxiety [83]. There is evidence supporting the hypothesis that physical activity is likely to prevent the development of vascular dementia [84]. Further research is needed to study the volume and mode of physical activity that is most psychologically beneficial and to explore the mechanisms by which physical activity improves mental health.

Sedentary behavior

During the last years knowledge regarding the importance of reduced sitting and maintaining non- exercise daily activities has grown. Several cross sectional, as well as prospective studies have demonstrated a relationship between sedentary behaviors especially during leisure time and obesity [84, 85] . Recently, prospective studies have also demonstrated a dose-response relationship between TV viewing and cardiovascular mortality, as well as total mortality [86]. Although residual confounding by unmeasured or poorly measured confounders (e.g. unconscious or poorly reported diet intake while viewing TV) cannot be excluded, these studies suggest the association may be independent of physical activity level and exercise habits [85]. Even in individuals fulfilling the recommendations for physical activity (which recommendations?) sitting for prolonged periods can compromise metabolic health [84].

The underlying mechanisms are yet not fully known but substantially decreased lipoprotein lipase activity as well as an instantaneously insulin resistant state during sitting may contribute [84]. Of importance is also the fact that the energy expenditure differs substantially when comparing sitting still with standing, walking or light indoor activity [87]. A study from Australia showed the frequency of breaks during prolonged sitting is associated with a favorable metabolic profile [88]. Reducing sedentary time should be considered as an additional strategy in combination with physical activity promotion for public health. Recommendations regarding reduced sedentary time are now being incorporated with those on physical activity in various countries for instance UK (http://www.dh.gov.uk/en/MediaCentre/Pressreleases/DH_128211).

Recommendations on physical activity

There is strong evidence that vigorous physical activity sufficient to improve cardio-respiratory fitness has a major impact on different health outcomes at all ages [12]. As a matter of fact, previous recommendations on physical activity were equal to the quantity and quality of exercise sufficient to develop and maintain cardiorespiratory fitness. However as previously described in this chapter, clinical and epidemiological studies have established that activity of a moderate intensity, without improvements in cardiorespiratory fitness, also provide favourable effects on several risk factors for CHD and type 2 diabetes [12, 89]. Therefore it is important to point out that substantial health gains can be achieved through moderate physical activity. Nevertheless, evidence from large population based studies in healthy individuals [34 90] demonstrate that physical activity with high intensity gives more robust risk reduction compared to that achieved by physical activity at low- and moderate intensity. These observations are in line with the cardiovascular adaptations observed after endurance training with high intensity compared to that obtained after low- to moderate intensity in small-scale randomized studies [91]. Interestingly, Stanaway et al followed 1705 men aged 70 or more for a mean of 59.3 months and observed that men who normally preferred to walk faster than 3 km/h were 23% less likely to die compared with those walking at a slower speed during the follow-up period [92].

Examples of energy requirements corresponding to 3-6 METs (moderate activity) and > 6 METs (vigorous activity) are given in Table 10.1. Cardiorespiratory fitness decreases as people age and also as a consequence of physical inactivity. Activity of a certain MET value therefore requires a greater percentage of a person's cardiorespiratory fitness (Table 10.1) as he or she ages. Note that activity of a certain energy cost may be perceived differently by different groups. For instance climbing stairs may be perceived as light activity for a 30-year-old but hard for a 70-year-old.

Table x.1. Energy requirements for performing various activities in different age groups shown as METs and as percentages of cardio-respiratory fitness (≈ maximal oxygen uptake)

Activities / Age in years	Energy cost in METs	Energy requirements as percentages of cardio-respiratory fitness (≈ maximal oxygen uptake) and corresponding rating of perceived exertion (Borg scale) raised and in bold. Young 20-39	Middle-aged 40-59	Old 60-79	Very old 80+
Watching TV/reading	1.3	10 **[<10]**	13 **[<10]**	15 **[<10]**	18 **[<10]**
Light household	2.5	20 **[<10]**	25 **[10-11]**	29 **[10-11]**	35 **[10-11]**
Driving car	1.5	12 **[<10]**	15 **[<10]**	18 **[<10]**	21 **[<10]**
Moderate physical activity					
Playing with small children	3.5	27 **[10-11]**	35 **[10-11]**	41 **[10-11]**	49 **[12-13]**
Climbing stairs	5.5	42 **[10-11]**	55 **[12-13]**	64 **[14-16]**	77 **[14-16]**
Walking (4.8 km/h)	3.5	27 **[10-11]**	35 **[10-11]**	41 **[10-11]**	49 **[12-13]**
Walking (6.4 km/h)	4.0	31 **[10-11]**	40 **[10-11]**	46 **[12-13]**	56 **[12-13]**
Snow clearing (snow blower)	3.0	23 **[<10]**	30 **[10-11]**	35 **[10-11]**	42 **[10-11]**
Snow clearing (manual)	6.0	47 **[12-13]**	60 **[14-16]**	70 **[14-16]**	84 **[14-16]**
Lawn mowing (manual)	4.5	35 **[10-11]**	45 **[12-13]**	53 **[12-13]**	63 **[14-16]**
Vigorous					
Lifting or carrying 11-20 kg	8.0	62 **[14-16]**	80 **[14-16]**	93 **[17-19]**	>100 **[20]**
Jogging 8.0 km/h	7.0	55 **[12-13]**	80 **[14-16]**	93 **[17-19]**	>100 **[20]**

* Activity of a certain energy cost may be perceived differently by people both as a function of age and physical inactivity. For instance climbing stairs may be perceived as light activity for a 30-year-old and hard for a 70-year-old. Rating of perceived exertion (Borg scale)[66]: Very light < 10; Light 10-11; Somewhat hard 12-13; Hard 14-16; Very hard; 17-19; Very, very hard 20.

The total amount of physical activity (a combination of intensity, duration and frequency) is related to a number of health variables in a dose-response relationship. The preventive effect (the health gain) increases with increasing activity level, but the relationship is not linear (Figure 10.1). Those who are physically inactive may achieve the greatest health gains. This applies even in old age [12, 16, 93]. The health gain seems to be dependent on the amount of physical activity, but the intensity of the aerobic physical activity may compensate for duration or frequency, and gives further health benefits than moderate intensity alone as described above. Another aspect is whether several short bouts of activity are as effective in influencing health outcome as one longer session of the same total duration [94]. Although aerobic physical activity is the type primarily recommended, some data also indicate that weight training may have a protective effect on the incidence of coronary heart disease [95].
The question of how much physical activity is needed to improve health is not straightforward, and depends on the group of interest: the young, older people, overweight individuals, initial health status etc. It is important, however, to keep in mind that physical activity may have different dose-response relationships with different health outcomes and these associations may also be dependent on the type of activity.

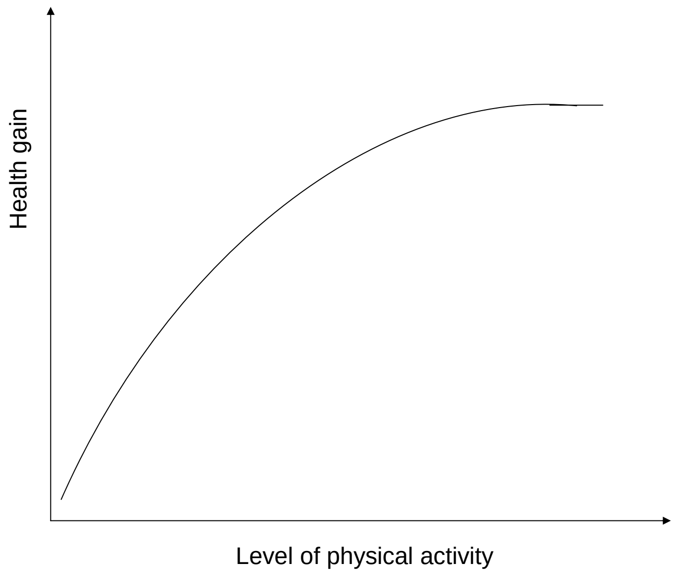

Figure x.1. Dose-response curve for physical activity and health [96]. Different health outcomes probably have different dose-response relationships.

Children and adolescents

Regular physical activity is necessary for normal growth and the development of cardio-respiratory endurance, muscle strength, flexibility, motor skills and agility [97-101]. In addition, physical activity during the formative years strengthens the bones and connective tissues and yields greater maximum bone density in adult life [97, 102, 103]. Exercise that give a high impact loading on bones is important for bone development, particularly during early puberty [104]. There is also evidence of an association between cardiorespiratory fitness and physical activity with cardiovascular disease risk factors in children and adolescents [27, 64, 105]. Furthermore, risk factors such as fatness, insulin: glucose ratio and lipids cluster in children and adolescents with low cardiorespiratory fitness and low level of physical activity [27, 64, 105].

Regular physical activity is associated with well-being and seems to promote self-esteem in children and adolescents. Furthermore, children and adolescents who are involved in physical activity seem to experience fewer mental health problems [106-109]. There is no indication that increased physical activity in school represents any risk of impairing children’s cognitive skills as a result of less time for theoretical school subjects [110]. However, fitness level in young adults is associated with better cognitive function, higher future educational level [111].

There is convincing evidence about the health effects of regular physical activity in children and adolescents [112]. Recent literature reviews has prompted WHO and the U.S. Health Authorities to refine their recommendations of physical activity guidelines for children [113-116]. The following is recommended for children and adolescents:

1. Children and adolescents should accumulate at least 60 minutes of moderate to vigorous-intensity physical activity daily.

2. Physical activity of amounts greater than 60 minutes daily will provide additional health benefits.

3. Most of daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.

4. Reduce and minimise periods of sedentary behaviour

Activities should be as diverse as possible in order to provide optimal opportunities for developing all aspects of physical fitness including cardiorespiratory fitness, muscle strength, flexibility, speed, mobility, reaction time and coordination. Varied physical activity provides opportunities to develop both fine-motor and gross-motor skills. Active children get the exercise they need while playing in the neighborhood, at day-care, or on the school playground and by participating in children's sports.

In NNR 2012 recommendations for children and adolescents are identical to those of WHO and others. WHO also specifically? recommend inactive children and youth, a progressive increase in activity to eventually achieve the recommendations mentioned above. Also, WHO states that the recommended levels of physical activity for children and adolescents should be achieved above and beyond the physical activity accumulated in the course of normal daily non-recreational activity.

Adults

Through an overall evaluation of the previous literature review and comments, the evidence suggest that adults who are physically inactive gain considerable health benefits from participating in moderate to vigorous physical activity about 30 min per day. The optimal health effects are likely expected from the combination of two modalities; that is 2-3 hours of vigorous exercise per week and daily moderate physical activity (see Figure xx.2). The recommendations on physical activity for adults are*:

1. Adults should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity preferably spread out on most days during the week.

2. Aerobic activity should be performed in bouts of at least 10 minutes duration.

3. For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity 4. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week.

5. Reduce and minimise periods of sedentary behaviour.

* In line but not entirely with WHO/UK/Canada

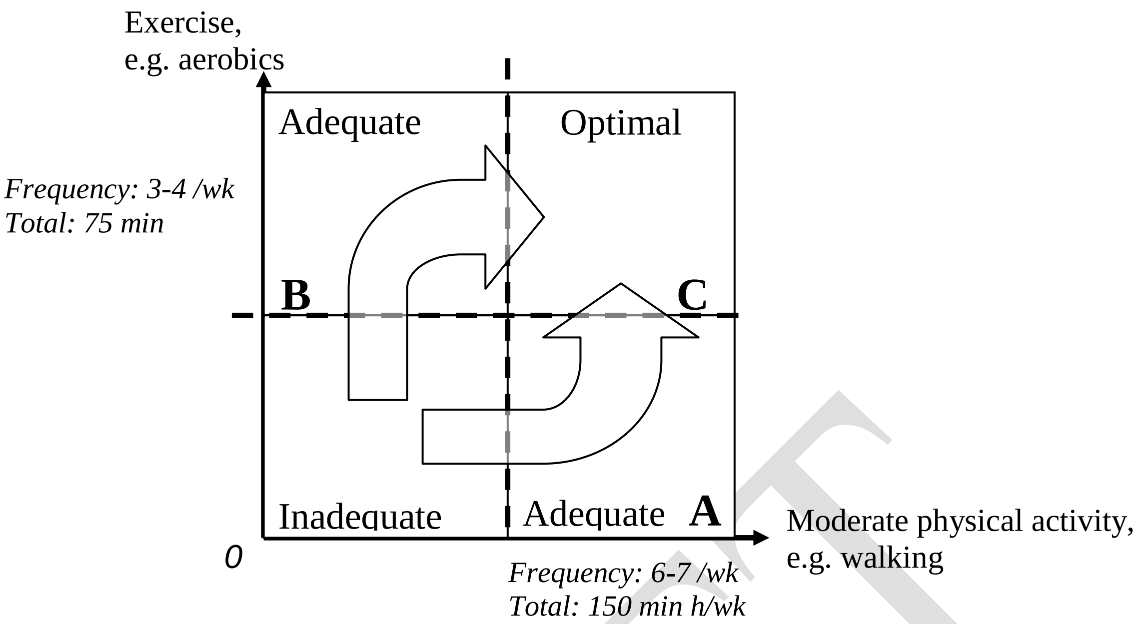

Figure x.2. Two modalities of physical activity adequate to give health benefits:

A) Physical activity of moderate intensity, for instance walking, household work and playing with a frequency of 6-7 times per week and a minimum of 150 min a week;

B) Exercise of moderate to vigorous intensity, for instance jogging, swimming, tennis, resistance training, circuit training, and cross-country skiing with a frequency of 3-4 times a week and a total of 75 min a week.

C) The *optimal* activity dose may be the combination of a) and b) (both moderate physical activity and moderate to vigorous exercise).

Elderly

Regular physical activity in elderly people is associated with improved strength and functional ability [117] and inversely related to mortality [118], and was strongly associated with maintaining mobility during a 4-year follow up [119].

Endurance training in the elderly has been found to improve oxygen consumption (VO_2 max) by approximately 23% in a meta-analysis [120]. Hard endurance training results in improved VO_2 max, increased muscle mass, unchanged body weight and unchanged daily energy expenditure because of a compensatory decline in physical activity during the remainder of the day [121, 122] while moderate endurance training increases basal energy expenditure, daily energy expenditure and total energy intake [123].

Resistance training increases basal energy expenditure, muscle mass and muscle strength [93, 124], and daily energy expenditure in the elderly [125] and may counteract the age-related accumulation of fat [126]. Frequency of high-resistance training may be less than 3 times a week [127]. Low-intensity and moderate exercise may be beneficial in the institutionalised elderly [128] and effects of resistance training have been seen even in 85-97 year-old subjects [129].

In general, healthy elderly people are advised to use the recommendations for the adult population. This particularly applies to the advice to become more physically active in daily life.

The following recommendations apply:

- Elderly should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity, preferably spread out on most days during the week.
- Aerobic activity should be performed in bouts of at least 10 minutes duration.
- For additional health benefits, elderly should increase their moderate intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous intensity activity.
- Adults of this age group with poor mobility should perform balance exercises to enhance balance and prevent falls on 3 or more days per week.
- Muscle-strengthening activities should be done involving major muscle groups, on 2 or more days a week.

When adults of this age group are unable to participate in activity according to the recommended amounts of physical activity due to health conditions, they should be as physically active as their abilities and conditions allow. The intensity can be increased by climbing stairs or hills of increasing steepness, preferably on uneven terrain (which is an advantage for improving balance. Other forms of aerobic exercise which can be engaged in as an alternative to walking include swimming and other water activities, various types of dance, cycling, rowing, exercise bicycle or rowing ergometers, etc.

Since resistance training is particularly valuable in maintaining muscle strength, a varied, progressive programme of weight training is recommended for older people. Strengthening exercises should be tailored to the needs of the individual with regard to types of exercises, number of sets, repetitions and frequency of training sessions. Strengthening exercises should optimally be combined with aerobic, balance and mobility training.

Pregnancy and lactation

Pregnancy is associated with extensive physiological and anatomical changes. Despite this, regular physical activity or exercise has minimal risk and confirmed benefits for most women [130]. Women who are moderately physically active during pregnancy experience easier pregnancies and deliveries, have better self-esteem, gain less weight, have more normal deliveries and fewer perinatal complications than women who have not engaged in physical activity during their pregnancy [131-133]. Except for complicated pregnancies and a few circumstances in which exercise is contraindicated (see Artal & O'Toole [130] for details), the following recommendations apply:

- Women who have previously not been physically active should engage in moderate physical activity during pregnancy with a gradual progression of up to 150 minutes a week
- Women who are regular exercisers before pregnancy should continue to engage in physical activity at an appropriate level. They should be able to engage in high intensity exercise, such as jogging, swimming and aerobics.
- Training the muscles of the pelvic floor is particularly important during pregnancy and after giving birth.

- Activities with a high risk of falling (such as horseback riding, downhill skiing) and activities that include contact sports (such as handball, basketball, ice hockey) may increase the risk of trauma and should be considered undesirable. Scuba diving should be avoided throughout the pregnancy.

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