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National Recommendations for Physical Activity and Physical Activity Promotion



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Objectives of the recommendations

An active lifestyle improves the health of individuals of all ages. In addition to healthy people, adults with chronic diseases also benefit from the positive effects of regular physical activity. Together with the recommendations for physical activity promotion described in the second section, recommendations for physical activity are a significant component of a comprehensive strategy for increasing the physical activity of the population and safeguarding the health benefits that can be achieved through such physical activity.

Target groups for these recommendations

These recommendations for physical activity are aimed at:

- all groups of people for whom respective specific recommendations are issued: children and adolescents, adults and older adults as well as adults with chronic diseases
- all stakeholders involved with the topic of physical activity promotion in the areas of health promotion, prevention and rehabilitation as well as;
- all stakeholders who develop strategies for physical activity promotion and for avoiding long sitting times.

Definitions

Physical activity is defined as any bodily movement produced by skeletal muscles that requires substantial energy expenditure above and beyond resting energy expenditure (one metabolic equivalent = 1 MET). The classification presented in Figure 1 [cf. 19, 117] with the respective intensities (light, moderate, vigorous) shows energy expenditure when resting and during physical activity. The volume of physical activity can be stated in MET minutes or MET hours accordingly. Everyday

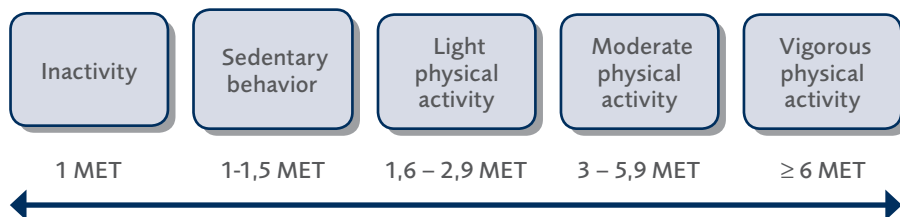


Figure 1. Energy expenditure in the unit of metabolic equivalents (MET) for various physical activity (PA) intensity levels.

activities up to 2.9 MET are also described as basic activity. Physical inactivity is used to describe a state where this basic activity is not accompanied by any moderate or vigorous physical activity.

Table 1 below includes explanations for important terms used.

Table 1: Terms to describe physical activity

Terms to describe physical activity	
Physical activity	Any bodily movement produced by skeletal muscles that requires increased energy expenditure above and beyond resting energy expenditure
Basic activity	Low-intensity physical activity (up to 2.9 MET) for performing everyday activities (household chores, standing, walking slowly etc.)
Aerobic physical activity	Physical activity over periods of more than a few minutes that uses large muscle groups, ensuring they are adequately supplied with oxygen. Examples include walking, power walking, jogging, cycling, swimming and corresponding ball sports etc.
Recreational physical activity	Physical activity during recreational pursuits or sport

Physical activity as a means of transport	Physical activity such as walking or cycling in order to cover distances e.g. to school, work or to go shopping
Physical activity at home or at work	Physical activity when carrying out household tasks or work-related activities
Muscle-strengthening physical activity	Physical activity that creates higher muscle tension through weight loading, leading to a strengthening of the muscles, e.g. functional gymnastic exercises or moving loads
Sedentary behavior	Physical inactivity with long periods sitting at a workstation and/or during leisure time and energy expenditure of less than 1.5 MET
Physical activity duration	Duration of the physical activity in minutes
Unit of physical activity	A physical activity carried out over a certain period
Physical activity frequency	Frequency of a unit of physical activity per day or per week

Physical inactivity	A state where basic activity is not accompanied by any moderate or vigorous physical activity.
Physical activity volume	The entire volume of physical activity as a product of physical activity duration, intensity and frequency.
Terms to describe the intensity of physical activity	
Absolute intensity of physical activity	Effort measured in metabolic equivalents (MET, see Fig. 1) or in relation to the maximum heart rate or oxygen uptake capacity achievable .
Relative intensity of physical activity	Effort in relation to the physical capacity or perceived level of exertion during physical activity.
High-intensity physical activity	Physical activity perceived as tiring where it is no longer possible to speak continuously; breathing rate rises moderately to somewhat more sharply. Examples include: running, fast cycling or swimming.
Moderate-intensity physical activity	Physical activity perceived as somewhat tiring where it is still possible to speak but not to sing; breathing rate rises slightly to moderately. Examples include: power walking, jogging.
Low-intensity physical activity	Physical activity scarcely perceived as tiring and that requires 1.5 to 2.9 times resting energy expenditure (1.5 to 2.9 MET), see Basic activity.
Resting energy expenditure, metabolic equivalent	The energy consumed when physically resting is described over the equivalent quantity of approximately 3.5 ml of oxygen taken up per minute and kilo of body weight; metabolic equivalent (= 1 MET).

Methodology used in developing the physical activity recommendations

The recommendations for health-enhancing physical activity were developed in a three-phase process with recourse to existing high-quality international recommendations. The basic outline of the methodology is set out in Table 2.¹

The recommendations for health-enhancing physical activity were developed in a three-phase process with recourse to existing high-quality international recommendations. The basic outline of the methodology is set out in Table 2 .

In Phase 1, existing physical activity recommendations for each of the groups children and adolescents, adults, older adults, and adults with chronic diseases were researched systematically (Work step 1A in Table 2). At the same time, an assessment model with quality criteria was developed to assess the quality of existing physical activity recommendations (expert survey, Work step 1B).

An expert survey was carried out to create the quality criteria (Work step 1B). The resulting list of quality criteria was agreed upon and signed off by all of those involved in preparing the physical activity recommendations. This resulted in a total of 28 quality criteria for Domain A "Scope of application and purpose", B "Methodological precision of the development of the recommendation", C "Clear content and differentiation" and D "Structure".²

In Phase 2, the quality of the physical activity recommendations researched was assessed based on the quality criteria (2A). High-quality physical activity recommendations were identified for each target group as 'source recommendations' (2B).

¹ A detailed description of the methodology is contained in individual articles in a special edition of the medical journal "Das Gesundheitswesen"

² A detailed description is found in Geidl et al. in a special edition of the medical journal "Das Gesundheitswesen"

After assessment using the quality criteria, the source recommendations identified in Phase 1 were subject to a systematic content analysis (2C). This was used as a basis for preparing a content summary in relation to existing physical activity recommendations, reported health effects of physical activity, dose-response relationships and risk-benefit considerations. Furthermore it was used to formulate recommendations for health-enhancing physical activity for each target group (children and adolescents, adults, older adults and adults with chronic diseases). For the target group "Adults with chronic diseases", source recommendations for seven diseases were reviewed and a higher-level chapter "Generic physical activity recommendations for chronic diseases" was prepared.

Table 2. Methodology for preparing the National Physical Activity Recommendations

Phase 1	<ul style="list-style-type: none"> • 1A: Systematic literature review based on current physical activity recommendations for a) Children and adolescents, b) Adults and older adults as well as c) Individuals with chronic diseases • 1B: Development and implementation of an expert survey for the preparation of quality criteria
Phase 2	<ul style="list-style-type: none"> • 2A: Assessment of the physical activity recommendations researched using quality criteria • 2B: Selection of high-quality physical activity recommendations as source recommendations • 2C: Content analysis of the source recommendations
Phase 3	<ul style="list-style-type: none"> • 3A: Synthesis of the content analyses and derivation of the recommendations for health-enhancing physical activity (2C)

Physical activity recommendations for children and adolescents

Target group

The recommendations apply to children and adolescents, broken down into the respective age groups between birth and 18 years. The recommendations are based primarily on the following source recommendations: UK [85], USA [78] and Canadian recommendations [129, 132, 147], supplemented with information from current reviews [48, 57, 133] on the topic.

Recommendations

Infants and toddlers (0 to 3 years)

- Infants and toddlers should get as much physical activity as possible and be prevented as little as possible from following their natural instinct to move; a safe environment must be ensured

Pre-school children (4 to 6 years)

- For pre-school children, physical activity should amount to a total of 180 minutes/day and more, which can comprise instructed and non-instructed physical activity

Primary school children (6 to 11 years)

- Children of primary school age should be moderately-to-vigorously physically active for 90 minutes or more each day. 60 minutes of that time can be spent on everyday activities, e.g. at least 12,000 steps/day

Adolescents (12 to 18 years)

- Adolescents should be moderately-to-vigorously physically active for 90 minutes or more each day. 60 minutes of that time can be spent on everyday activities, e.g. at least 12,000 steps/day

Sitting and using screen media (TV, computer/tablet, smartphone etc.)

- Avoidable sitting times should be reduced to a minimum. In addition to (motorized) transport, e.g. in a baby carrier or child seat, or periods spent inside unnecessarily, this relates in particular to reducing consumption of screen media to a minimum:
 - Infants and toddlers: 0 minutes
 - Pre-school children: as little as possible, maximum of 30 minutes/day
 - Primary school children: as little as possible, maximum of 60 minutes/day
 - Adolescents: as little as possible, maximum of 120 minutes/day

Specific aspects

- For primary school aged children, the large muscle groups should be subject to higher-intensity loading on two to three days a week in order to improve strength and endurance, taking into account respective developmental stages
- Special aspects as well as interests, needs and possible barriers of the respective target group should be taken into consideration, e.g. age, gender, sociocultural factors
- Physically inactive children and adolescents should be introduced gradually to the target, e.g. initially 30 minutes of physical activity on one to two days per week. The duration is then increased first, after which the intensity is increased

Reasons for the recommendations

General health benefits of physical activity³

The role of physical activity and the reduction of sitting times for the healthy physical, psychosocial and intellectual development of children and adolescents is undisputed [47, 127]. Physical activity has positive effects on the cardiovascular and metabolic risk profile, motor abilities and skills, cognitive performance, musculoskeletal health and the prevalence of overweight/obesity. There is strong evidence to suggest a link between muscular fitness as a result of physical activity and the reduction of (central) obesity, cardiometabolic risk factors such as insulin resistance, blood pressure, bone health and feelings of self-esteem [116]; the greater the volume of physical activity, the larger the assumed health benefit. There are also indications that the extent of physical activity at pre-school age has a positive influence on time devoted to physical activity as an adult [124].

Based on the recommendations of the World Health Organization (WHO) [46], most recommendations across all age groups are for at least 60 minutes of moderate-to-vigorous physical activity per day. Such recommendations are generally accompanied by a reference to the fact that this is a minimum figure and that more physical activity also leads to greater health benefits.

For infants and toddlers, there is very little data available on possible links between physical activity and health. It mainly comes from the UK and North American working groups that have made specific recommendations [78, 85, 129 132]. For example, the guidelines state that infants should be restricted as little as possible in the time they spend physically active. Toddlers and pre-school children should have 180 minutes of physical activity per day – instructed and non-instructed. The Canadian recommendations for the 0-to-4 age group are based on a systematic review by Timmons et al. [127] on the following indicators: incidence of overweight and obesity, cardiovascular factors (including blood pressure, lipids, glucose and insulin as well as inflammation parameters), skeletal system, motor skill development, psychosocial health (self-concept, self-esteem, aggression, behavior etc.) and cognitive

³ The health effects and reasons for the physical activity recommendations reported here are based on the selected source recommendations (for the methodology, see Geidl et al., Füzeki et al., Pfeifer et al. in a special edition of the medical journal "Das Gesundheitswesen"). For other comprehensive current reviews, see e.g. Pedersen & Saltin 2016 [95]

development (including speech development). While the level of evidence ranged from low to high, overall it was shown that a higher extent of physical activity is linked to a lower prevalence of obesity, fewer cardiometabolic risk factors, better motor skills, superior bone health, favorable psychosocial adjustment and improved cognitive development. However, it is not yet possible to make unequivocal statements regarding the specific dose of physical activity, i.e. intensity, frequency and/or type of physical activity/sport. The consensus in all recommendations available to date for this age group is to offer as much physical activity as possible, not to limit the natural need for physical activity, and to raise the awareness of the parents or guardians in relation to the importance of physical activity [127, 129]. No risks or side effects from increased physical activity were described [127]. The environment should be safe for children accordingly.

The data available for the other age groups are much better, particularly from primary school age upwards. As a basis for the Canadian physical activity recommendations, Janssen and LeBlanc [55] assessed the health benefits of physical activity for schoolchildren: Nine studies dealt with the impact on cholesterol and blood lipids. In an observational study, it was demonstrated that less physically active 12 to 19-year old girls and boys have a 1.9 to 3.7-times higher risk of high cholesterol. The other experimental studies were focused on higher plasma lipid concentrations and/or obesity. The findings were inconsistent. Aerobic exercise led to an improvement, particularly in levels of triglycerides. The effects of strength exercise were minimal. Eleven studies dealt with the influence on blood pressure. However, the effects were low for aerobic exercise (1.39 mmHg reduction in systolic and 0.39 mmHg reduction in diastolic blood pressure) and not really possible to assess for strength exercise. The links to overweight and obesity were examined far more frequently. In 31 studies, the impact for aerobic exercise was -0.40 for percentage body fat and -0.07 for BMI, while for strength exercise the impact was -0.19 for percentage body fat. In studies on links to metabolic syndrome and fasting insulin levels, the impact was -0.60 for aerobic exercise and -0.31 for strength exercise. Positive findings were also reported for bone density, the incidence of injuries, depression and corresponding symptoms. Nevertheless a lot of questions remain unanswered here too, e.g. in terms of types of physical activity/sport, intensity, social and cultural prerequisites as well as adequate age and gender-based differentiation.

In a more recent review, the link was examined between muscular fitness as a result of physical activity and a reduction in (central) obesity, cardiometabolic risk factors such as insulin resistance, blood pressure, bone health as well as feelings of self-

esteem [116]. The greater the volume of physical activity, the larger the assumed health benefits. For Germany, the MOMO collective (MOMO: Motoric Module as a sub-group of the representative KiGGS cohort) showed a weekly period of physical activity of around 480 minutes on average for boys and around 400 minutes for girls (n=4401) [142]. This means that the target of more than 60 minutes per day spent on physical activity is met. Taking these national particularities into account, the expert consensus reached for Germany was for 90 minutes of physical activity for children of primary-school age and older [47, 48].

Benefits of the different types of physical activity and volume of physical activity

There are only a few studies on the benefits of physical activity as a means of transport. The German consensus statement recommends using physical activity as a means of getting to school [5, 48, 133].

The literature contains indications for translating the recommendation of 60 minutes of physical activity a day into roughly 11,500 steps/day [5], or – broken down by age and gender – between 10,000 and 12,000 steps/day for girls of primary school age and between 13,000 and 15,000 steps/day for boys of the same age as well as between 11,000 and 11,700 steps/day for older children and adolescents [133].

Various recommendations give indications on certain types of physical activity [85, 131]. These include playing on the floor for younger children and cycling for older children. However, there is no scientific evidence for the preference or superiority of individual types of physical activity or sport. The basic advice is to follow the child's natural tendencies and not to limit the time spent on physical activity, particular for younger toddlers and pre-school children. For older children, most recommendations discuss types of physical activity aimed at improving endurance and muscle strength [57]. They recommend adequately exercising the large muscle groups on three or more days per week in order to improve muscle strength, bone density and cardiorespiratory fitness.

Physical activity should be adapted to age and stage of development in order to avoid any injury to the growing organism and in particular to allow children and adolescents to enjoy physical activity [98]. For small children (aged under 3), there is an additional recommendation to create a safe environment. In a current review on inju-

ries during physical activity [79], between 0.2 and 0.3 medically treated incidents are reported per 1,000 hours of activity for the eight to twelve-year old age group. The absolute figure relating to unstructured recreational physical activity was higher than the absolute number of injuries reported in organized sports. On the whole, there is a lack of data differentiated by age. It was demonstrated that targeted exercise (especially of coordination and strength) can prevent sports injuries in adolescents [108].

As far as introducing inactive children and adolescents to physical activity is concerned, only the Irish recommendations provide for a gradual process [57, 146].

Sitting activities in leisure time and using screen media

Sedentary behavior has emerged more and more as an independent risk factor for the development of overweight, but also for psychosocial conditions [128]. Sedentary behavior refers to physical inactivity characterized by an energy expenditure of less than 1.5 MET, e.g. when sitting, watching TV, playing video games etc.

In addition to pointing out the problem of sitting times spent in (motorized) transport, e.g. in a baby carrier or child seat, the recommendations refer to the use of audiovisual media during leisure time (e.g. playing video games and watching TV) that are not explicitly required for school-related tasks [128]. Longer screen times (generally two or three hours) are linked to an increased prevalence of overweight and obesity, a higher BMI, lower fitness, lower self-esteem, poorer academic achievement and more behavioral problems [131]. The severity of these problems increases in line with screen time [131].

For children below the age of two, the recommendation is to avoid screen time completely [16] and not to expose children to incidental media use (no TV on in the background, no TV in the child's bedroom). For the groups of 2 to 5-year olds, it is recommended [8, 57, 129] to avoid screen time in as far as possible and or to limit it to a maximum of one hour per day. The German consensus statement thus recommends a maximum of 30 minutes/day of unnecessary media use for children of pre-school age and no more than 60 minutes/day for children of primary school age [48]. For older children, the recommendation is generally a maximum of two hours of screen time during leisure time [131], and this has also been adopted for adolescents in the German consensus statement [48].

Physical activity recommendations for adults

Target group

The recommendations apply to healthy adults aged between 18 and 65. They also apply to adults with chronic diseases that do not restrict mobility (e.g. hypertension or type 2 diabetes) for whom there are no specific contraindications for physical activity.

The recommendations are based primarily on the following source recommendations: WHO recommendations [46], national recommendations for physical activity from Canada [140], Australia [17], the UK [99], recommendations by the American College of Sports Medicine (ACSM) [43] as well as the "European Guidelines on Cardiovascular Disease Prevention in Clinical Practice" [96]

Recommendations

- Adults should be physically active on a regular basis. This can help to achieve significant health effects and to reduce the risk of developing chronic diseases
- The greatest health benefits take place when individuals who were entirely physically inactive become somewhat more active. This means that all additional physical activity is linked to health benefits. Every single step away from physical inactivity is important, no matter how small, and promotes health
- To maintain and promote health comprehensively, the following minimum recommendations apply:
 - adults should have moderate-intensity aerobic physical activity for at least 150 minutes/week where possible (e.g. 5 x 30 minutes/week) **or**

- at least 75 minutes/week of vigorous-intensity aerobic physical activity **or**
- aerobic physical activity in a corresponding combination of both intensities
- **and** should group the overall activity in at least 10-minute individual units distributed over days and weeks (e.g. at least 3 x 10 minutes/day on five days per week)
- Adults should also have muscle-strengthening physical activity at least two days per week
- Adults should avoid long and uninterrupted sitting times and should regularly interrupt sitting with physical activity where possible
- Adults can achieve further health effects if they increase the volume and/or intensity of physical activity above the minimum recommendations

Taking pregnancy-specific physical adjustments into account, these recommendations also apply to pregnant women or women who have recently given birth; see Ferrari & Graf in the medical journal "Das Gesundheitswesen"

Reasons for the recommendations

General health benefits of physical activity⁴

Regular physical activity reduces overall mortality risk considerably. In the underlying epidemiological studies, the most physically active groups were compared against the least physically active groups in this regard. The existing international physical activity recommendations that make reference to this point consistently report an approximately 30% lower overall mortality risk for active individuals versus inactive

⁴ The health effects and reasons for the physical activity recommendations reported here are based on the selected source recommendations (for the methodology, see Geidl et al., Füzeki et al., Pfeifer et al. in a special edition of the medical journal "Das Gesundheitswesen"). For other comprehensive current reviews, see e.g. Pedersen & Saltin 2016 [95].

individuals [17, 140]. The WHO recommendations also highlight a lower mortality risk of physically active adults compared with inactive adults [46].

A significant risk reduction of 20 to 33% is reported in the occurrence of cardiovascular diseases through regular physical activity [17, 96, 140]. The recommendations of the World Health Organization emphasize the cardioprotective effects of regular physical activity [46]. The risk reduction achievable through physical activity is independent of other known risk factors for cardiovascular diseases [140]. In addition, based on extensive reviews and meta-analyses, the American College of Cardiology and the American Heart Association describe a positive influence on cardiometabolic risk indicators (reduction in LDL cholesterol and non-HDL cholesterol, drop in blood pressure) and recommend three to four units of aerobic physical activity per week lasting approximately 40 minutes each and reaching both moderate and vigorous intensity [32].

In relation to the prevention of overweight, the Australian physical activity recommendations consider at least 60 minutes of physical activity per day necessary [17]. The ACSM recommends moderate-intensity physical activity between 150 and 250 minutes per week in order to prevent weight gain [28]. The UK physical activity recommendations describe the health benefits achieved through physical activity even without weight reduction [99]. The World Health Organization emphasizes the substantial inter-individual variability between physical activity and weight status, and assumes that more than 150 minutes of physical activity per week is necessary to maintain weight [46]. The substantial inter-individual variability between physical activity and weight gain, which is also influenced by factors such as energy intake, medication, smoking, alcohol consumption and co-morbidities, makes it more difficult to make precise statements on the prevention of overweight.

In relation to the risk of developing type 2 diabetes, the comparison between the most physically active or fittest and least physically active or least fit group in the Canadian physical activity recommendations showed an average risk reduction of 42% [140]. Physical activity was also found to have a favorable effect on diabetes risk even without weight reduction [17 and 141]. The American Diabetes Association describes a risk reduction of 34-43% [119] through lifestyle interventions, physical activity, a change of diet and calorie reduction.

The European Code against Cancer [67], the American Cancer Society [63] and the World Health Organization [46] report substantial evidence that physical activity can

reduce the risk of occurrence of various types of tumor, e.g. breast, intestinal and endometrial tumors. According to the Canadian physical activity recommendations, a comparison of the most physically active with the least physically active group resulted in an average relative risk reduction of 30% [140]. The Australian physical activity recommendations report a somewhat lower risk reduction (20% for men and 14% for women) [17]. The European Code against Cancer mentions a relative risk reduction of 27% [67]. The protective effects appear to be independent of body weight [17, 67], hormone replacement therapy, diet and family history of cancer [17]. The S-3 guideline "Colorectal carcinoma" finds that active individuals have fewer colon polyps (adenomas) and up to 30% lower risk of a carcinoma [66]. For incidences of breast cancer, the Canadian physical activity recommendations calculate a risk reduction from physical activity of 20-40% [141]. The underlying data used by the European Code against Cancer [67] distinguishes between post-menopausal and pre-menopausal cancer. It is considered probable that regular physical activity lowers the risk of post-menopausal tumors.

The Canadian physical activity recommendations and the recommendations of the World Health Organization emphasize that regular physical activity and exercise help bone health, i.e. contributes to the prevention of osteoporosis [46, 140]. Ebeling et al. [31] report on positive effects of weight-bearing aerobic exercise, high-impact exercises (high pressure and tensile forces on bones) and strength exercise on the bone mineral density of pre-menopausal women.

The Australian physical activity recommendations make mention of the potential to prevent depression. According to those recommendations, regular physical activity protects against the onset of depression, although the impact is small to moderate with significant heterogeneity [17]. Effects are assumed to be greater among those who are inactive and those with lower levels of psychosocial functioning.

Health benefits depending on the volume of physical activity

The figures provided in the recommendations on the volume of physical activity are additional to basic activity. Persons who only carry out basic activity are considered inactive.

The dose-response relationship between physical activity and health benefits is generally assumed to be curvilinear (Figure 2). The greatest health benefits are observed

amongst inactive individuals who increase their activity at least a little. Accordingly, even a relatively small increase in physical activity is linked to significant improvements in the health and fitness of initially inactive and unfit individuals. Even physical activity of approximately half the recommended volume is associated with a lower early mortality risk [17, 46, 99]. Larger volumes bring additional benefits, which then decrease again with increasing volume. It is therefore assumed that the curve of the dose-response relationship flattens out above a certain volume and then only small additional health benefits are achievable through additional physical activity. It is not possible to determine this volume precisely based on the source recommendations available [17, 99].

The precise volume and type of physical activity necessary for a specific health benefit cannot be defined precisely [17, 30, 43, 96], nor it is possible yet to make disease-specific preventive physical activity recommendations [99]. It is also probable that the curve of the dose-response relationship will be different depending on the health effect observed and the initial fitness level of the individual. For example, there are indications that a volume greater than 150 minutes/week of physical activity is necessary in order to achieve specific health effects such as weight reduction, the prevention of type 2 diabetes or the prevention of certain types of tumors [17, 46, 63, 66, 140].

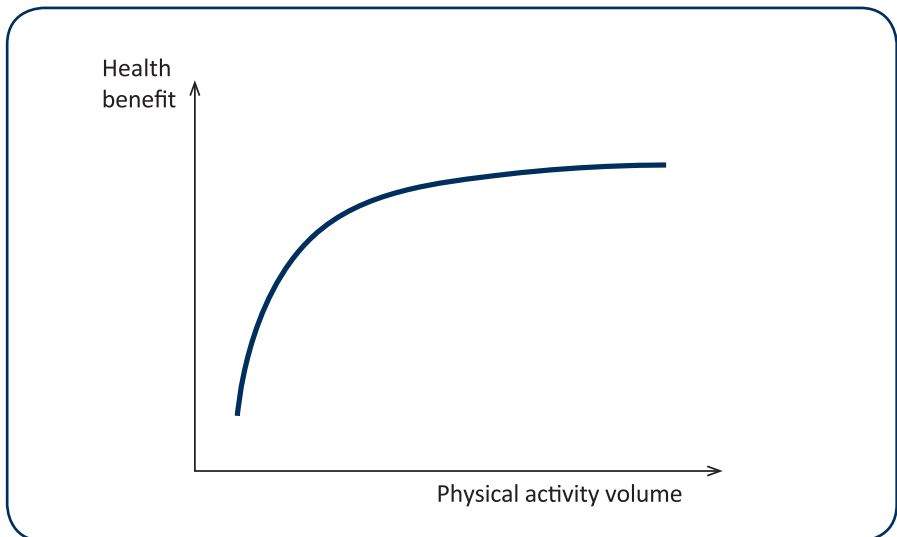


Figure 2: Assumed dose-response relationship between physical activity and health

On the whole, the volume of physical activity plays a more important role than the type of physical activity [17, 99]. Adults can achieve extensive health benefits if their physical activities comprise or address all motor abilities (strength, endurance, mobility, coordination) [43].

The volume and intensity of physical activity should be increased gradually until the set target is achieved. Aerobic physical activity of moderate intensity is viewed more positively from an affective-emotional perspective than vigorous-intensity physical activity and must be seen as more favorable in terms of engaging individuals in physical activity [43].

For very inactive adults, physical activity units of less than ten minutes may make sense, as they can encourage the commencement of an active lifestyle. This recommendation is consistent with the understanding that physical activity even below the recommended volume of 150 minutes/week can be health effective [99].

Health benefits depending on the duration and frequency of the individual units of physical activity

Existing source recommendations give the minimum duration for one individual unit of physical activity as 10 minutes; in addition they describe the option of accumulating the overall duration of physical activity from individual units [17, 43]. Daily physical activity is desirable in order to achieve the desired acute and chronic metabolic effects [17, 43], with health effects considered certain if physical activity is undertaken three times a week. As far as the minimum or ideal frequency of physical activity is concerned, the source recommendations do not yet provide sufficient information. Some studies suggest that even one correspondingly long unit of physical activity per week is beneficial to health [17, 43].

Health benefits depending on the intensity of physical activity

According to source recommendations, it is certain that moderate-intensity physical activity results in the health benefits described. There are indications that vigorous-intensity physical activity reduces the risk of cardiovascular diseases and premature death more substantially than moderate-intensity physical activity (with the same energy expenditure). Accordingly, moderate-to-vigorous intensity physical activity is

recommended [46, 99]. It is assumed that the increased energy expenditure at higher intensities "counts" more. For very inactive individuals and those with a low level of fitness, low-intensity physical activity is also recommended [17, 43].

Health benefits depending on the type of physical activity

The evidence of health benefits from physical activity stem chiefly from epidemiological studies in which recreational physical activity as well as walking and cycling as a means of transport were recorded [17, 46]. In terms of overall mortality, cycling and walking as a means of transport appear to result in comparable risk reductions to recreational physical activity [17]. Based on meta-analysis indications, the Australian national physical activity recommendations state that the effects of work-related physical activity on reducing cardiovascular diseases are smaller than those of recreational physical activity [17]. The Canadian physical activity recommendations recommend work-related physical activity as well as physical activity as a means of transport in order to lower the risk of developing type 2 diabetes [140].

It seems that it is not the type of physical activity but the overall energy expended that is relevant for the prevention of overweight [17]. The ACSM Position Stand recommends a larger volume of physical activity in day-to-day life as a strategy in weight management programs [28].

The benefit of aerobic physical activity as well as strength exercise for bone health, especially amongst post-menopausal women, is considered assured in the source recommendations. The data available does not currently allow for any specific exercise norms for reducing the incidence of osteoporosis. What is certain is that the adaptations in the bone depend on exercise and are specific to the respective body part [17, 140]. In order to prevent osteoporosis, weight-bearing activities or activities with high ground reaction forces as well as strength exercise are recommended [17, 31, 140].

The significance of long sitting periods

There are indications that sedentary behavior increases the risks of developing chronic diseases such as type 2 diabetes, obesity, some forms of cancer or cardiovascular diseases and can be associated with higher mortality [17, 43, 63, 67]. Conversely,

there are studies on interrupting long sitting periods with light physical activity which highlight the significance of muscle contractions in supporting health-enhancing physiological effects [17]. Accordingly, it is recommended to limit the time spent sitting at work, during leisure time and in traffic and where possible to punctuate it with physical activity [17, 27, 43, 67]. It is not yet possible to specify the dose-response relationship based on the source recommendations available [17].

What are the risks of physical activity, and what should be considered before taking up or increasing physical activity?

It can be derived from the existing source recommendations that the benefit of physical activity is far greater than the risks.

Possible risks described include musculoskeletal injuries, cardiac events and upper respiratory tract infections [98]. The incidence of injury is low, and non-contact sports (power walking, running, swimming etc.) are far less risky with approximately one injury per 1,000 hours of physical activity than for example ball sports (basketball: 9.1 injuries per 1,000 hours). Cardiac events are very rare, with one event per 36.5 million hours of physical activity. On the whole, the risks can be minimized by taking precautionary measures such as slowly increasing the volume and intensity of activity, regeneration and recovery phases, correct implementation of physical activity as well as appropriate equipment. Upper respiratory tract infections are less frequent in moderately physically active people than in inactive individuals; the risk increases again for very active individuals [17].

The ACSM and the World Health Organization recommend a medical examination before taking up or returning to physical activity in the case of pre-existing diseases [43, 46]. The Deutsche Gesellschaft für Sportmedizin und Prävention or DGSP (German Association of Sports Medicine and Prevention) generally advises individuals taking up or returning to physical activity to be checked by a physician in order to identify potential pre-existing diseases and risks.

Physical activity recommendations for older adults

Target group

The recommendations contained here apply to older adults aged 65 and above.

They are based on the following source recommendations: The recommendations by the World Health Organization are geared to healthy and chronically ill older adults aged 65 and older [46], while the Canadian recommendations for physical activity are aimed at healthy, non-institutionalized individuals aged between 65 and 85 [94]. The UK recommendations define the target group as persons above the age of 65 [99], while the national recommendations for New Zealand distinguish between older adults aged over 65 and frail older adults aged over 65 [81]. The Position Stand by the American College of Sports Medicine (ACSM) for older adults is geared primarily to persons aged over 65, but also considers individuals in the 50 to 64 age group with more serious chronic diseases or functional limitations that reduce mobility, fitness or physical activity [21].

Recommendations

- Older adults should be physically active on a regular basis. This can help them to achieve significant health effects and to reduce the risk of developing chronic diseases
- The greatest health benefits occur when individuals who were entirely physically inactive become somewhat more active. This means that all additional physical activity is linked to a health benefit. Every single step away from physical inactivity is important, no matter how small, and promotes health

- To maintain and promote health comprehensively, the following minimum recommendations apply to older adults:
 - Older adults should have moderate-intensity aerobic physical activity for at least 150 minutes/week where possible (e.g. 5 x 30 minutes / week) **or**
 - at least 75 minutes/week of vigorous-intensity aerobic physical activity **or**
 - aerobic physical activity in a corresponding combination of both intensities
 - **and** should group the overall activity in at least 10-minute individual units distributed over days and weeks (e.g. at least 3 x 10 minutes/day or 5 x 30 minutes/week)
- Older adults with limited mobility should perform balance exercises at least three days a week in order to prevent falls
- Older adults should have muscle-strengthening physical activity at least two days per week
- Older adults should avoid long and uninterrupted sitting times and should regularly interrupt sitting with physical activity where possible
- Older adults can achieve further health effects if they increase the volume and/or intensity of physical activity above the minimum recommendations
- Older adults who cannot meet the recommendations due to health conditions should be as active as their current state of health allows

Reasons for the recommendations

General health benefits of physical activity

While the biological aging process cannot be halted through physical activity, regular physical activity is a prerequisite for maintaining physical functions. Regular physical activity can thus slow down the age-related physiological loss of function and increase life expectancy in good health [21]. Overall, comparable positive effects of physical activity can be expected for older adults as for adults aged between 18 and 65 (see the chapter on "Physical activity recommendations for adults") [21, 81, 94, 99]. The dose-response relationship between physical activity and health benefits also appears to be very similar for adults and older adults [99]. Older adults can achieve extensive health benefits if their physical activities comprise or address all motor abilities (strength, endurance, mobility, coordination) [21, 81, 99]. Older adults who were very inactive in the past already benefit from relatively little additional physical activity; greater volumes (>150 minutes per week) result in additional health benefits, which are however smaller in relative terms [99]. Because acute effects of physical activity are short-lived and are lost relatively quickly after the end of the exercise program, physical activity or exercise should take place regularly in order to create chronic adaptations [21, 99].

In addition, further health effects relevant for older adults from physical activity are described.

Reducing the risk of falling

The various source recommendations consistently agree on the ability of physical exercise to lower the risk of falling. There are reliable indications that this is the case from multimodal exercise programs comprising elements from at least two areas (strength, balance, flexibility or endurance) as well as Tai Chi as an intervention form [21, 81]. Physical activity-related fall prevention is also effective in a hospital or nursing home setting [81]. For older adults living independently, there are reports of a reduction in the relative fall risk of between 17 and 34%, and of 42% when they carry out challenging balance exercises and take a higher dose of physical activity (e.g. 50 hours of 2 x 1h/week) [126]. Accordingly, physical exercise is recommended as a central element of fall prevention strategies [21, 46, 77, 81]. Both group exercise and

exercise interventions that take place at home are effective. A large range of exercise volumes (from fewer than 9 hours to more than 75 hours) appear to be effective [77].

It is probable that lasting risk reduction can only be achieved if exercise takes place continuously. Strength exercise probably is most significant for individuals who are out of shape and can increase their functional capacity through improved strength. The role of general physical activity for fall prevention, i.e. not of systematic exercise, has not yet been clearly described. It appears certain that more active individuals suffer from fewer falls than inactive individuals. The effects of health sports activities like aerobic gymnastics, tennis, yoga or dancing have not been examined in detail. Because they require coordination and balance, it can be assumed that these activities can contribute to maintaining balance in middle-aged and older adults without a risk of falling.

Osteoporosis

Aerobic physical activity can counteract the age-related reduction in bone mineral density in post-menopausal women. Several large prospective cohort studies show that a high volume of physical activity, in particular walking, can reduce the risks of osteoporosis-related fractures by between 30 and 50% [21]. Furthermore, the positive effect of aerobic exercise and strength exercise on bone mineral density in pre-menopausal and post-menopausal women is seen as proven [21, 81].

In particular, weight-bearing physical activity is recommended to maintain bone density [31, 81]. Activities with higher intensities such as climbing stairs, brisk walking, walking with weights or running as well as intensive strength exercise are associated with more pronounced effects [21, 31]. The focus of the exercise should not only be on slowing down the loss of bone mineral density but also on maintaining or increasing muscle mass and strength in order to lower the risk of falling thanks to improved gait and mobility. At least three exercise sessions per week are recommended. The strength exercise should challenge particularly those muscle groups connected to bones frequently affected by osteoporotic fracture and that play an important role for gait and balance [31].

Independence, physical functions and activities

Physical exercise or activity is thought to have a positive effect on physical functioning capacity or lead to increased ease in carrying out everyday activities [21, 81]. However, the source recommendations report that the underlying data are not yet precise. Some but not all studies report improvements after exercise interventions including walking, climbing stairs and balance exercises. Some studies showed evidence of an improvement in various different functional tasks, while others indicate that the adaptations are more specific in the individual functional areas. The principle of exercise specificity suggests that the most unambiguous adaptations can be expected when the exercise program imitates the specific requirements of the activities of everyday life. The effect of the exercise and physical activity on maintaining functional capacity also appears to depend on hormonal status [21]. The literature review for the Canadian national physical activity recommendations [94] summarizes 66 studies on the effects of physical activity on functional limitations. The prospective studies show that regular physical activity in middle age and old age is linked to fewer functional losses; depending on the outcome variable, the risk reduction lies between 30 and 50%. Studies that also record the changes in physical activity behavior provide indications that even physical activity taken up later in life can be effective. Experimental studies show the positive effects of combined aerobic and strength exercise interventions on physical functions and activities in particular [94].

Cognitive functions

The source recommendations assume a positive link in relation to maintaining cognitive functions and preventing dementia. For example, the ACSM Position Stand states that regular physical activity reduces the risk of dementia and the risk of cognitive decline [21]. The intervention studies described show that physical exercise can lead to direct short-term improvements in memory, attention and reaction times. Regular activity can improve executive functions. In the national physical activity recommendations for New Zealand, based on two systematic reviews, six randomized controlled trials and one prospective cohort study it is assumed that physical activity can influence cognitive function positively [81]. Based on the 34 studies summarized for the Canadian physical activity recommendations, habitual physical activity appears to be linked to a lower risk of dementia and Alzheimer's disease [94]. In addition, physical exercise can improve cognitive functions in healthy older people. On the whole,

however, the underlying data are described as inconsistent. This was also confirmed in a comprehensive evidence report by Williams et al. [141] for the link between dementia and physical activity.

Psychosocial well-being and quality of life

Physical activity is associated with significant improvements in mental health and well-being as well as in some areas of quality of life [21]. New Zealand's national physical activity recommendations based on eight systematic reviews, eleven randomized controlled trials and one prospective cohort study found that physical activity is linked to positive effects on quality of life in both healthy and chronically ill older adults [81]. The intervention studies reported on therein provide indications that physical exercise can have a positive impact on quality of sleep and can promote vitality. On the whole, moderate-intensity physical activity appears to be more effective than low or high-intensity physical activity for improving well-being. The precise dose-response relationships cannot yet be described [21, 81].

The significance of long sitting periods

Some of the source recommendations available describe a link between the time spent sitting and an increased mortality risk (overall mortality, cardiovascular and tumor-related morbidity) [31, 81, 99]. There are also reports of indications that long periods spent sitting increases the risk of developing certain chronic diseases such as type 2 diabetes, breast cancer, cardiovascular diseases, dementia and osteoporosis. It is also assumed that sitting for long periods raises the risk of stroke and of mobility restrictions. Accordingly, older individuals are advised to limit the time spent sitting and where possible to interrupt with frequent physical activity. It is not yet possible to derive a precise dose-response relationship based on the source recommendations.

What are the risks of physical activity, and what should be considered before taking up or increasing physical activity?

It can be derived from the existing source recommendations that the general benefit of physical activity for older adults is far greater than the risks.

However, the need for older adults to take into account specific age-related risks is highlighted. For example, age-related sensory impairment or slowed reactions as well as possible pre-existing conditions mean that individual adjustments are necessary in terms of the type and dose of physical activity or its increase [46, 81, 94, 99, 126].

Older adults, in particular individuals who had been inactive along with individuals with existing illnesses, are advised to consult with a healthcare professional (e.g. doctor, sports scientist, physiotherapist) [81] or get medical advice before taking up exercise. [46]. The Deutsche Gesellschaft für Sportmedizin und Prävention or DGSP (German Association of Sports Medicine and Prevention) specifically advises individuals taking up or returning to physical activity to be checked by a physician in order to identify potential pre-existing diseases and prevent risks.

Physical activity recommendations for adults with a chronic disease

Target group

The recommendations apply to adults aged between 18 and 65 with a chronic disease such as type 2 diabetes, chronic obstructive pulmonary disease (COPD), arthritis in the hip or knee, clinically stable ischemic heart disease, after a stroke (> 6 months after the acute event), with clinical depression or chronic non-specific back pain.

Recommendations

- Adults with a chronic disease should be physically active on a regular basis. This will allow them to achieve significant health effects
- Health effects already take place when individuals who were entirely physically inactive become somewhat more active. This means that all additional physical activity is linked to health benefits. Every single step away from physical inactivity is important, no matter how small, and promotes health
- In order to maintain and promote health comprehensively, adults with a chronic disease should follow the physical activity recommendations for adults without chronic illnesses. Most adults with a chronic disease can and should have
 - moderate-intensity aerobic physical activity for at least 150 minutes/week where possible (e.g. 5 x 30 minutes / week) **or**

- at least 75 minutes/week of vigorous-intensity aerobic physical activity **or**
 - aerobic physical activity in a corresponding combination of both intensities
 - of which the overall activity should be in at least 10-minute individual units distributed over days and weeks (e.g. at least 3 x 10 minutes/day on five days per week)
 - **additionally**, should also have muscle-strengthening physical activity at least two days per week
- In phases in which they cannot be as physically active as the recommendations for healthy adults suggest, e.g. due to severity of the illness, symptoms or physical functional capacity, adults with a chronic disease should be as active as their current situation permits
 - To increase the safety and effectiveness of physical activity, adults with a chronic disease should
 - have a (sports) medical examination carried out when beginning a physically active lifestyle or entering a physical exercise program decide together with a doctor whether independent implementation of physical activities is safe and appropriate or whether it is better to have professional care from physical activity professionals upon commencement
 - adjust the dose of physical activity (type of physical activity, exercise intensity, duration, frequency) individually together with a physical activity professional
 - obtain professional advice from healthcare professionals in phases of progression of the illness, lack of control over the illness or deterioration of the state of health. as it may be necessary to change physical activities or even take a break

Reasons for the recommendations

The generic physical activity recommendations described here for adults with a chronic disease are based on disease-specific physical activity recommendations developed separately for seven nationally significant diseases [101]. Namely for arthritis (hip/knee), type 2 diabetes, chronic obstructive pulmonary disease (COPD), clinically stable ischemic heart disease, stroke, clinical depression and chronic non-specific back pain. These seven disease-specific recommendations can be found at www.sport.fau.de/bewegungsempfehlungen (German language).

Health effects of physical activity with chronic diseases

Physical activity is highly significant for the health of adults with a chronic disease, and constitutes an effective therapy option as exercise therapy [95, 123]. Consequently, exercise therapy is used as an extensive standard intervention as part of medical rehabilitation of chronic diseases. The diverse health effects of physical activity for individuals with chronic diseases include favorable effects in terms of pathogenesis and pathophysiology, weakening of symptoms, increased physical functional performance and capacity, improved psychosocial well-being as well as a better health-related quality of life [e.g. 95, 123]. For some diseases, the positive effects of physical activity on overall mortality rates are also proven, for example in the case of type 2 diabetes and obesity [38, 115] or for cardiovascular diseases [14].

What are the risks of physical activity, and what should be considered before taking up or increasing physical activity?

Physical activity is linked to a variety of positive health effects for people with a chronic disease. However, physical activity is not completely without risk for such individuals. In particular any increase in the level of physical activity as well as the commencement of a physical exercise program can be linked to a higher risk of the occurrence of side effects and the incidence of undesired events [106, 137]. Potential risks of physical activity range from minor negative effects (e.g. sore muscles) to severe and life-threatening side effects (e.g. heart attack).

Most of the risks of physical activity can be minimized by adjusting the exercise individually to the disease and symptoms, and by finding a suitable type of physical activity [74]. Side effects can be avoided if implemented correctly. Suitable physical activity in line with the recommendations for healthy adults can be carried out safely and at low risk by adults with a chronic disease [13, 20, 35, 37, 39, 42, 53, 82, 91, 104, 144]. The positive benefits of physical activity outweigh the costs or side effects [52]. A sedentary or physically inactive lifestyle is linked to more significant health risks (e.g. in relation to the emergence of follow-on damage and related illnesses) than physical activity [72, 114].

The incidence of side effects among adults with a chronic disease from physical activity depends among other things on the nature and severity of the disease, individual symptoms, the individual level of fitness as well as on the type and dose of physical activity (e.g. type of physical activity or sport, intensity, volume of physical activity) [45, 106]. In order to assess current state of health and fitness precisely, it is essential for men and women with a chronic disease to obtain medical advice or undergo a medical check before beginning a physical exercise program and before increasing their physical activity [13, 20, 42, 44, 45, 60, 91, 114, 144]. The physician should clarify, among other things, the nature and severity of the health issue and consider tests of physical functions/structures, limitations of activities and participation as well as individual context factors. Based on this, the risk for the incidence of side effects can be estimated and suitable physical activities and exercise doses can be selected [2]. Further to the medical examination, it can be decided whether the persons concerned can be physically active independently or whether it makes sense to be assisted by physical activity professionals.

Based on a medical examination, physical activity professionals can help individualize and adjust physical activities, e.g. in relation to symptoms, pain, physical performance and capacity, psychological state, experience with physical and sporting activity, exercise-related preferences etc. [35, 53, 105, 136]. Professional support and expert instruction by a physical activity specialist should in particular play a part for persons who, because of their chronic disease, a) are subject to a higher risk of side effects from physical activity, b) need physical activity to be customized to their current symptoms, c) need adjustments to medications or d) are fearful in respect of physical activity [18, 37, 75, 91, 113, 144]. For individuals with a chronic disease that does not entail any limitations in terms of carrying out physical and sporting activities, these individuals can be physically active independently. Professional support and instruction is not essential.

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