Physical activity guidelines 2017

To the Minister of Health, Welfare and Sport
No. 2017/08e, The Hague, August 22, 2017

Health Council of the Netherlands

contents

executive summary

Background

Three standards for physical activity are applied in the Netherlands: the Dutch Standard for Healthy Physical Activity, which recommends physical activity of moderate intensity, such as brisk walking, at least five days a week for a minimum of thirty minutes; the Fitnorm, which recommends vigorous physical activity, such as running, at least three days a week for a minimum of twenty minutes; and the Combinorm, for which the Activity Standard and/or the Fitnorm must be met. At the request of the Minister of Health, Welfare and Sport, the Committee for Guidelines on Physical Activity has assessed these guidelines in the light of new scientific developments. The question of whether all aspects of physical activity could be incorporated into one directive was also considered.

Methodology

In order to derive new guidelines for physical activity, the committee undertook a systematic review of research on the effects of physical activity on the risk of chronic diseases and physical limitations (in older people), and fitness (in children). The findings were summarised in two background documents, in which different levels of evidential strength were assigned. Subsequently, the committee took those effects with a strong level of evidence as a starting point for the derivation of the new guidelines, also taking international guidelines into account.

Findings

The numerous beneficial effects of regular physical activity were reaffirmed once again in these recommendations. Physical activity is healthy for all age groups. This applies both to endurance training and to muscle-strengthening activity.

In adults and older persons, physical activity reduces the risks of cardiovascular disease, diabetes and depressive symptoms. Furthermore, higher levels of physical activity are associated with a lower risk of breast and colon cancer and premature death. Research shows that the beneficial effects increase in proportion to the amount of physical activity done. In relative terms, the most health gains are made when changing from being physically inactive to being physically active (moderately vigorous activity levels or higher).

Among older people, physical activity reduces the risk of bone fractures and improves muscle strength and walking speed. Higher levels of physical activity in this group are also associated with a lower risk of physical constraints, cognitive decline and dementia.

In children, physical activity also lowers the risk of depressive symptoms, improves insulin sensitivity and bone quality, and reduces body mass index and fat mass in children who are overweight or obese. Physical activity also improves physical fitness and muscle strength.

A sedentary lifestyle, by contrast, appears to be detrimental to health, being associated with a higher risk of cardiovascular disease and premature death. However, this association becomes weaker the more physical activity that people engage in, and is not present in people who engage in a great deal of physical activity (significantly more than the current standard for physical activity). The scientific evidence for the health effects of a sedentary lifestyle is currently much less strong than that for physical activity.

Physical activity guidelines

The physical activity guideline for adults and older people is as follows:

- *Physical activity is good for you – the more, the better.*
- *Engage in physical activity of moderate intensity for at least 150 minutes every week, spread over several different days. For example, walking and cycling. The longer you are physically active, and the more frequent and/or more vigorous the activity, the more your health will benefit.*
- *Do activities that strengthen your muscles and bones at least twice a week. Older people should combine these with balance exercises.*
- *And: avoid spending long periods sitting down.*

For children from four to eighteen years, the following physical activity guideline applies:

- *Physical activity is good for you – the more, the better.*
- *Engage in physical activity of moderate intensity for at least one hour every day. The longer you are physically active, and the more frequent and/or more vigorous the activity, the more your health will benefit.*
- *Do activities that strengthen your muscles and bones at least three times a week.*
- *And: avoid spending long periods sitting down.*

The Committee emphasises that the association between the amount of activity and health is a continuum. The guideline for physical activity in adults and older people represents a minimum standard to motivate people who are less physically active to become more physically active. People who follow this guideline can achieve further health benefits by engaging in more physical activity. The committee recommends emphasizing this in communication regarding the physical activity guidelines.

Recommendations for monitoring, research and implementation

In the Netherlands, the new guidelines for physical activity of moderate intensity and bone- and muscle-strengthening activities are met by around 45 percent of children, adults and older people. Moderately intense physical activity includes all physical activity that is moderate or vigorous, whether it is done at home, at school, at work or during leisure activities. The figures are based on questionnaire data, which provide a good impression of trends in physical activity over time. Because questionnaires are less accurate for determining the actual amount of exercise done, the Committee argues for the

use of instruments such as accelerometers to measure the amount of physical activity actually done.

The percentages reveal that a large proportion of the population still does not engage in much physical activity. The challenge is to achieve a lasting change in sedentary behaviour and increase levels of physical activity. We also need to achieve a better understanding of the factors that encourage and discourage people from engaging in sufficient physical activity. One factor that can help is when people incorporate physical activity into their daily lives, such as by walking or cycling to school or work. Physical activity programmes can also help to motivate people. Because only a small number of these have been proven to be effective, the committee recommends that more research is done in relation to such programmes. Programmes that aim to reduce the amount of time people spend sitting down also deserve further research. Finally, a permanent change in physical activity habits could be supported by taking this into account in the design of the physical environment.

The guidelines focus primarily on physical activity behaviours among the general public. But in view of the major importance of this question to public health, the guidelines are not only a matter for individuals but also for the government. The committee advises the minister to invest in interventions to ensure that people engage in more physical activity on a permanent basis. The success of such interventions can be maximised by working together with other parties, such as local government, employers, schools and health professionals.

Figure 1 **Physical Activity Guidelines 2017**

Physical activity is good for you – the more, the better

Adults and older persons

Moderate or vigorous activity
at least **150 minutes** every week,
spread over several different days

Activities that strengthen muscles and bones (for older people, including balance exercises):
at least **twice** a week

And: **avoid spending long periods sitting down**

Children

Moderate or vigorous activity
at least **1 hour** per day

Activities that strengthen muscles and bones
at least **three times** a week

And: **avoid spending long periods sitting down**

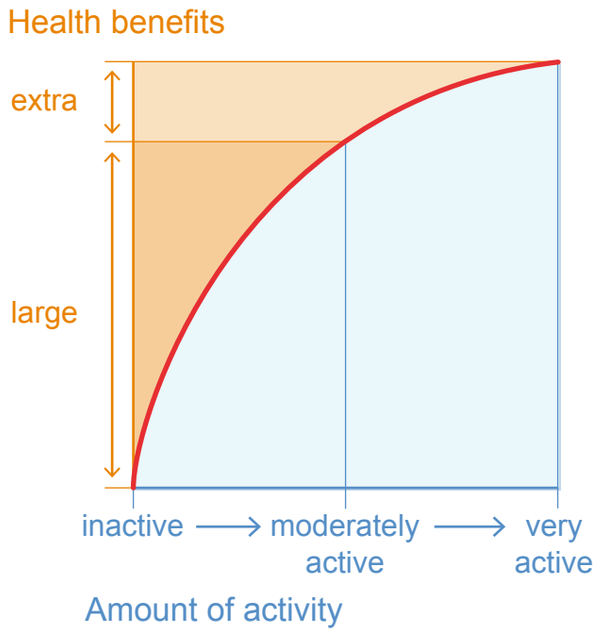
What percentage of people currently meet the guidelines?

18 years old and above

4 - 11 years

12 - 17 years

The greatest health benefits are achieved when you start to become physically active



Types of activities for:

Strengthening muscles
Improving the strength and stamina of the skeletal muscles

Strengthening bones
Load-bearing exercises with own body weight

Intensity of exercise

As the intensity increases, heart rate, respiratory rate and energy consumption also increase further

Sitting down
Watching television, working with a computer

Heart rate
Respiratory rate
Energy consumption

Light
Playing music, washing up

Moderate
Walking, cycling

Vigorous
Running, playing football

01 introduction

1.1 Background and request for recommendations

The Netherlands uses a range of standards in relation to physical activity: the Dutch Standard for Healthy Physical Activity, the Fitnorm and the Combinorm (see Standards for physical activity). The Minister of Health, Welfare and Sport asked the Health Council of the Netherlands to evaluate these standards in the light of the latest scientific developments. For example, research has become available on the effect of muscle-strengthening exercises and there are indications that long periods of sedentary behaviour may have adverse health effects. The evaluation should focus on the effect of physical activity on health. The minister asked the Council to integrate all aspects of physical activity into one set of guidelines tailored to young people, adults and older persons, and to ensure that these guidelines would be practical and quantifiable (measurable).

Standards for physical activity

Since 1998, the Dutch Standard for Healthy Physical Activity has been applied in the Netherlands. Because this standard is based on moderately intensive activity, the Fitnorm was added later. This Fitnorm indicates how much physical activity is sufficient at higher intensities. In order to create one unified measure for physical activity across the whole population, the Combinorm was then developed, which is achieved by meeting one of the other standards.

Dutch Standard for Healthy Physical Activity (NNGB)

Adults (aged 18-55 years) need to engage in moderately intensive physical activity for at least half an hour on at least five days a week. Examples are brisk walking, cycling and gardening. This activity must be sustained for at least ten consecutive minutes.

The physical activity standard for those aged over 55 years is the same, but involves engaging in more moderate activity over a half-hour period. Examples of moderately intensive physical activity for older persons include walking and cycling.

Children (under the age of 18) need to engage in moderate to vigorous physical activity for at least one hour every day, such as walking, cycling or physically active playing. This physical activity should aim to improve or maintain strength, agility, coordination and bone strength twice a week.[1,2]

Fitnorm

To meet the Fitnorm, it is necessary to engage in at least 20 minutes of vigorous physical activity three times a week. These are activities that affect the heart rate, such as swimming, speed cycling or running. This standard is the same for all ages.

Combinorm

To meet the Combinorm, you can meet the Dutch Standard for Healthy Physical Activity or the Fitnorm; one of these standards is sufficient.[3,4]

1.2 Scope

The Physical Activity Guidelines Committee has conducted a literature review and its new guidelines have been derived from studies that considered physical activity and sitting in relation to premature mortality, (risk factors for) chronic diseases, disability and fitness.
The committee evaluated research studies relating to children and adolescents up to eighteen years of age, adults and the elderly separately.

1.2.1 Prospective research

The committee limited itself to prospective research: research in which the outcome is determined after the exposure has been determined (in this case, physical activity or sitting). This research involves cohort studies and randomized controlled intervention studies (RCTs). In cohort research, the physical activity and/or sitting behaviour of a large group of people is surveyed beforehand, after which that group is monitored over the course of a number of years to determine the incidence and risk of disease and/or mortality. In RCTs, the effect of an intervention (e.g., increased physical activity) is compared to a control group; who participates in the intervention and who is in the control group is decided at random.

1.2.2 Physical activity and sitting

The committee looked specifically at research into the effects of physical activity and sitting (see inset for the various forms of physical activity). Research involving physical activity combined with other interventions such as nutritional advice was not considered. This is because the effects of the physical activity cannot be evaluated in isolation in such studies. Cohort research mainly considers physical activity and sitting in free time, distinguishing between sitting and physical activity of light, moderate and vigorous intensity (see Characteristics of physical activity). RCTs often distinguish between training aimed at promoting endurance, strength or a combination of these. In some studies, specific types of training were investigated, such as strength training aimed at bone strength or balance.

Forms of physical activity

There are five different forms of physical activity.[5-8]

- Physical activity is defined as any physical movement involving skeletal muscles that results in energy use. In the context of this report, these are activities involving one or more major muscle groups. Most forms of physical activity involve both an endurance component and a strength component.
- Balance exercises are static and dynamic exercises aimed at improving balance while someone is standing or moving, such as standing on one leg or picking up an object from the ground.
- Bone-strengthening exercises include strength training and activities in which the body supports its own weight, such as jumping, climbing stairs, walking, running and dancing.

- Endurance exercises are activities where the aim is to increase stamina. Large muscle groups are usually involved, and the activity occurs at a rate that can be sustained for more than a few minutes. Examples include walking, swimming, cycling and dancing.
- Strength training: see muscle-strengthening exercises. Examples are exercises that involve the use of body weight, loose weights (dumbbells) or machines to create resistance.
- Muscle-strengthening exercises (strength training or a combination of strength and endurance exercises) include activities that improve the strength, capacity, stamina and size of skeletal muscles. Examples are strength-training exercises using the body's own weight and endurance activities such as cycling.

Sitting, as defined for our purposes, includes activities performed in a sitting, reclining or lying posture with little energy being consumed (≤1.5 MET, see inset on Characteristics of physical activity), excluding sleep. In specialist literature, this is referred to using the term sedentary behaviour. It includes watching television, reading, sewing, working with a computer, sitting while playing video games or sitting while travelling. [9]

Characteristics of physical activity

The amount of physical activity is determined by its intensity, frequency and duration / volume.[5-8]

- The metabolic equivalent (MET) is a unit of measurement that defines the level of physical activity, in multiples of the energy that is required at rest. One MET is the energy used at rest.
- Absolute intensity is divided into light, moderate and vigorous.
  - Light physical activity consists of activities that involve standing or moving while upright. Examples include cooking, grocery shopping, and playing darts. Energy consumption ranges from 1.6 to 2.9 MET.
  - Moderate physical activity relates to activities performed at an intensity that requires effort, but during which conversation remains possible, such as hiking, cycling and swimming. Energy consumption ranges from 3.0 to 5.9 MET.
- Vigorous physical activity causes rapid breathing, or shortness of breath depending on fitness levels. Examples include aerobics, running, speed cycling and certain competitive sports. Energy consumption is 6 MET or more.
- Duration is the time during which a physical activity (in number of minutes spent sitting or walking) is sustained per session or the total time spent on this physical activity within a longer period of time (for example, number of minutes sitting or walking per week).

- Frequency refers to the number of occasions per unit of time that a particular physical activity is carried out, expressed in times per day or per week.
- Volume (per session) refers to the number of exercises, sets and repetitions within one training session.

1.2.3 Chronic diseases, disability and fitness

The physical activity guidelines are intended to promote health. The primary focus is on preventing chronic diseases among the general population. The committee also focused on disabilty among older persons and on fitness among children (strength and stamina). Although the 2017 guidelines are aimed at the general population, they are also important for many specific patient groups. RCTs demonstrate that the beneficial effect of physical activity on the risk of premature death in patients with cardiovascular disease and diabetes is often comparable to that of using medicines.[10] Certain patient groups will require adjustments relating to a particular health condition. However, these are not discussed in these recommendations.

Neither do the guidelines include specific recommendations regarding the prevention of obesity or unwanted weight gain. The Health Council of the Netherlands issued recommendations on obesity in 2003.[11] In the Guidelines for a Healthy Diet 2006, the Council concluded that people with unwanted weight gain, excess weight or obesity should increase their levels of physical activity to at least one hour of moderate physical activity per day.[12] If desired, the Council is ready to update these reports at any time.

1.3 Methodology

In order to derive the physical activity guidelines, the committee evaluated scientific findings in the field of physical activity, sitting and the risk of chronic diseases. The findings from cohort studies and RCTs were subsequently integrated into conclusions. Finally, the conclusions were translated into guidelines.

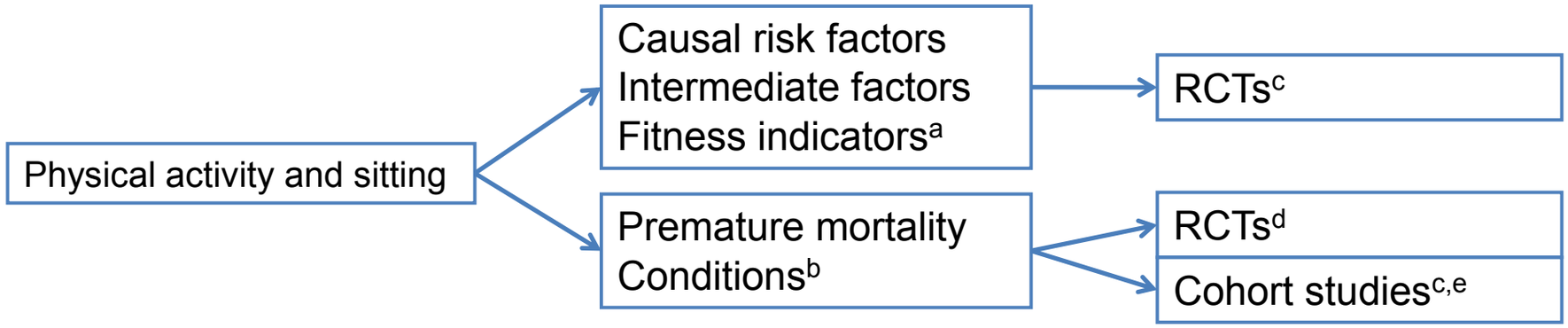
1.3.1 Evaluation of new scientific findings

The evaluations of new scientific findings are described in two background documents, one regarding physical activity and one regarding sitting.[13,14] A methodological background document[15] describes in detail how the committee approached this exercise. In summary, the evaluation of the scientific literature was restricted to meta-analyses and systematic reviews of cohort studies and RCTs published before October 1, 2016. These included cohort studies on the relationship between physical activity and sitting and the risk of premature death, common chronic diseases and disability, as well as RCTs relating to these outcomes, the risk factors associated with these conditions and indicators of fitness. In relation to the risk factors, the committee distinguished between causal risk factors and intermediate factors. For the causal risk factors, it has been shown that a change in the factor leads to a change in the risk of

that condition; for the intermediate factors there is an association but no proven effect.

When deriving the physical activity guidelines, the committee only considered findings with a strong level of evidence. The level of evidence depends, among other things, on the availability and quality of the research, the conclusiveness of the findings and the strength of any association or effect identified.

A schematic representation of the evaluation:



a. The committee evaluated the effect of physical activity on the following causal risk factors: systolic blood pressure, LDL cholesterol, body weight (adults) and body mass index (children), and insulin sensitivity; the intermediates: blood glucose, fat mass, abdominal fat, abdominal circumference, fat-free mass and bone density; the fitness indicators: cardiorespiratory fitness, functional performance and muscle strength.
b. The committee evaluated the association between physical activity and sitting and premature death and the following conditions: coronary heart disease, stroke, heart failure, type 2 diabetes mellitus, chronic obstructive pulmonary disease (COPD), breast cancer, colorectal cancer, lung cancer, disability, fractures, osteoarthritis, injuries, dementia and cognitive decline, depression and depressive symptoms, and ADHD symptoms.
c. The committee based its findings mainly on pooled analyses, meta-analyses, and systematic reviews.
d. RCTs into the effect on disease are few in number. In view of the importance of such studies for conclusions regarding causality, these RCTs are described where no meta-analyses or systematic reviews are available.
e. The term cohort study is used for all types of prospective observational studies.[15]

1.3.2 Integration of findings from cohort studies and RCTs

In order to derive its guidelines, those findings with a strong level of evidence from cohort studies and RCTs were integrated into conclusions that were ‘convincing’ or ‘plausible’ (this is explained in more detail in section 2.1). The difference is reflected in the content of the accompanying guideline. A convincing conclusion may lead to a quantitative recommendation if the underlying data lends itself to this; a plausible conclusion does not.

1.3.3 Derivation of the guidelines

When deriving the new physical activity guidelines, the aim was to develop measurable and practically applicable guidelines based on the current state of scientific knowledge, in accordance with the Minister’s request. The committee indicates to what extent each guideline is based on the integrated conclusions from cohort studies and RCTs. It also considers the existing Dutch standards[1,2] and recent international guidelines. These guidelines are very similar.[5-7,16-21] The practical application of the guidelines itself falls outside the scope of this recommendation.

1.4 Reader’s Guide

In Section 2, the committee discusses and integrates those findings with a strong level of evidence for physical activity and the risk of chronic diseases, disability and fitness for adults, older persons and children. This always involves a consideration of the extent to which the required amount of physical activity can be quantified in relation to the findings. Section 3 takes a similar approach to those findings with strong level of evidence for sitting. Subsequently, in Section 4, the committee derives its guidelines for physical activity and sitting. Section 5 relates to the consequences for practice.

02
physical activity contributes to good health

Research shows that physical activity has positive effects on health: it reduces the risk of various chronic diseases and improves muscle strength and fitness. In this section, the committee describes which conclusions can be drawn from scientific research regarding the effect of physical activity on health in adults, older persons and children. It also discusses which areas relevant to the guidelines require more research.

2.1 Methodology for integrating findings from cohort studies and RCTs

In order to derive the physical activity guidelines, those findings with a strong level of evidence from cohort studies and RCTs were integrated into conclusions that were 'convincing' or 'plausible'. Where the outcomes of meta-analyses of RCTs and cohort studies supported each other, the committee considers the evidence that physical activity or sitting has a beneficial or adverse effect on the risk of chronic diseases to be convincing. This also applies where there are only RCTs for disease, mortality (hard outcomes measures), risk factors or indicators of fitness.[a] Where there are only results from cohort studies, the committee believes that an association between physical activity and ill health or mortality is plausible.

As a consequence of this methodology, outcomes may in theory be convincing when it comes to the effect of physical activity on the risk of cardiovascular disease, diabetes, dementia, depression and fractures. This is because RCTs are available into the effects of physical activity on the causal risk factors for these conditions (blood pressure and LDL cholesterol for cardiovascular disease, weight and insulin sensitivity for diabetes) as precursors of disease (cognitive decline for dementia) or the risk of the condition itself (depressive symptoms and fractures). The associations between physical activity and the risk of cancer, COPD and osteoarthritis can, at most, be plausible, since only cohort research is available.

When quantifying a guideline, the committee considered conclusions with convincing evidence. In principle, it maintains the level of physical activity reported in cohort research, which allows us to draw conclusions regarding the attainability of the standards of physical activity in practice. Where possible, this is supplemented with data from RCTs regarding the effective levels of intensity, frequency and duration of physical activity. Those conclusions with a plausible level of evidence do not provide a sufficient basis on which to derive quantitative guidelines.

2.2 Adults

2.2.1 In adults and older persons, physical activity reduces the risks of cardiovascular disease, diabetes and depressive symptoms

There is convincing evidence that physical activity reduces the risk of

[a] Risk factors relate to both causal risk factors and intermediates. This is explained in more detail in the methodology document.[15]

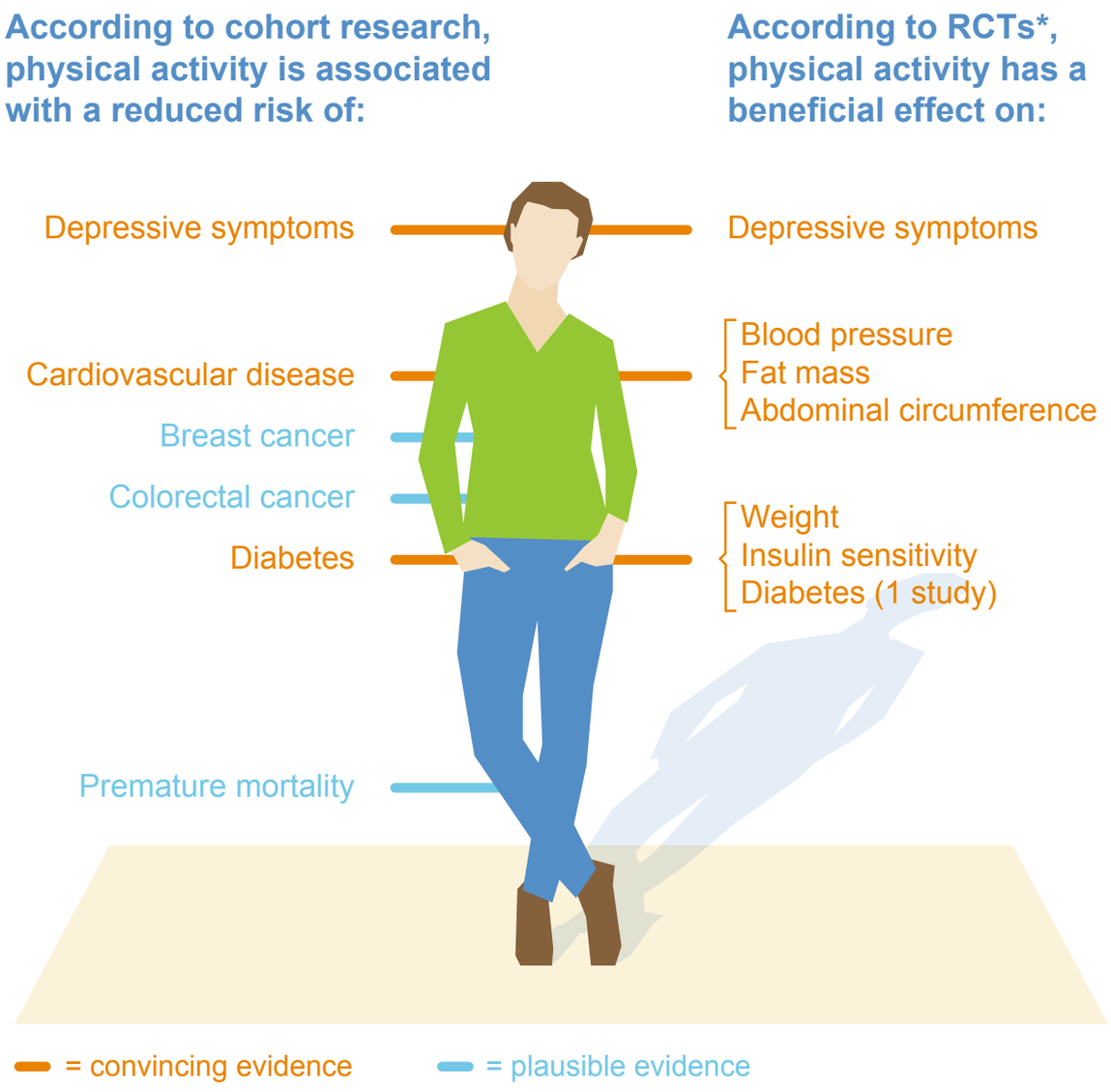
cardiovascular disease.[13] Cohort research reveals an association between a high level of physical activity and a reduced risk of cardiovascular disease.[22-24] This is supported by RCTs that demonstrate that endurance training and strength training reduce blood pressure.[25-27] In addition, endurance training also reduces fat mass and abdominal circumference.[26,28-30]

The cohort research provides some indication of the required amount and intensity of the physical activity. The key finding is: the more physical activity, the greater the beneficial effects. In relative terms, the greatest benefit can be achieved when a physically inactive person becomes active, i.e. engages in sufficient physical activity of at least moderate intensity: research shows that 75 minutes a week of moderately intensive physical activity reduces the risk of heart attack and heart failure; at 150 minutes a week, the risk decreases further, and at 300 minutes or more the effect is even more beneficial.[13,22,23] The stroke studies also shows a beneficial effect of physical activity of moderate and vigorous intensity.[24] RCTs confirm the importance of endurance training of moderate and vigorous intensity and of strength training three to five times a week, using the muscles of the hands or legs four times for two minutes.[25-27] Based on the RCTs, it is not possible to draw any conclusion regarding the amount of physical activity required. That is because the variation between the studies in frequency and duration of the endurance training and the intensity of the strength training is too large.

Convincing evidence was also found that more physical activity reduces the risk of diabetes.[13] Cohort research shows an association,[31,2] which is supported by findings from RCTs. For example, endurance training and strength training have been shown to improve insulin sensitivity.[33,34] Endurance training also reduces body weight in adults with normal weight, excess weight and obesity.[26,28,29,35-37] Finally, one specifically designed RCT has shown that physical activity reduces the risk of diabetes.[38] How much physical activity is required to reduce the risk of diabetes is not known on the basis of the cohort studies because the amount of physical activity was not quantified sufficiently.[31,32] Neither do the RCTs give a good indication. RCTs show that moderate to vigorous-intensity endurance training has a beneficial effect, but the variation in training frequency (three to six times a week) and duration (24 to 90 minutes[a]) was too large to say how much physical activity is needed.[26,28,29,33-36] RCTs that looked at strength training have found favourable effects for two to three training sessions a week at moderate to vigorous intensity. Again, the available data is too limited to determine the amount required.[33] In the only RCT to look at the effect of physical activity on diabetes, the training programmes used differed too widely (30 to 60 minutes of light activity per day to five to ten minutes of vigorous-intensity activity per day) in order to quantify the amount of physical activity required.[38]

[a] These data apply for the RCTs looking at insulin resistance. In the RCTs concerning weight in healthy adults, the variation was smaller: the training frequency ranged from three to five times a week and the duration from 30 to 60 minutes.[26,28,29,35]

Figure 2 **Health effects of physical activity**
Outcomes of research in adults



*RCT: randomized study with a control group

The effect of physical activity on the risk of depressive symptoms is also convincing[13]: cohort research shows an association between physical activity and lower risk of depressive symptoms.[37,39] This is supported by RCTs showing that endurance training of moderate to vigorous intensity and strength training reduce the risk of depressive symptoms.[40] As with diabetes, based on the studies, it is not possible to quantify how much physical activity is needed to achieve the beneficial effect.

2.2.2 Physical activity is associated with a lower risk of premature death, breast and colorectal cancer

Cohort research has found an association between physical activity and a reduced risk of premature death, breast cancer and colorectal cancer.[13,41-47] This makes it plausible that there is indeed an association. For premature mortality and breast cancer, there are indications that the greatest relative benefit is achieved when inactive persons (during free time) become active. Higher levels of physical activity are associated with further health gains.[41-46]

2.2.3 Conclusion

Figure 2 illustrates which health benefits can be achieved by physical activity in adults. Within this group, 75 minutes per week of physical activity at moderate intensity results in health benefits, 150 minutes per week yields further benefits still, and (over) double is even better for health. In cohort studies, the beneficial effects increase as the physical

activity increases. In relative terms, the greatest benefits can be achieved by moving from being physically inactive (no activity of moderate or vigorous intensity), to being active with moderate or vigorous intensity. RCTs find beneficial effects for moderate and vigorous intensity endurance training and strength training two to five times a week.

2.3 Older persons

The research in adults described often also includes older persons. In addition to these findings, there is evidence among older persons of an association between physical activity and the risk of fractures, disability, and cognitive decline and dementia.

2.3.1 Physical activity reduces the risk of fractures

It has been convincingly demonstrated that physical activity reduces the risk of fractures in older persons.[13] Cohort studies show that higher levels of physical activity are associated with a lower risk of fractures in general and hip fractures in particular[48,49], while RCTs demonstrate that the combination of endurance and strength training and/or balance exercises reduce the risk of fractures.[50]

The cohort research on fractures does not provide an indication of the amount of physical activity required, as this was insufficiently quantified in the studies.[48,49] In the RCTs looking at the combination of endurance training and strength training, the endurance training was of moderate to vigorous intensity. However, the frequency (one to seven times a week), duration (20 to 60 minutes per session), type of strength training and intensity (light to vigorous) varied too much to make a conclusive statement about the amount required.[50]

2.3.2 Strength training improves walking speed and muscle strength

It has been shown convincingly that strength training improves walking speed and muscle strength.[13] There are RCTs that show that strength training increases walking speed in older persons.[51,52] RCTs also show that strength training increases muscle strength and fat-free mass in older persons.[53,54]

In the RCTs, the beneficial effects on walking speed were found for strength training two to three times a week with 45 to 60 minute sessions.[51,52] Strength training two to three times a week at light to moderate intensity increases the fat-free mass[53] and the effect on muscle strength increases with the intensity of strength training.[54,55] These studies do not provide data about the number of exercises and the number of times they are performed for each training (volume), and therefore do not provide a basis for a statement about the quantification of physical activity needed to achieve the beneficial effect.

2.3.3 Physical activity is associated with a lower risk of disability, cognitive decline and dementia

It is plausible that physical activity is associated with a lower risk of

disability.[13] Cohort research finds such a link with a moderate to high level of physical activity.[56]

It is also plausible that higher levels of physical activity in older persons are associated with a lower risk of cognitive decline, dementia and Alzheimer's disease.[13] This has been shown by cohort studies.[57, 58]

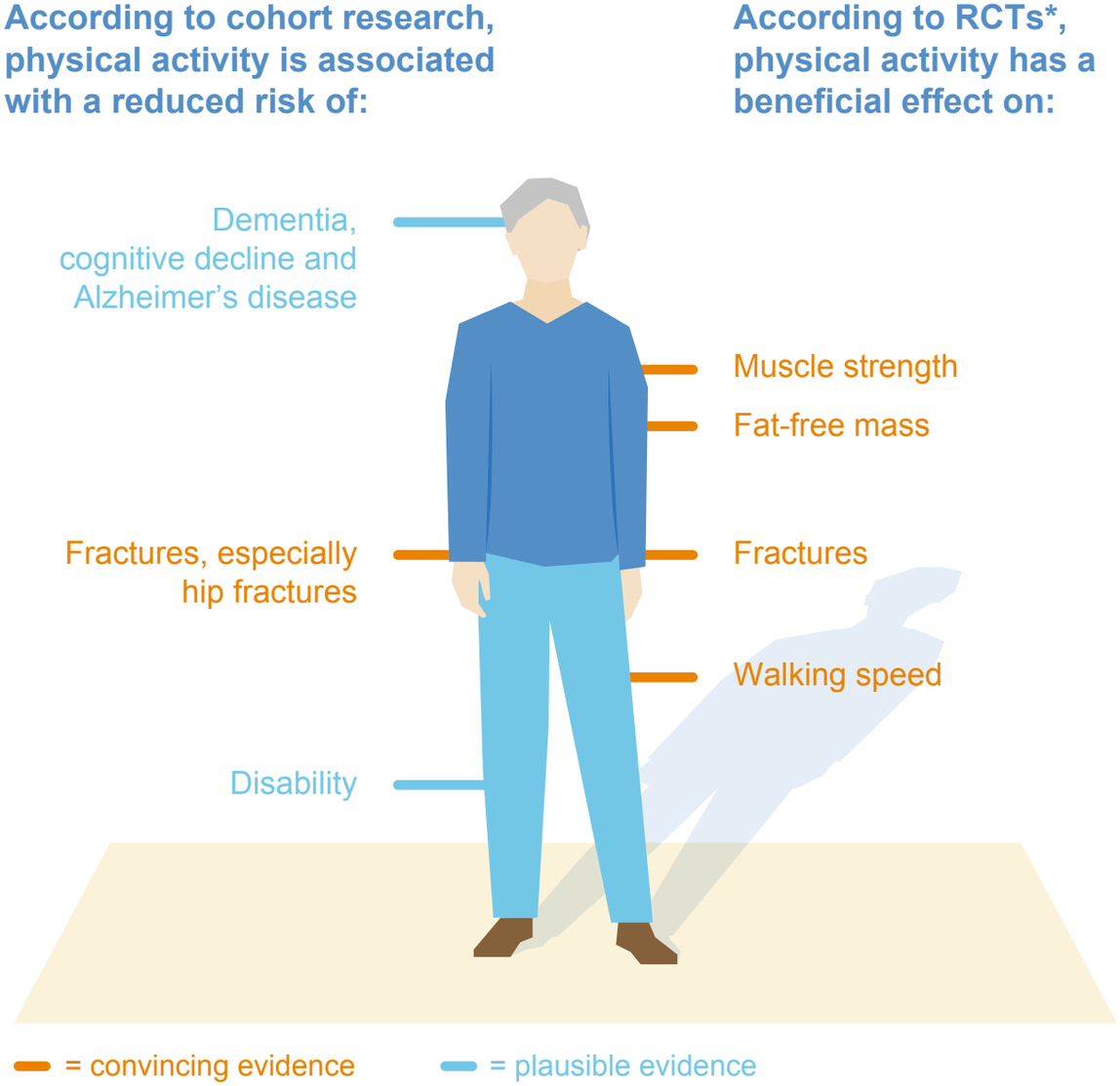
2.3.4 Conclusion

Figure 3 shows which health benefits are provided by physical activity for older persons. In addition to studies in adults, research performed specifically among older persons reveals beneficial effects for strength training two to three times a week and the combination of moderate to vigorous-intensity endurance training with strength training and/or balance exercises. The intensity and volume of the strength training cannot be specified in further detail. This also applies to the frequency, duration and volume of the combination of strength and endurance training.

2.4 Children

In children there is evidence that physical activity has a positive effect on (risk factors for) chronic diseases and indicators of fitness in children and adolescents. The studies were almost all conducted in children aged four years and above.

Figure 3 **Health effects of physical activity**
Outcomes of research in older persons



*RCT: randomized study with a control group

2.4.1 Physical activity reduces the risk of depressive symptoms

There is convincing evidence that physical activity reduces the risk of depressive symptoms.[13] Cohort research finds an association between increased physical activity in children and a lower risk of depressive symptoms[37,39,59] and RCTs show that endurance training in children with an increased risk of these symptoms reduces the chance that these will actually occur.[60]

The level of physical activity required for a beneficial effect is not clear. The amount of physical activity was not quantified in cohort studies.[37,39,59] The RCTs involved moderate to vigorous-intensity endurance training two to three times a week, but the variation in duration (20 to 90 minutes per session) is too large to draw a definitive conclusion on the amount required.[60]

2.4.2 Physical activity reduces body mass index and fat mass and improves insulin sensitivity and bone quality

It has been demonstrated convincingly that physical activity reduces body mass index (BMI) and fat mass in overweight and obese children, after natural growth is accounted for.[13,61,62] No effects have been found in children who are not overweight.[63-65] RCTs have found that endurance training at moderate to vigorous intensities has a beneficial effect on BMI and fat mass in overweight and obese children, although these effects are small. The variation in the frequency and duration of the sessions is too large to say how much training is required.[60-62,66]

It has also been shown convincingly that strength training during which body weight is used as resistance increases bone quality.[13] However, the required amount of strength training cannot be deduced from these RCTs.[67] The frequency and volume of physical activity in the studies varied too much, and there was insufficient information about its intensity. Finally, a combination of endurance and strength training improves insulin sensitivity.[13,68] The training done was 40 to 90 minutes, two to four times a week. Because no information is provided about the intensity or volume of training, these RCTs are not sufficient to quantify the amount of training required.[68]

2.4.3 Physical activity improves fitness

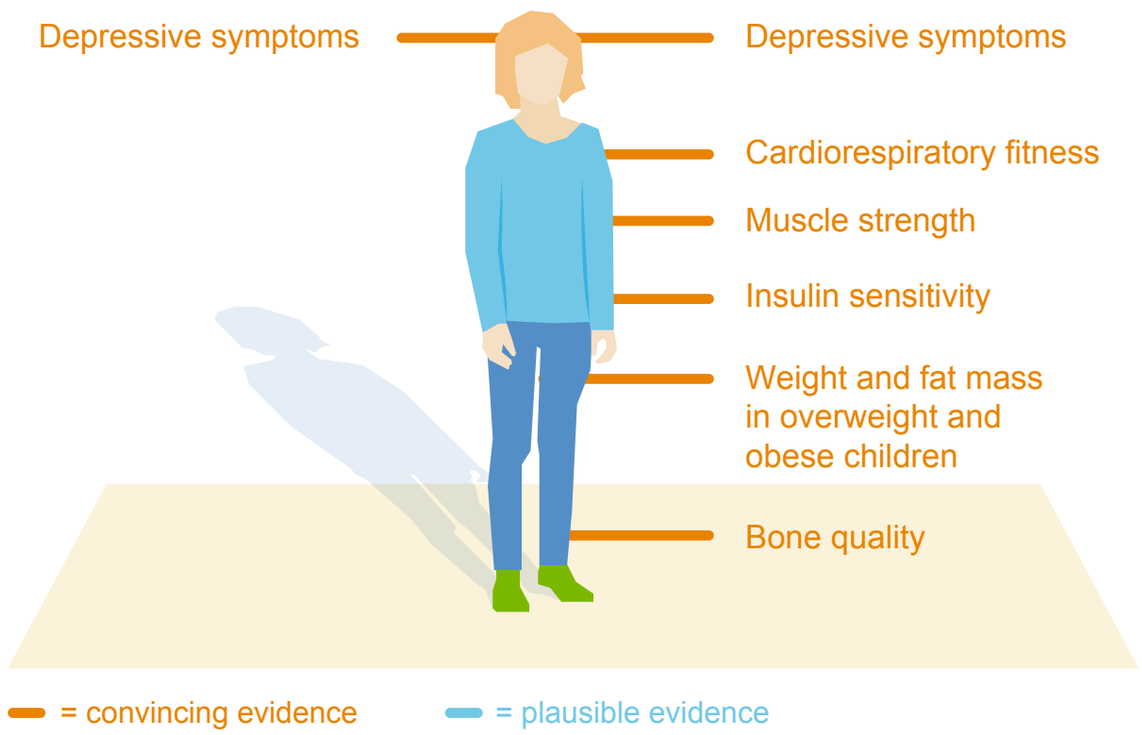
It has been demonstrated convincingly that endurance training improves cardiorespiratory fitness in children and that strength training increases muscle strength in children.[13] This is evident from RCTs.[66,69,70] For an effect on cardiorespiratory fitness, a combination of moderate to vigorous-intensity exercise is required.[66] Here too, the RCTs do not provide any evidence regarding the amount of physical activity required.[66,69,70]

2.4.4 Conclusion

Research in children has shown beneficial effects for endurance training of moderate to vigorous intensity and strength training, but, on the basis of the research, it is not possible to quantify the amount of physical activity

required. Figure 4 illustrates which health benefits can be achieved by physical activity in children.

Figure 4 **Health effects of physical activity**
Outcomes of research in children



*RCT: randomized study with a control group

2.5 Questions for further research

2.5.1 Intensity, duration and frequency

From the description of the research findings, it appears that on the basis of the research, only limited conclusions about the intensity, frequency and duration of physical activity required to achieve the beneficial effects are possible.

Furthermore, some aspects were substantiated less fully in previous guidelines. International guidelines, for example, specify that only ten minutes of uninterrupted physical activity count. The implications of this for health are unclear due to lack of research. Furthermore, there is too little research to say whether it is better to engage in physical activity every day or whether the recommended amount of physical activity in one or two longer sessions per week will lead to similar effects. In most RCTs, two to three endurance or strength training programmes were used every week, but no direct comparison with other frequencies is available.[13]

Cohort studies mainly measure physical activity in free time at moderate or vigorous intensity, as well as the total amount of physical activity. Whether physical activity at work or during household activities leads to similar health benefits, for example, has not been investigated sufficiently.

2.5.2 Questionnaires and accelerometers

Cohort research generally uses questionnaires that have limited validity.[71,72] Accelerometers can measure the actual amount and intensity

of physical activity accurately, but at the time of the literature review only a very limited number of cohort studies using accelerometers was available.[73-75] This also applies to the number of RCTs performed with accelerometers.[76,77]

The committee expects that cohort research involving accelerometers will, in the coming years, provide greater clarity regarding the total amount of physical activity required, and whether physical activity at work, for example, produces the same health benefits as leisure-time physical activity, and the significance of light-intensity activity for health. Furthermore, the effectiveness of intervention programmes in RCTs can be studied using accelerometers, and the extent to which any compensation effects occur when people engage in moderate to vigorous-intensity physical activity. This could include reducing the amount of low intensity activity or spending more time sitting.

2.5.3 Adverse effects of physical activity

In these recommendations, statements regarding the association between physical activity, sitting and musculo-skeletal disease are limited to osteoarthritis, fractures and injuries.[13,14] It is striking that only limited research has been done into the risk of injuries when following a programme of physical activity. The committee found weak evidence that a small proportion of people engaging in physical activity may suffer a slight injury, while it is unlikely that increased levels of physical activity increase the risk of serious injuries.[78] However, there are strong indications that the risk of injury is greater for contact sports than non-contact sports.[37,79] When deriving these guidelines, the committee did not consider the effect of posture while exercising, standing and sitting on the risk of musculoskeletal problems. Only a limited number of systematic reviews of prospective research are available on this subject, and these indicate the evidence in this area remains weak.[80-82]

2.6 Conclusion

Physical activity is healthy for all age groups. In adults, physical activity reduces the risks of cardiovascular disease, diabetes and depressive symptoms. Furthermore, higher levels of physical activity are associated with a lower risk of breast and colorectal cancer and premature death. The beneficial effects increase in proportion to the amount of physical activity done. The greatest health benefits are achieved by changing from being physically inactive to engaging in at least moderately intense physical activity. In adults, 75 minutes per week of moderately intense physical activity will yield a health benefit. At 150 minutes a week, the benefits are greater, and at 300 minutes or more even greater still. RCTs find beneficial effects for moderate and vigorous-intensity endurance training and strength training two to five times a week.

In older persons, physical activity also reduces the risk of bone fractures and improves muscle strength and walking speed. These beneficial effects are found with strength training two to three times a week and the combination of endurance, strength and/or balance training. Higher levels

of physical activity in older persons are also associated with a lower risk of disability, cognitive decline and dementia.
In children, physical activity lowers the risk of depressive symptoms, improves insulin sensitivity and bone quality, and reduces body mass index and fat mass in children who are overweight or obese. Physical activity also improves cardiorespiratory fitness and muscle strength in this group. These beneficial effects are found for endurance training of moderate to vigorous intensity and for strength training.

03
sitting for prolonged periods appears to have adverse health effects

Sitting for prolonged periods appears to have adverse health effects. In this section, the committee describes the limited research that has been carried out in this field.

3.1 Availability of research

3.1.1 Prolonged sitting is associated with a higher risk of premature death and cardiovascular disease mortality

It is plausible that prolonged sitting is associated with a higher risk of premature death and death from cardiovascular disease.[14] Cohort research shows this association for prolonged sitting (more than eight hours a day compared to less than four hours a day). The association becomes weaker as people engage in more physical activity and is not present in people who are very physically active.[83] On the basis of the research, it is not possible to quantify the amount of time spent sitting that causes these adverse associations.

3.2 Questions for further research

Limited cohort research has been carried out into the effects of sitting on health and almost no RCTs have addressed this question. This applies to research in children as well as adults and older persons. As a result, definitive conclusions regarding these effects are not possible.

In some cohort studies, watching television or the use of a screen are used as indicators for sitting.[84-88] It is unclear to what extent the outcomes relate to sitting in general and the extent to which the association is limited to watching television or use of a screen and other activities involved, such as the consumption of sugary drinks and snacks.[83]

Furthermore, the effect of sitting appears to depend on the degree of physical activity at moderate and vigorous intensity done. Future research using accelerometers is expected to provide better insight into the effects of sitting (and physical activity). This will involve not only the importance of reducing time spent sitting for health, but also the question of the importance of regular interruptions to sitting. For example, when sitting is completely replaced by light-intensity activity, or by standing and other light-intensity activities at regular intervals, does this lead to health benefits?

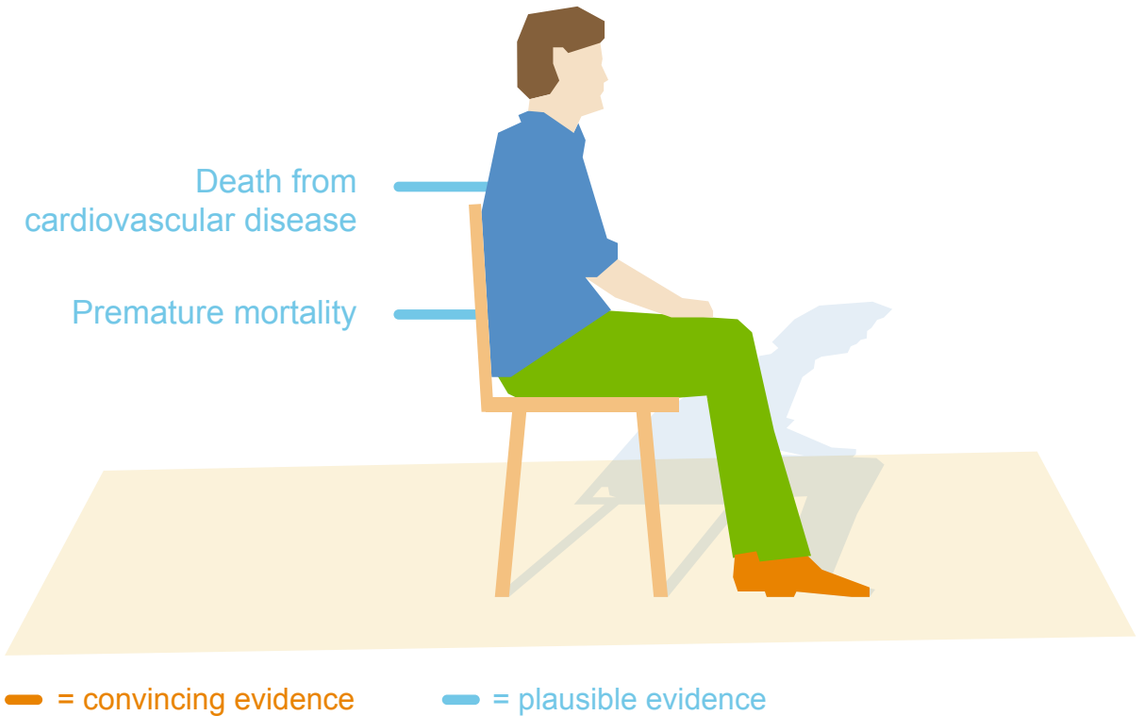
The committee recommends further research into these questions.

3.3 Conclusion

Prolonged sitting is related to an increased risk of death due to cardiovascular disease and premature death (Figure 5). This association becomes weaker the more physical activity that people engage in, and is not present in those who engage in a great deal of physical activity (significantly more than the current standard for physical activity). The scientific evidence for the health effects of sitting is currently much less strong than that for physical activity, both in adults and older persons, and in children. Therefore, no quantification is possible on the basis of the research.

Figure 5 **Health effects of prolonged sitting**
Outcomes of research in adults

According to cohort research, sitting is associated with an increased risk of:



04 physical activity guidelines

Having assessed the current state of scientific knowledge, the current standards for physical activity merit adjustment on a number of points in the view of the committee. In this section, the committee derives the new physical activity guidelines. Per age category, the section lists specific recommendations for moderate and vigorous-intensity physical activity, for muscle and bone strengthening activities and for sitting. It will also consider the current standards and insights from the research and from international guidelines. On the basis of its recommendations, the committee will then formulate specific physical activity guidelines for adults and older persons and children. At the end of this section, the committee compares the new guidelines with the previous standards.

4.1 Recommendations for adults and older persons

Engage in moderately intensive physical activity such as walking or cycling for at least 150 minutes a week, spread over several days. The longer you are physically active, and the more frequently and/or more vigorous the activity, the greater the health benefit derived.

The committee concludes that research in adults and older persons provides grounds for recommending at least 150 minutes of physical activity per week at moderate intensity, spread over several days.

Because in many studies, the amount of physical activity was insufficiently quantified, the research provides insufficient grounds for deviating from this widely used recommendation. It is clear, however, that higher levels of physical activity, in terms of duration, frequency and/or intensity, provide added health benefits. The committee has chosen one single guideline for adults and older persons because much adult research includes older persons. The research carried out specifically in older persons confirms the required intensity (moderate to vigorous). The advice to spread the physical activity over several days is influenced by the fact that in most RCTs, physical activity programmes that occur more than once a week were investigated.[13] However, the committee sees no scientific basis for spreading the 150 minutes over at least five days a week, nor for a continuous period of at least 10 minutes, as required by the current Dutch Standard for Healthy Physical Activity.[1,2,13] The committee concurs with the international criteria for light, moderate and vigorous intensity because there is no scientific reason to deviate from these, and because this facilitates international comparison. Various international guidelines recommend similar minimum amounts of physical activity for adults and older persons.[5-7,16-19]

Engage in physical activities that strengthen muscles and bones at least twice a week, such as climbing stairs, repeatedly rising from your chair, and strength training, and, for older persons, combine these with balance exercises.

The committee concludes that the benefits of muscle and bone-strengthening exercises in general, and the addition of balance exercises for older persons, have been proven. Because in most RCTs these

exercises were carried out two to three times per week, the committee recommends at least twice a week.[13]

This corresponds to international physical activity guidelines for muscle-strengthening activities (involving large muscle groups) at least twice a week. Some guidelines also recommend bone-strengthening exercises. Exercises that focus on balance and flexibility are sometimes covered by these guidelines and sometimes under the guidelines for persons with an increased risk of falling.[5-7,16-19]

Some physical activity is better than none

The committee wishes to emphasise that health benefits can be derived when adults who only engage in light-intensity physical activity start to engage in moderate or vigorous-intensity activity. Where the recommendations are not attainable, any physical activity is better than none, and this applies to everybody.[13]

4.2 Recommendations for children aged four to eighteen years

Engage in moderate to vigorous-intensity physical activity for at least one hour every day

The research evaluated does not provide enough indications to derive an exact quantification for this physical activity recommendation, and neither does it provide grounds for adapting the current standard.[13] The committee therefore advises children to engage in moderate to vigorous-intensity physical activity for at least one hour every day. International guidelines for this age range are broadly similar (at least one hour a day at moderate to vigorous intensity), with Germany being the only country to advise at least 90 minutes a day because German children already engage in physical activity for at least one hour a day on average. It is unclear whether this hour includes only moderate to vigorous-intensity activities or also light-intensity activity.[5-7,16-19]

The committee concurs with the international criteria for light, moderate and vigorous intensity because there is no scientific reason to deviate from this, and because this facilitates international comparison.

Engage in activities that strengthen muscles and bones at least three days a week, such as running, jumping and other activities where the body supports its own weight.

The research evaluated shows the beneficial effects of muscle and bone-strengthening activities. The research draws no conclusions regarding the number of times per week that is required. Neither did the committee find any research into the effects of exercises that focus on agility and coordination on risk factors and fitness.[13] Internationally, most countries recommend at least three times a week (as part of the vigorous-intensity physical activity)[6,7,16-19]; only the Dutch Standard for Healthy Physical Activity[1,2] mentions twice a week while Germany recommends two to three times a week.[5] The committee has chosen to concur with the international guidelines for physical activity, at least three times per week, in order to facilitate comparison.

4.3 Children aged zero to four years

4.3.1 No recommendation due to lack of research

The committee found no research that provides a basis for establishing a recommendation for this age group.[13] International physical activity guidelines for this age group are based on opinions of experts and experience in practice.[5-7,16] The Dutch Standard for Healthy Physical Activity includes no separate recommendations for young children.[1,2] The committee has chosen to make no specific recommendation for this age group. It emphasises that it is particularly important for young children to engage in varied forms of physical activity and to acquire motor skills.

4.4 Recommendation regarding sitting

Avoid prolonged sitting by engaging in regular physical activity. Where sitting cannot be avoided, ensure compliance with the recommendations on physical activity.

The research evaluated has enabled a qualitative recommendation but there is not yet enough data to make a quantitative recommendation. Those who comply with the physical activity recommendations are less likely to be exposed to health risks than those who do not. However, that risk is not eliminated entirely: that only applies when people are highly physically active (significantly above the current standard for physical activity). The recommendations are based on adult research, but the committee is of the opinion that this recommendation also applies to children aged four years and over and adolescents.[14]

The international guideline that advises the avoidance of prolonged sitting for children predates that for adults. Recent guidelines from Flanders, France, Germany, Australia and Great Britain now advise adults to limit the time that they spend sitting. The Flemish guideline recommends interrupting sitting every 20 to 30 minutes[20], while the French guideline[21] recommends doing so every 90 to 120 minutes. The variations in international guidelines illustrate that research into the health effects of sitting is still emerging.[5-7,16,20,21]

4.5 Physical activity guidelines

These recommendations lead to the following physical activity guidelines.

For adults and older persons:

- Physical activity is good for you – the more, the better.
- Engage in physical activity of moderate intensity for at least 150 minutes every week, spread over several different days. For example, walking and cycling. The longer you are physically active, and the more frequent and/or more vigorous the activity, the more your health will benefit.
- Engage in activities that strengthen your muscles and bones

at least twice a week. Older people should combine these with balance exercises.
- And: avoid spending long periods sitting down.

For children aged four to eighteen years:
- Physical activity is good for you – the more, the better.
- Engage in physical activity of moderate intensity for at least one hour every day. The longer you are physically active, and the more frequent and/or more vigorous the activity, the more your health will benefit.
- Do activities that strengthen your muscles and bones at least three times a week.
- And: avoid spending long periods sitting down.

4.6 How do the new guidelines relate to the current standards?

The new guidelines are very similar to the Dutch Standard for Healthy Physical Activity, the Fitnorm and the Combinorm.[1-4] However, there are some differences. Firstly, recommendations for moderate and vigorous-intensity activities are combined in the new guidelines, in accordance with the minister's request. Furthermore, in adults and older persons, the minimum amount of physical activity required is not expressed per day or in units of ten minutes, but per week, spread over a few days. There is also a new recommendation that these groups should do muscle and bone-strengthening activities, for older persons in combination with balance exercises. In children, these recommendations only relate to muscle and bone-strengthening exercises and, due to the absence of evidence, no longer relate to agility and coordination. For all age categories applies that the longer you are physically active, and the more frequent and/or vigorous the activity, the greater the health benefit will be. In addition, the classification of the intensity of physical activity has been brought into line with international guidelines (see inset on the characteristics of physical activity in Section 1).[5-7,16,19] These changes affect the extent to which the population complies with the physical activity guidelines: children are more likely to meet the new guidelines than the current standards and older persons less likely, while for adults there is little difference between the new guidelines and the current standards (see 5.1). Finally, the guideline related to sitting is new.

05 consequences for practice

A significant proportion of the Dutch population still do not meet the new physical activity guidelines. This calls for a sustained change in behaviour in the areas of physical activity and sitting. In this section, the committee describes the extent to which Dutch people currently comply with the new guidelines for physical activity and sitting. It will then address the desired shifts in behaviour, the implementation of the physical activity guidelines and the parties involved.

5.1 How is the Netherlands doing now?

RIVM estimates that 44% of adults and older persons currently meet the new physical activity guidelines of at least 150 minutes per week of physical activity at moderate intensity, spread over a number of days and muscle and bone-strengthening activities at least two days a week.[a] Over 40 percent of children engage in physical activity at moderate to vigorous intensity an hour every day and in muscle and bone-strengthening activities at least three days a week. These percentages have been calculated on the basis of data from the Lifestyle Monitor 2016 core module, which includes specific questions about physical activity and sports.[89]

In addition to the fact that not all Dutch people meet the physical activity guidelines, there are also many people who spend prolonged periods of time sitting.[90]

[a] 55 percent of children aged 4 to 11 years and 28 percent of children aged 12 to 17 years. Because levels of physical activity change with age, one questionnaire was used for children aged up to 11 years and a different one for the older age group.

Questionnaires can provide us with a good idea of any changes in physical activity and sitting, but they are less suitable when it comes to determining the actual amounts of physical activity and sitting.[71,72,91,92] The committee would therefore argue for the monitoring of physical activity in the Netherlands using accelerometers in addition to questionnaires.[93,94] In addition, the committee believes that significantly more research is needed on which factors can encourage people to engage in sufficient physical activity and discourage them from spending time sitting still.

5.2 Which changes in behaviour are desirable?

The committee emphasises that the new guideline for adults and older persons indicates a minimum level of physical activity that is important to health. People who find this level easy to achieve should aim for a higher level of activity. At the same time, those who currently engage in little or no physical activity should not be discouraged or daunted by the guidelines: among this group it is important to emphasise that any physical activity at all is better than nothing. In communication regarding the physical activity guidelines, the committee recommends emphasising that the more physical activity people do, the more their health will benefit.

5.3 Conclusion

The challenge is to achieve a lasting change in behaviour, increase levels of physical activity and decrease the length of time that people spend sitting. Therefore this is not just about encouraging people to engage in

more physical activity and spend less time sitting, but also ensuring that they continue to do so. In this regard, recommendations to build physical activity into people's daily lives can play a role, as well as exercise programmes and the design of the physical living environment.

5.3.1 Integrating physical activity into daily life

As already noted in relation to the current standards[1,2], the chance of a lasting change in physical activity levels is increased by – as well as doing sports – integrating physical activity into daily life, such as cycling to school or work, doing the shopping by foot, and taking the stairs instead of the elevator or escalator.

5.3.2 Physical activity programmes

Although a large number of physical activity programmes have been developed for various groups, their effectiveness has been very limited. According to the report on the German physical activity guidelines, only physical activity programmes for children at school have been shown to be effective (*strong evidence*). Much less research has been conducted into the effectiveness of physical activity programmes for children in other settings (at home, childcare, sports club, leisure time). There is, at best, a weak level of evidence for the effectiveness of physical activity programmes for adults and older persons and programmes aimed at the general population (*medium evidence* or *weak evidence/not researched*).[95] Systematic reviews of the quality of programmes that are in use provide no convincing evidence of their effectiveness. This is due to both a lack of good quality research and findings that are ambiguous.[96,97]

The committee recommends that research be carried out into the effectiveness of physical activity programmes and programmes that limit the amount of time spent sitting.

The use of accelerometers can help people understand how much they are moving around. However, many of these meters measure all movement and not only physical activity of moderate or vigirous intensity. As a result, users may be led to believe that they meet the physical activity guidelines when in reality this is not the case.[98] Whether the use of these meters actually motivates people to engage in physical activity and to continue doing so is another question that merits further investigation.[99]

5.3.3 Design of the living environment

Finally, a permanent change in physical activity habits could be promoted by taking this into account in the design of the living environment. Cross-sectional studies reveal an association between specific aspects of the physical environment and physical activity,[100-102] but there is scant hard evidence that changes in the physical environment lead to changes in physical activity.[103]

The committee concurs with the Health Council of the Netherlands' 2010 recommendation to utilise opportunities for changes in the physical living environment, despite the scarcity of evidence.[104] One recent example of this is the expansion of possibilities for outdoor recreation in and around cities.[105]

5.4 Parties involved

The physical activity guidelines describe the advice that should be issued regarding physical activity and sitting on the basis of the current state of scientific knowledge and from a public health perspective. Based on these guidelines, it may be difficult for people to conceptualise in concrete terms how they can engage in more physical activity and spend less time sitting. Those who are currently inactive, for example, will view this differently from those who are already physically active, and the situation for younger persons is different from that of older persons. The Knowledge Centre for Sport Netherlands is therefore working on translating the physical activity guidelines in a practical manner. This will include a special focus on informing the professionals who will work with the guidelines.

The guidelines focus primarily on physical activity behaviours among the general public but they are not the only party involved. The committee advises the minister to invest in interventions to ensure that people engage in more physical activity on a permanent basis. The success of such interventions can be maximised by working together with other parties, such as local government, employers and companies, schools, healthcare professionals and providers of effective physical activity programmes.

literature

1 Kemper HGC, Ooijendijk WTM, Stiggelbout M. *Consensus over de Nederlandse Norm voor Gezond Bewegen.* Tijdschr Soc Gezondheidsz 2000; 78: 180-3.

2 Hildebrandt VH, Ooijendijk WTM, Stiggelbout M. *Trendrapport bewegen en gezondheid 1998/1999*. Lelystad: Koninklijke Vermande, 1999.

3 Ministerie van Volksgezondheid, Welzijn en Sport. *Nota Tijd voor sport, bewegen, meedoen, presteren.* Vergaderjaar 2005.

4 Ooijendijk WTM, Hildebrandt VH, Hopman-Rock M. *Bewegen in Nederland 2000-2005*. Editor: Hildebrandt VH, Ooijendijk WTM and Hopman-Rock M. Trendrapport bewegen en gezondheid 2004/2005: Hoofddorp/Leiden: TNO; 2007.

5 Pfeifer K, Banzer W, Ferrari N, Fükézi E, Geidl W, Graf C, et al. *Recommenations for physical activity* Editor: Rütten A and Pfeifer K. National recommendations for physical activity and physical activity promotion: Erlangen: FAU University Press, 2016.

6 Australian Government Department of Health and Ageing. *Australia's Physical Activity and Sedentary Behaviour Guidelines*. 2014. http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines. Consulted on: 12-08-2015.

7 Department of Health, Physical Activity, Health Improvement and Protection. *Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers*. London: Department of Health, Physical Activity, Health Improvement and Protection, 2011.

8 Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion. *Physical activity basics. Glossary of terms*. 2015: http://www.cdc.gov/physicalactivity/basics/glossary/ Consulted on: 06-04-2016.

9 Sedentary Behaviour Research Network. *Letter to the editor: Standardized use of the terms "sedentary" and "sedentary behaviours".* Appl Physiol Nutr Metab 2012; 37(3): 540-2.

10 Naci H, Ioannidis JP. *Comparative effectiveness of exercise and drug interventions on mortality outcomes: metaepidemiological study*. BMJ 2013; 347: f5577.

11 Health Council of the Netherlands. *Overweight and obesity*. The Hague: Health Council of the Netherlands, 2003; publication no. 2003/07.

12 Health Council of the Netherlands. *Guidelines for a healthy diet 2006*. The Hague: Health Council of the Netherlands, 2006; publication no. 2006/21E.

13 Health Council of the Netherlands. *Physical activity and risk of chronic diseases. Background document to the Dutch physical activity guidelines 2017*. The Hague: Health Council of the Netherlands, 2017; publication no. 2017/08B.

14 Health Council of the Netherlands. *Sedentary behaviour and the risk of chronic diseases. Background document to the Dutch physical activity guidelines 2017*. The Hague: Health Council of the Netherlands, 2017; publication no. 2017/08C.

15 Health Council of the Netherlands. *Methodology for the evaluation of*

evidence. Background document to the Dutch physical activity guidelines 2017. The Hague: Health Council of the Netherlands, 2017; publication no. 2017/08Ae.

16 Canadian Society for Exercise Physiology. *Canadian Physical Activity Guidelines and Canadian Sedentary Behaviour Guidelines.* 2011. http://www.csep.ca/en/guidelines/read-the-guidelines. Consulted on: 10-02-2016.

17 World Health Organisation. *Global Recommendations on Physical Activity for Health*. Geneva: World Health Organisation, 2010.

18 US Department of Health. *2008 Physical Activity Guidelines for Americans*. 2008. http://www.health.gov/paguidelines/guidelines/default.aspx#toc. Consulted on: 12-08-2015.

19 Vlaams Insituut voor Gezondheidspromotie en ziektepreventie. *Aanbevelingen voor beweging*. Brussel: Vlaams Insituut voor Gezondheidspromotie en ziektepreventie, 2016

20 Vlaams Instituut voor Gezondheidspromotie en Ziektepreventie. *Aanbevelingen voor sedentair gedrag*. Brussel: Vlaams Instituut voor Gezondheidspromotie en Ziektepreventie, 2016.

21 French Agency for Food Environmental and Occupational Health & Safety. Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on the “Updating of the PNNS guidelines: Revision of the guidelines relating to physical activity and sedentarity”. Maisons-Alfort Cedex: French Agency for Food, Environmental and Occupational Health & Safety, 2015; ANSES Opinion Request No 2012-SA-0155.

22 Sattelmair J, Pertman J, Ding EL, Kohl HW, 3rd, Haskell W, Lee IM. *Dose response between physical activity and risk of coronary heart disease: a meta-analysis*. Circulation 2011; 124(7): 789-95.

23 Pandey A, Garg S, Khunger M, Darden D, Ayers C, Kumbhani DJ, et al. *Dose-Response Relationship Between Physical Activity and Risk of Heart Failure: A Meta-Analysis*. Circulation 2015; 132(19): 1786-94.

24 Li J, Siegrist J. *Physical activity and risk of cardiovascular disease--a meta-analysis of prospective cohort studies*. Int J Environ Res Public Health 2012; 9(2): 391-407.

25 Cornelissen VA, Smart NA. *Exercise training for blood pressure: a systematic review and meta-analysis*. J Am Heart Assoc 2013; 2(1): e004473.

26 Murtagh EM, Nichols L, Mohammed MA, Holder R, Nevill AM, Murphy MH. *The effect of walking on risk factors for cardiovascular disease: an updated systematic review and meta-analysis of randomised control trials*. Prev Med 2015; 72: 34-43.

27 Inder JD, Carlson DJ, Dieberg G, McFarlane JR, Hess NC, Smart NA. *Isometric exercise training for blood pressure management: a systematic review and meta-analysis to optimize benefit*. Hypertens Res 2016; 39(2): 88-94.

28 Gao HL, Gao HX, Sun FM, Zhang L. *Effects of walking on body composition in perimenopausal and postmenopausal women: a systematic review and meta-analysis*. Menopause 2016; 23(8): 928-34.

[29] Hespanhol Junior LC, Pillay JD, van Mechelen W, Verhagen E. *Meta-Analyses of the Effects of Habitual Running on Indices of Health in Physically Inactive Adults*. Sports Med 2015; 45(10): 1455-68.

[30] Kuhle CL, Steffen MW, Anderson PJ, Murad MH. *Effect of exercise on anthropometric measures and serum lipids in older individuals: a systematic review and meta-analysis*. BMJ open 2014; 4(6): e005283.

[31] Cloostermans L, Wendel-Vos W, Doornbos G, Howard B, Craig CL, Kivimaki M, et al. *Independent and combined effects of physical activity and body mass index on the development of Type 2 Diabetes - a meta-analysis of 9 prospective cohort studies*. Int J Behav Nutr Phys Act 2015; 12: 147.

[32] Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. *Physical activity and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis*. Eur J Epidemiol 2015; 30(7): 529-42.

[33] Mann S, Beedie C, Balducci S, Zanuso S, Allgrove J, Bertiato F, et al. *Changes in insulin sensitivity in response to different modalities of exercise: a review of the evidence*. Diabetes Metab Res Rev 2014; 30(4): 257-68.

[34] Lin X, Zhang X, Guo J, Roberts CK, McKenzie S, Wu WC, et al. *Effects of Exercise Training on Cardiorespiratory Fitness and Biomarkers of Cardiometabolic Health: A Systematic Review and Meta-Analysis of Randomized Controlled Trials*. J Am Heart Assoc 2015; 4(7).

[35] Weber Buchholz S, Wilbur J, Halloway S, McDevitt JH, Schoeny ME. *Physical activity intervention studies and their relationship to body composition in healthy women*. Editor: Kasper CE and Smith BA. Annual review of nursing research. Excercise in health and disease: 71-142. New York: Springer Publishing Company; 2013.

[36] Thorogood A, Mottillo S, Shimony A, Filion KB, Joseph L, Genest J, et al. *Isolated aerobic exercise and weight loss: a systematic review and meta-analysis of randomized controlled trials*. Am J Med 2011; 124(8): 747-55.

[37] US Department of Health and Human Services. *Phyiscal activity guidelines advisory committee report.* Washington: US Department of Health and Human Services, 2008.

[38] Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. *Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study*. Diabetes Care 1997; 20(4): 537-44.

[39] Mammen G, Faulkner G. *Physical activity and the prevention of depression: a systematic review of prospective studies*. Am J Prev Med 2013; 45(5): 649-57.

[40] Rethorst CD, Wipfli BM, Landers DM. *The antidepressive effects of exercise: a meta-analysis of randomized trials*. Sports Med 2009; 39(6): 491-511.

[41] Arem H, Moore SC, Patel A, Hartge P, Berrington de Gonzalez A, Visvanathan K, et al. *Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship*. JAMA Intern Med 2015; 175(6): 959-67.

[42] Ekelund U, Ward HA, Norat T, Luan J, May AM, Weiderpass E, et al. *Physical activity and all-cause mortality across levels of overall and abdominal adiposity in European men and women: the European Prospective Investigation into Cancer and Nutrition Study (EPIC)*. Am J Clin Nutr 2015; 101(3): 613-21.

[43] Hupin D, Roche F, Gremeaux V, Chatard JC, Oriol M, Gaspoz JM, et al. *Even a low-dose of moderate-to-vigorous physical activity reduces mortality by 22% in adults aged >/=60 years: a systematic review and meta-analysis*. Br J Sports Med 2015; 49(19): 1262-7.

[44] Moore SC, Lee IM, Weiderpass E, Campbell PT, Sampson JN, Kitahara CM, et al. *Association of Leisure-Time Physical Activity With Risk of 26 Types of Cancer in 1.44 Million Adults*. JAMA Intern Med 2016; 176(6): 816-25.

[45] Wu Y, Zhang D, Kang S. *Physical activity and risk of breast cancer: a meta-analysis of prospective studies*. Breast Cancer Res Treat 2013; 137(3): 869-82.

[46] Liu L, Shi Y, Li T, Qin Q, Yin J, Pang S, et al. *Leisure time physical activity and cancer risk: evaluation of the WHO's recommendation based on 126 high-quality epidemiological studies*. Br J Sports Med 2016; 50(6): 372-8.

[47] Robsahm TE, Aagnes B, Hjartaker A, Langseth H, Bray FI, Larsen IK. *Body mass index, physical activity, and colorectal cancer by anatomical subsites: a systematic review and meta-analysis of cohort studies*. Eur J Cancer Prev 2013; 22(6): 492-505.

[48] Qu X, Zhang X, Zhai Z, Li H, Liu X, Li H, et al. *Association between physical activity and risk of fracture*. J Bone Miner Res 2014; 29(1): 202-11.

[49] Rong K, Liu XY, Wu XH, Li XL, Xia QQ, Chen J, et al. *Increasing Level of Leisure Physical Activity Could Reduce the Risk of Hip Fracture in Older Women: A Dose-Response Meta-analysis of Prospective Cohort Studies*. Medicine (Baltimore) 2016; 95(11): e2984.

[50] Kemmler W, Haberle L, von Stengel S. *Effects of exercise on fracture reduction in older adults: a systematic review and meta-analysis*. Osteoporos Int 2013; 24(7): 1937-50.

[51] Abbema R van, de Greef M, Craje C, Krijnen W, Hobbelen H, van der Schans C. *What type, or combination of exercise can improve preferred gait speed in older adults? A meta-analysis*. BMC Geriatr 2015; 15: 72.

[52] Hortobagyi T, Lesinski M, Gabler M, VanSwearingen JM, Malatesta D, Granacher U. *Effects of Three Types of Exercise Interventions on Healthy Old Adults' Gait Speed: A Systematic Review and Meta-Analysis*. Sports Med 2015; 45(12): 1627-43.

[53] Peterson MD, Sen A, Gordon PM. *Influence of resistance exercise on lean body mass in aging adults: a meta-analysis*. Med Sci Sports Exerc 2011; 43(2): 249-58.

[54] Borde R, Hortobagyi T, Granacher U. *Dose-Response Relationships of Resistance Training in Healthy Old Adults: A Systematic Review and Meta-Analysis*. Sports Med 2015; 45(12): 1693-720.

[55] Labra C de, Guimaraes-Pinheiro C, Maseda A, Lorenzo T, Millan-

Calenti JC. *Effects of physical exercise interventions in frail older adults: a systematic review of randomized controlled trials*. BMC Geriatr 2015; 15: 154.

56 Tak E, Kuiper R, Chorus A, Hopman-Rock M. *Prevention of onset and progression of basic ADL disability by physical activity in community dwelling older adults: a meta-analysis*. Ageing Res Rev 2013; 12(1): 329-38.

57 Beckett MW, Ardern CI, Rotondi MA. *A meta-analysis of prospective studies on the role of physical activity and the prevention of Alzheimer's disease in older adults*. BMC Geriatr 2015; 15: 9.

58 Blondell SJ, Hammersley-Mather R, Veerman JL. *Does physical activity prevent cognitive decline and dementia?: A systematic review and meta-analysis of longitudinal studies*. BMC Public Health 2014; 14: 510.

59 Bursnall P. *The relationship between physical activity and depressive symptoms in adolescents: a systematic review*. Worldviews Evid Based Nurs 2014; 11(6): 376-82.

60 Brown HE, Pearson N, Braithwaite RE, Brown WJ, Biddle SJ. *Physical activity interventions and depression in children and adolescents : a systematic review and meta-analysis*. Sports Med 2013; 43(3): 195-206.

61 Kelley GA, Kelley KS, Pate RR. *Effects of exercise on BMI z-score in overweight and obese children and adolescents: a systematic review with meta-analysis*. BMC Pediatr 2014; 14: 225.

62 Stoner L, Rowlands D, Morrison A, Credeur D, Hamlin M, Gaffney K, et al. *Efficacy of Exercise Intervention for Weight Loss in Overweight and Obese Adolescents: Meta-Analysis and Implications*. Sports Med 2016; 46(11): 1737-51.

63 Mei H, Xiong Y, Xie S, Guo S, Li Y, Guo B, et al. *The impact of long-term school-based physical activity interventions on body mass index of primary school children - a meta-analysis of randomized controlled trials*. BMC Public Health 2016; 16: 205.

64 Cesa CC, Sbruzzi G, Ribeiro RA, Barbiero SM, de Oliveira Petkowicz R, Eibel B, et al. *Physical activity and cardiovascular risk factors in children: meta-analysis of randomized clinical trials*. Prev Med 2014; 69: 54-62.

65 Guerra PH, Nobre MR, Silveira JA, Taddei JA. *The effect of school-based physical activity interventions on body mass index: a meta-analysis of randomized trials*. Clinics (Sao Paulo) 2013; 68(9): 1263-73.

66 Okely AD, Salmon J, Vella SA, Cliff D, Timperio A, Tremblay MS, et al. *Systematic review to update Australian physical activity guidelines for children and young people. Report prepared for the Australian Government Department of Health*. 2012. http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines/$File/SR-APAGCYP.pdf. Consulted on: 30-02-2016.

67 Behringer M, Gruetzner S, McCourt M, Mester J. *Effects of weight-bearing activities on bone mineral content and density in children and adolescents: a meta-analysis*. J Bone Miner Res 2014; 29(2): 467-78.

68 Fedewa MV, Gist NH, Evans EM, Dishman RK. *Exercise and insulin*

resistance in youth: a meta-analysis. Pediatrics 2014; 133(1): e163-74.

69 Lesinski M, Prieske O, Granacher U. *Effects and dose-response relationships of resistance training on physical performance in youth athletes: a systematic review and meta-analysis*. Br J Sports Med 2016; 50(13): 781-95.

70 Behringer M, Vom Heede A, Yue Z, Mester J. *Effects of resistance training in children and adolescents: a meta-analysis*. Pediatrics 2010; 126(5): e1199-210.

71 Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U. *A systematic review of reliability and objective criterion-related validity of physical activity questionnaires*. Int J Behav Nutr Phys Act 2012; 9: 103.

72 Silsbury Z, Goldsmith R, Rushton A. *Systematic review of the measurement properties of self-report physical activity questionnaires in healthy adult populations*. BMJ open 2015; 5(9): e008430.

73 Klenk J, Dallmeier D, Denkinger MD, Rapp K, Koenig W, Rothenbacher D, et al. *Objectively Measured Walking Duration and Sedentary Behaviour and Four-Year Mortality in Older People*. PLoS One 2016; 11(4): e0153779.

74 Fishman EI, Steeves JA, Zipunnikov V, Koster A, Berrigan D, Harris TA, et al. *Association between Objectively Measured Physical Activity and Mortality in NHANES*. Med Sci Sports Exerc 2016.

75 Koster A, Caserotti P, Patel KV, Matthews CE, Berrigan D, van Domelen DR, et al. *Association of sedentary time with mortality independent of moderate to vigorous physical activity*. PLoS One 2012; 7(6): e37696.

76 Falck RS, McDonald SM, Beets MW, Brazendale K, Liu-Ambrose T. *Measurement of physical activity in older adult interventions: a systematic review*. Br J Sports Med 2016; 50(8): 464-70.

77 Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput JP, Janssen I, et al. *Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth*. Appl Physiol Nutr Metab 2016; 41(6 Suppl 3): S197-239.

78 Girardi A, Babul S, Rajabali F, Pike I. *The injury consequences of promoting physical activity: an evidence review. A report prepared by the BC Injury Research and Prevention Unit for the Provincial Health Services Authority.* Vancouver, BC, 2013.

79 Brown WJ, Bauman AE, Bull FC, Burton NW. *Development of evidence-based physical activity recommendations for adults (18-64 years)*. 2012. http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines/$File/DEB-PAR-Adults-18-64years.pdf. Consulted on: 30-03-1016.

80 Bakker EW, Verhagen AP, van Trijffel E, Lucas C, Koes BW. *Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies*. Spine (Phila Pa 1976) 2009; 34(8): E281-93.

81 Chen SM, Liu MF, Cook J, Bass S, Lo SK. *Sedentary lifestyle as a risk*

factor for low back pain: a systematic review. Int Arch Occup Environ Health 2009; 82(7): 797-806.

82 Brink Y, Louw QA. *A systematic review of the relationship between sitting and upper quadrant musculoskeletal pain in children and adolescents*. Man Ther 2013; 18(4): 281-8.

83 Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE, et al. *Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women*. Lancet 2016; 388(10051): 1302-10.

84 Wilmot EG, Edwardson CL, Achana FA, Davies MJ, Gorely T, Gray LJ, et al. *Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis*. Diabetologia 2012; 55(11): 2895-905.

85 Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS, et al. *Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis*. Annals of internal medicine 2015; 162(2): 123-32.

86 Zhou Y, Zhao H, Peng C. *Association of sedentary behavior with the risk of breast cancer in women: update meta-analysis of observational studies*. Annals of epidemiology 2015; 25(9): 687-97.

87 Cong YJ, Gan Y, Sun HL, Deng J, Cao SY, Xu X, et al. *Association of sedentary behaviour with colon and rectal cancer: a meta-analysis of observational studies*. British journal of cancer 2014; 110(3): 817-26.

88 Zhai L, Zhang Y, Zhang D. *Sedentary behaviour and the risk of depression: a meta-analysis*. Br J Sports Med 2015; 49(11): 705-9.

89 Centraal Bureau voor de Statistiek in samenwerking met Rijksinstituut voor Volksgezondheid en Milieu. *Gezondheidsenquête/Leefstijlmonitor*, 2016.

90 Rijksinstituut voor Volksgezondheid en Milieu. *Sport Kernindicatoren*. 2017. https://www.volksgezondheidenzorg.info/sport/kernindicatoren/beweeg-en-zitgedrag#!node-beweeggedrag-naar-leeftijd. Consulted on: 13-04-2017.

91 Lubans DR, Hesketh K, Cliff DP, Barnett LM, Salmon J, Dollman J, et al. *A systematic review of the validity and reliability of sedentary behaviour measures used with children and adolescents*. Obes Rev 2011; 12(10): 781-99.

92 Clark BK, Sugiyama T, Healy GN, Salmon J, Dunstan DW, Owen N. *Validity and reliability of measures of television viewing time and other non-occupational sedentary behaviour of adults: a review*. Obes Rev 2009; 10(1): 7-16.

93 Loyen A, Clarke-Cornwell AM, Anderssen SA, Hagstromer M, Sardinha LB, Sundquist K, et al. *Sedentary Time and Physical Activity Surveillance Through Accelerometer Pooling in Four European Countries*. Sports Med 2016; 47(7): 1421-35.

94 Loyen A, Van Hecke L, Verloigne M, Hendriksen I, Lakerveld J, Steene-Johannessen J, et al. Variation in population levels of physical activity in European adults according to cross-European studies: a systematic

literature review within DEDIPAC. Int J Behav Nutr Phys Act 2016; 13: 72.

[95] Rütten A, Abu-Omar K, Burlacu I, Gediga G, Messing S, Pfeifer K, et al. *Recommendations for physical activity promotion*. Editor: Rütten A and Pfeifer K. National recommendations for physical activity and physical activity promotion: Erlangen: FAU University Press; 2016.

[96] Altenburg TM, Kist-van Holthe J, Chinapaw MJ. *Effectiveness of intervention strategies exclusively targeting reductions in children's sedentary time: a systematic review of the literature*. Int J Behav Nutr Phys Act 2016; 13: 65.

[97] Wu L, Sun S, He Y, Jiang B. *The effect of interventions targeting screen time reduction: A systematic review and meta-analysis*. Medicine (Baltimore) 2016; 95(27): e4029.

[98] Thompson D, Batterham AM, Peacock OJ, Western MJ, Booso R. *Feedback from physical activity monitors is not compatible with current recommendations: A recalibration study*. Prev Med 2016; 91: 389-94.

[99] Gierisch JM, Goode AP, Batch BC, Huffman KN, Hall KS, Hastings SN, et al. The Impact of Wearable Motion Sensing Technologies on Physical Activity: A Systematic Review: Washington (DC): Department of Veterans Affairs (US), 2015.

[100] Malambo P, Kengne AP, De Villiers A, Lambert EV, Puoane T. *Built Environment, Selected Risk Factors and Major Cardiovascular Disease Outcomes: A Systematic Review*. PLoS One 2016; 11(11): e0166846.

[101] Cerin E, Nathan A, van Cauwenberg J, Barnett DW, Barnett A, Council on E, et al. *The neighbourhood physical environment and active travel in older adults: a systematic review and meta-analysis*. Int J Behav Nutr Phys Act 2017; 14(1): 15.

[102] McGrath LJ, Hopkins WG, Hinckson EA. *Associations of objectively measured built-environment attributes with youth moderate-vigorous physical activity: a systematic review and meta-analysis*. Sports Med 2015; 45(6): 841-65.

[103] Benton JS, Anderson J, Hunter RF, French DP. *The effect of changing the built environment on physical activity: a quantitative review of the risk of bias in natural experiments*. Int J Behav Nutr Phys Act 2016; 13(1): 107.

[104] Health Council of the Netherlands. *On the move. The effect of the built environment on our physical activity*. The Hague: Health Council of the Netherlands, 2010; publication no. 2010/04.

[105] Health Council of the Netherlands. *Healthy green spaces in and around the city.* The Hague: Health Council of the Netherlands, 2017; publication no. 2017/05.

The Health Council of the Netherlands, established in 1902, is an independent scientific advisory body. Its remit is “to advise the government and Parliament on the current level of knowledge with respect to public health issues and health (services) research...” (Section 22, Health Act).
The Health Council receives most requests for advice from the Ministers of Health, Welfare and Sport, Infrastructure and the Environment, Social Affairs and Employment, and Economic Affairs. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.
Most Health Council reports are prepared by multidisciplinary committees of Dutch or, sometimes, foreign experts, appointed in a personal capacity. The reports are available to the public.

This publiation can be downloaded from www.healthcouncil.nl.

Preferred citation:
Health Council of the Netherlands. Physical activity guidelines 2017.
The Hague: Health Council of the Netherlands, 2017; publication no. 2017/08e.