

PART D. INTEGRATING THE EVIDENCE

Table of Contents

Introduction	D-1
Overall Benefits.....	D-4
Question 1. What does current scientific evidence reveal about the relationship between moderate-to-vigorous physical activity and risk of developing a variety of chronic diseases and other conditions?	D-4
Question 2. Does current evidence indicate that people who habitually perform greater amounts of moderate-to-vigorous physical activity feel better and sleep better?	D-6
Question 3. Does the evidence indicate that people who are more physically active are better able to perform everyday tasks without undue fatigue?	D-7
Question 4. How soon do the benefits of physical activity accrue?	D-7
Question 5. What does the evidence indicate about the public health target range, or “dose,” of moderate-to-vigorous physical activity that is likely to provide many of the health benefits listed in Table 1?	D-8
Question 6. What does the evidence indicate about the benefits of moderate-to-vigorous physical activity below or above the target range?	D-9
Question 7. What does current evidence indicate about the importance of the intensity, duration, and frequency of moderate-to-vigorous physical activity that comprise the weekly target volume of physical activity?	D-10
Question 8. What does current scientific evidence demonstrate about the relationship between sedentary behavior and the risk of developing various chronic diseases or conditions?	D-12
Question 9. What does current scientific evidence indicate about how the risks of sedentary behavior and the benefits of moderate-to-vigorous physical activity interact to determine overall risk or benefit?	D-12
Question 10. How do different types of physical activity contribute to health outcomes?	D-14
Question 11. What does the scientific evidence indicate about the association between walking and health benefits?	D-16
2018 Physical Activity Guidelines Advisory Committee Scientific Report	D-1

Part D. Integrating the Evidence

Brain Health D-17

 Question 12. Is there evidence that moderate-to-vigorous physical activity influences brain-related health outcomes? D-17

Youth..... D-19

 Question 13. Does current evidence indicate health and fitness benefits from physical activity for children and youth? D-19

 Question 14. What does the evidence indicate about the type and dose of physical activity most likely to produce these health benefits among children?..... D-19

Older Adults D-20

 Question 15. Is there evidence that the target range for moderate-to-vigorous physical activity should differ for older adults? D-20

 Question 16. Is there evidence of health benefits of particular importance for older adults?..... D-21

Selected Common Chronic Conditions D-21

 Question 17. Does the evidence indicate that habitual moderate-to-vigorous physical activity provides preventive health benefits to individuals with some common chronic conditions?..... D-21

Pregnancy..... D-23

 Question 18. Is there evidence regarding the benefits or risks of light-to-moderate intensity physical activity during pregnancy and the postpartum period?..... D-23

Weight Status..... D-24

 Question 19. Does the evidence demonstrate that moderate-to-vigorous physical activity contributes to preventing or minimizing excessive weight gain?..... D-24

 Question 20. Does moderate-to-vigorous physical activity provide health benefits for people with overweight or obesity even if their weight status remains the same? D-24

Influence of Race or Ethnicity, and Socioeconomic Status on Health Outcomes..... D-25

 Question 21. Is there evidence that the volume of moderate-to-vigorous physical activity associated with health benefits differs by race or ethnicity, or socioeconomic status?..... D-25

Adverse Events..... D-25

Part D. Integrating the Evidence

Question 22. What does the scientific evidence indicate about the pattern of physical activity that is most likely to produce the fewest adverse medical events while providing benefits?.....	D-25
Question 23. What does the scientific evidence say about actions that can be taken to reduce the risk of injury during physical activity?	D-26
Question 24. Is there evidence regarding who should see a physician or have a medical examination before increasing the amount or intensity of physical activity they perform?	D-27
Promotion of Physical Activity	D-27
Question 25. What interventions are effective for promoting regular physical activity participation? D-27	
Question 26. What interventions are effective for reducing sedentary behavior?.....	D-29
References	D-30

INTRODUCTION

This chapter, *Part D. Integrating the Evidence*, is the final step in the development of this report. *Part F. The Science Base* contains the findings from the Subcommittees' reviews of the scientific literature about the relationships between physical activity and selected health outcomes or conditions, about the importance of physical activity for selected age groups or populations, about the types of physical activity that influence health outcomes, and about the promotion of physical activity. Each chapter in Part F provides a review of the scientific literature on one or more specific topics. The conclusions of each chapter were discussed and approved at the public meetings over the course of the Committee's deliberations. The purpose of this chapter is to summarize findings from the various chapters in Part F that share a similar feature, such as improved health or reduced risk of disease, a common population group, such as youth or older adults, or that pertain to the types and amounts of physical activity associated with the observed benefits. The chapter uses a question-and-answer format to address questions typically raised by the public, policy makers, and health and fitness professionals.

OVERALL BENEFITS

Question 1. What does current scientific evidence reveal about the relationship between moderate-to-vigorous physical activity and risk of developing a variety of chronic diseases and other conditions?

Current evidence from large numbers of peer-reviewed scientific articles expands the previously documented health benefits that accrue to more physically active individuals when compared to less physically active individuals¹ (Table D-1). Notably, a greater volume of moderate-to-vigorous physical activity is associated with a reduced risk of excessive weight gain for both the general population and for pregnant women. Regular moderate-to-vigorous physical activity also reduces feelings of anxiety and depression, and improves sleep and quality of life. A single episode provides temporary improvements in cognitive function. Current evidence demonstrates that even young children, ages 3 to 5 years, have greater bone strength and a healthier weight status if they are more physically active. Among older adults, regularly performed physical activity reduces the risk of dementia, improves physical function (the ability to accomplish routine tasks) and reduces the risk of falling and the risk of injury if a fall does occur. Current evidence also demonstrates that more physical activity reduces the risk of cancers of the bladder, breast, colon, endometrium, esophagus (adenocarcinoma), kidney, stomach, and lung. For people with colorectal cancer, women with breast cancer, and men with prostate cancer, greater amounts of physical activity are associated with reduced risk of mortality from the original type of cancer; for people with colorectal cancer or women with breast cancer, greater amounts of physical activity are associated with reduced risk of all-cause mortality. Physical activity-related benefits also have been demonstrated for the large number of individuals who already have one or more chronic conditions, such as osteoarthritis, hypertension, type 2 diabetes, dementia, multiple sclerosis, spinal cord injury, stroke, Parkinson's disease, schizophrenia, attention deficit hyperactivity disorder, and recent hip fracture. Individuals considered to be frail also benefit from regular physical activity.

Table D-1. Physical Activity-Related Health Benefits for the General Population and Selected Populations Documented by the 2018 Physical Activity Guidelines Advisory Committee

Children	
3 to <6 Years of Age	Improved bone health and weight status
6 to 17 years of age	Improved cognitive function (ages 6 to 13 years) Improved cardiorespiratory and muscular fitness Improved bone health Improved cardiovascular risk factor status Improved weight status or adiposity Fewer symptoms of depression
Adults, all ages	
All-cause mortality	Lower risk
Cardiometabolic conditions	Lower cardiovascular incidence and mortality (including heart disease and stroke) Lower incidence of hypertension Lower incidence of type 2 diabetes
Cancer	Lower incidence of bladder, breast, colon, endometrium, esophagus, kidney, stomach, and lung cancers
Brain health	Reduced risk of dementia Improved cognitive function Improved cognitive function following bouts of aerobic activity Improved quality of life Improved sleep Reduced feelings of anxiety and depression in healthy people and in people with existing clinical syndromes Reduced incidence of depression
Weight status	Reduced risk of excessive weight gain Weight loss and the prevention of weight regain following initial weight loss when a sufficient dose of moderate-to-vigorous physical activity is attained An additive effect on weight loss when combined with moderate dietary restriction
Older Adults	
Falls	Reduced incidence of falls Reduced incidence of fall-related injuries
Physical function	Improved physical function in older adults with and without frailty
Women who are Pregnant or Postpartum	
During pregnancy	Reduced risk of excessive weight gain Reduced risk of gestational diabetes No risk to fetus from moderate-intensity physical activity
During postpartum	Reduced risk of postpartum depression

Individuals with Pre-Existing Medical Conditions	
Breast cancer	Reduced risk of all-cause and breast cancer mortality
Colorectal cancer	Reduced risk of all-cause and colorectal cancer mortality
Prostate cancer	Reduced risk of prostate cancer mortality
Osteoarthritis	Decreased pain Improved function and quality of life
Hypertension	Reduced risk of progression of cardiovascular disease Reduced risk of increased blood pressure over time
Type 2 diabetes	Reduced risk of cardiovascular mortality Reduced progression of disease indicators: hemoglobin A1c, blood pressure, blood lipids, and body mass index
Multiple sclerosis	Improved walking Improved physical fitness
Dementia	Improved cognition
Some conditions with impaired executive function (attention deficit hyperactivity disorder, schizophrenia, multiple sclerosis, Parkinson’s disease, and stroke)	Improved cognition

Note: Benefits in **bold font** are those added in 2018; benefits in normal font are those noted in the 2008 Scientific Report.¹ Only outcomes with strong or moderate evidence of effect are included in the table.

Question 2. Does current evidence indicate that people who habitually perform greater amounts of moderate-to-vigorous physical activity feel better and sleep better?

People who are more physically active feel better and sleep better (see *Part F. Chapter 3. Brain Health*). In addition to reductions in risk for a variety of chronic health diseases and conditions, strong evidence demonstrates that more physically active people consistently report better quality of life, reduced anxiety, and reduced feelings of depression. The improved feelings have been observed in both observational cohort studies and experimental trials. Strong evidence also demonstrates that people who are more physically active sleep better. Laboratory assessments of sleep using polysomnography demonstrate that greater volumes of moderate-to-vigorous physical activity are associated with reduced sleep latency (taking less time to fall asleep), improved sleep efficiency (higher percentage of time in bed actually sleeping), improved sleep quality, and more deep sleep. Research using standardized self-reported assessments of sleep demonstrate that a greater volume of moderate-to-vigorous physical activity is associated with significantly less daytime sleepiness, better sleep quality, and a reduced frequency of use of medication to aid sleep. These improvements in sleep are reported

Part D. Integrating the Evidence

by people with chronic insomnia as well as by people without diagnosed sleep disorders. Evidence also indicates that, in general, the number of hours before bed time at which the activity is performed does not matter; benefits are equivalent for bouts of activity performed more than 8 hours before bedtime, 3 to 8 hours before, and less than 3 hours before bedtime.

Question 3. Does the evidence indicate that people who are more physically active are better able to perform everyday tasks without undue fatigue?

People who are more physically active are better able to perform everyday tasks without undue fatigue. Increased amounts of moderate-to-vigorous physical activity are associated with improved cardiorespiratory and muscular fitness and improved physical function for adults of all ages. (For more details, see *Part C. Background and Key Physical Activity Concepts*). Climbing stairs, carrying heavy packages, performing household chores, and carrying out other daily tasks are all accomplished more easily by individuals who are more physically active because of a higher capacity to perform work. More physically active children and adolescents have higher cardiorespiratory and muscular fitness. Among older adults, both observational and experimental studies demonstrate that greater amounts of physical activity are associated with improved physical function and slowing of age-related loss of physical function. The improvements include faster gait speed, better balance, improved ability to get up from a seated position, and greater ability to carry out activities of daily living, such as bathing, dressing, toileting, and eating. At all ages, for a given amount of physical activity, the relative gains in physical fitness and physical function are greatest for individuals who have not been physically active.

Question 4. How soon do the benefits of physical activity accrue?

Some benefits occur immediately after a session of moderate-to-vigorous physical activity, commonly referred to as the “last bout effect.” Reduced feelings of anxiety, improved sleep, and improved cognitive function are examples of benefits that can occur after a single episode of moderate-to-vigorous physical activity. If participation in physical activity becomes regular, reductions in routine (baseline) feelings of anxiety occur, the last bout effect on deep sleep becomes more pronounced, and components of executive function continue to improve. Executive function includes the processes of the brain that help organize daily activities and plan for the future. Tasks such as the ability to plan and organize; monitor, inhibit, or facilitate behaviors; initiate tasks; and control emotions all are part of executive function.

Part D. Integrating the Evidence

The cardiometabolic profile also shows improvements soon after an episode of moderate-to-vigorous physical activity. Blood pressure is reduced, and insulin sensitivity is increased. These cardiometabolic benefits persist for hours to days after the last bout. They also may be sufficient to lower the blood pressure of people with pre-hypertension and hypertension into normal ranges for a major portion of the day.

Other benefits, such as reduced risk of cardiovascular disease (CVD), diabetes, falls, and fall-related injuries among older adults, and improved physical function accrue as the physiologic adaptations to greater physical activity transpire. Improved cardiorespiratory and muscular fitness and biomarkers of disease risk start to accrue within days, and for a given amount of physical activity, maximize after a few months. Additional benefits accrue if physical activity volume is further increased. The reductions in risk apply every day and at all ages, including young adults, even though their risk for chronic disease is lower than for middle-aged and older adults.

Question 5. What does the evidence indicate about the public health target range, or “dose,” of moderate-to-vigorous physical activity that is likely to provide many of the health benefits listed in Table 1?

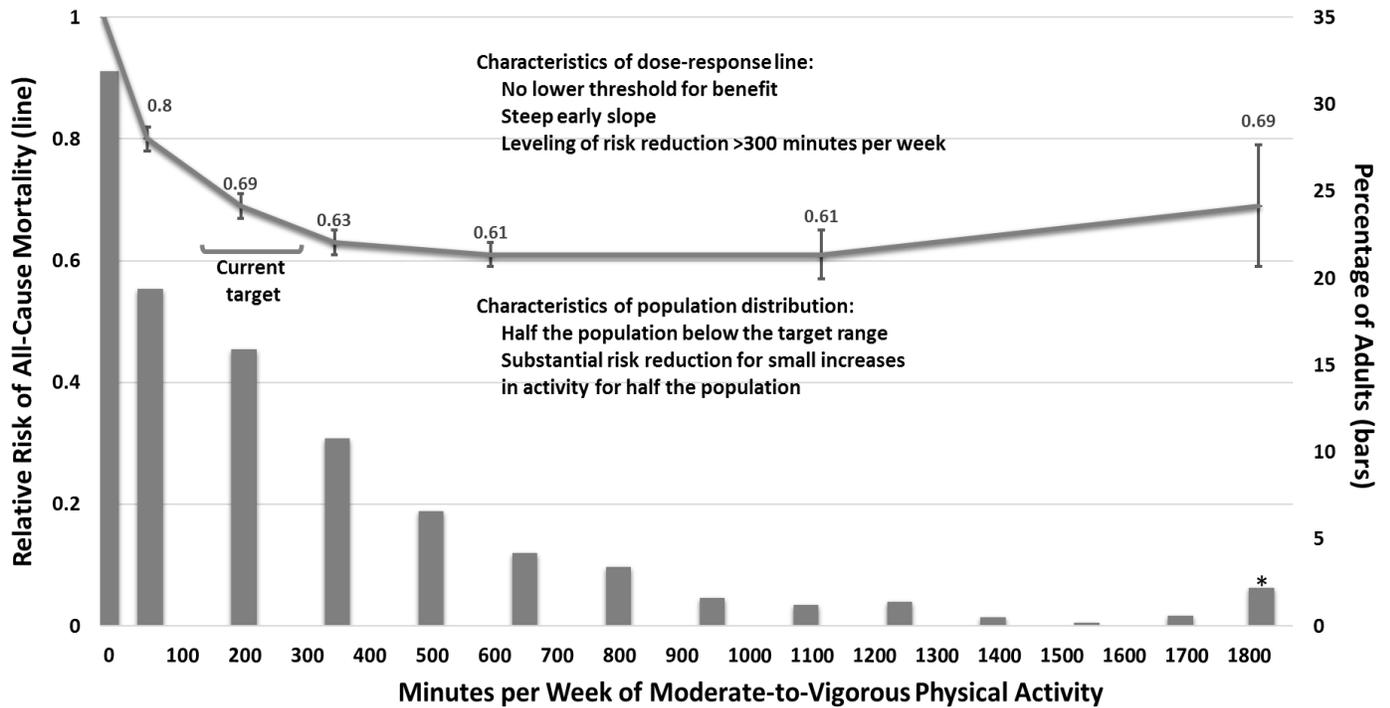
Current evidence continues to indicate that the majority of potential benefit or risk reduction is achieved by people who perform in the range of 500 to 1,000 MET-minutes per week of aerobic physical activity. Because MET-minutes is a unit of measure unfamiliar to most people, the target range has been commonly expressed as 150 to 300 minutes of moderate-intensity physical activity per week. Because vigorous-intensity physical activities (6 or more METs) require roughly twice the energy expenditure of moderate-intensity activities (3 to less than 6 METs), the time required to perform 500 to 1,000 MET-minutes of vigorous-intensity physical activity is roughly half that for moderate-intensity physical activity. As a result, about 75 to 150 minutes of vigorous-intensity physical activity per week is considered within the target range. Combinations of moderate- and vigorous-intensity activity that sum to within 500 to 1,000 MET-minutes per week are also in the target range. As an example, most healthy adults walking at about 3 miles per hour for 150 minutes during a week, or about a total of 7.5 miles, will expend about 500 MET-minutes of energy; if they walk for 300 minutes, or about 15 miles, they will expend about 1,000 MET-minutes of energy. Fewer minutes are needed to be in the target range for more vigorous activities. For example, running at 5 miles per hour would require about 60 minutes to reach 500 MET-minutes per week, or 120 minutes to reach 1,000 MET-minutes per week.

Question 6. What does the evidence indicate about the benefits of moderate-to-vigorous physical activity below or above the target range?

People do not need to reach the lower end of the 150 to 300-minute target range to benefit from regular physical activity. Individuals who exceed the target range usually achieve even greater health benefits. For example, the line in Figure D-1 displays a typical dose-response curve for moderate-to-vigorous physical activity and the relative risk of all-cause mortality. The dose-response curve indicates no lower threshold and a steep early decline in relative risk. It also suggests some additional reduction in risk at volumes of physical activity above the current target range. In addition, the bars on the figure display the percentage of adults reporting different amounts of moderate-to-vigorous physical activity. The population distribution of self-reported moderate-to-vigorous physical activity indicates that about half of the adult population could reduce their risk substantially by modestly increasing their moderate-to-vigorous physical activity.

The shape of the dose-response curves for cardiovascular disease incidence and mortality, and for the incidence of type 2 diabetes are similar to the shape of the dose-response curve for all-cause mortality depicted in Figure D-1. The evidence is currently insufficient to depict dose-response curves for other health outcomes listed in Table D-1, such as reduction in risk of dementia, several cancer sites, or excessive weight gain.

Figure D-1. Risk of All-Cause Mortality and Self-Reported Physical Activity, by Minutes of Moderate-to-Vigorous Physical Activity per Week



Note: *Includes all adults reporting greater than 1800 minutes per week of moderate-to-vigorous physical activity.
 Source: Adapted from data found in Arem et al., 2015² and National Center for Health Statistics, 2015.³

Question 7. What does current evidence indicate about the importance of the intensity, duration, and frequency of moderate-to-vigorous physical activity that comprise the weekly target volume of physical activity?

Intensity

The Committee did not specifically examine the relative value of different levels of intensity of physical activity, such as moderate- versus vigorous-intensity physical activity. Volume is accumulated more quickly when performing activities at greater intensity, reducing the number of minutes required to reach a desired volume. Greater intensity also brings greater levels of cardiorespiratory fitness, but also has greater risk of injury, especially if one is unaccustomed to vigorous physical activity. Greater intensity is inversely associated with pleasure during moderate-to-vigorous physical activity, so displeasure is higher during vigorous- than during moderate-intensity activity. This unpleasant affective experience dissipates soon after the episode of moderate-to-vigorous physical activity ends. For public health purposes, total volume of physical activity is a more important target than the specific intensity at which it is accumulated.

Part D. Integrating the Evidence

High intensity interval training (HIIT), sometimes called sprint interval training, has been a recent topic of discussion in both lay and scientific publications. HIIT consists of short periods of high intensity anaerobic exercise, commonly less than 1 minute, alternating with short periods of less intense recovery. The length of time spent at high intensity and recovery intensity varies among regimens, as does the total duration of a training session. Current evidence indicates that HIIT is an efficient method for increasing cardiorespiratory fitness, providing equal fitness benefits with about half the energy expenditure when compared with continuous moderate-to-vigorous intensity exercise. There may also be some benefits on insulin-mediated glucose control. The unpleasant affective response associated with increased intensity is greatest above the lactate and ventilatory thresholds. Current information is insufficient about other potential health benefits, the risks of adverse events, and the long-term sustainability of HIIT training regimens.

Please see Question 9 for a broader consideration of the issue of intensity.

Duration

The total volume of accumulated moderate-to-vigorous physical activity is a more important determinant of health benefits than the duration of the episodes that comprise the total. The *Physical Activity Guidelines Advisory Committee Report, 2008*,¹ accepted prior conclusions that bouts as short as 10 minutes added benefit and should be included in the accumulated total. At the time, evidence was not reviewed to determine if bouts shorter than 10 minutes also contributed, largely because the available data collection systems could not accurately collect information about the multiple short bouts of moderate-to-vigorous physical activity scattered throughout normal daily activity. The evidence from recent observational studies of cardiometabolic risk factors using device-measured physical activity indicates that bouts of moderate-to-vigorous physical activity of any duration contribute to the total volume of physical activity that determines benefit. These findings do not support the previous recommendation that only bouts of 10 or more minutes provide health benefits.

Frequency

Total volume of moderate-to-vigorous physical activity is more important than the number of days per week on which individuals perform the activity. For benefits derived from single episodes, such as reduced anxiety, improved sleep and executive function, blood pressure reductions, and improved insulin sensitivity, regular participation throughout the week would likely be more beneficial. A limited amount of evidence suggests that individuals who accumulate all or almost all of their weekly moderate-

to-vigorous physical activity on 1 or 2 days per week experience reductions in all-cause and cardiovascular mortality commensurate with individuals who accumulate an equivalent total volume on 3 or more days per week. If time for moderate-to-vigorous physical activity is available only 1 or 2 days per week, doing it on those days is better than not doing it.

Question 8. What does current scientific evidence demonstrate about the relationship between sedentary behavior and the risk of developing various chronic diseases or conditions?

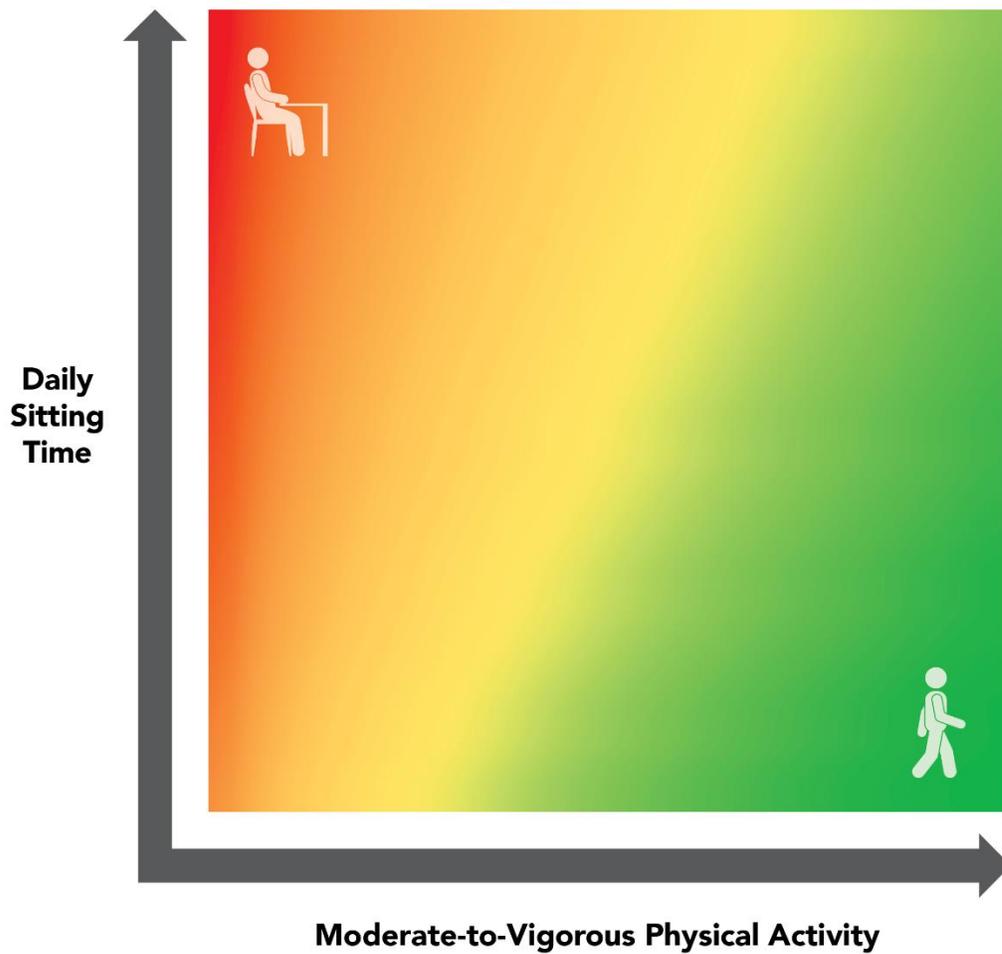
Scientific evidence demonstrates that more time spent in sedentary behavior is related to greater all-cause mortality, CVD mortality and incidence, type 2 diabetes incidence, and the incidence of colon, endometrial, and lung cancer. Evidence is insufficient to determine whether breaks in sedentary behavior reduce the risk. For inactive adults, replacing sedentary behavior with light-intensity physical activities is likely to produce some health benefits. Among all adults, replacing sedentary behavior with higher intensity (moderate-to-vigorous) physical activities may produce even greater benefits.

Question 9. What does current scientific evidence indicate about how the risks of sedentary behavior and the benefits of moderate-to-vigorous physical activity interact to determine overall risk or benefit?

Evidence indicates that the volume of moderate-to-vigorous physical activity affects the level of risk of all-cause mortality and cardiovascular disease mortality associated with sedentary behavior time. The Committee developed a “heat map” depicting the risk of all-cause mortality associated with various combinations of sitting time and moderate-to-vigorous physical activity using regression techniques to interpolate the hazard ratios between four levels of sitting time and four levels of moderate-to-vigorous physical activity⁴ (Figure D-2).

In the heat map, red represents higher risk of all-cause mortality, and green represents lower risk. The greatest risk of mortality is borne by individuals who sit the most and who do the least moderate-to-vigorous physical activity (the upper left corner of the heat map). The lowest risk of mortality is achieved by individuals who sit the least and do the most moderate-to-vigorous physical activity (lower right corner of the heat map).

Figure D-2. Relationship Among Moderate-to-Vigorous Physical Activity, Sitting Time, and Risk of All-Cause Mortality



Risk of all-cause mortality decreases as one moves from red to green.

Source: Adapted from data found in Ekelund et al., 2016.⁴

At the greatest time spent sitting (the top row), the risk of all-cause mortality begins to decrease (color becomes orange) even with small additions of moderate-to-vigorous physical activity. At the greatest volume of moderate-to-vigorous physical activity, the risk is low even for those who sit the most. The best currently available estimate of this volume is about 37 to 38 MET-hours per week, equal to about 80 to 90 minutes per day of moderate-intensity activities, such as walking or yard work at a moderate level of effort, or 40 to 45 minutes per day of vigorous-intensity activities, such as running at 4 to 5 miles per hour, bicycling at 10 or more miles per hour, climbing hills with 20-pound pack, or vigorous dancing.

Part D. Integrating the Evidence

At the lowest volume of moderate-to-vigorous physical activity (the ordinate), the risk of all-cause mortality increases as time spent sitting increases. This suggests that for individuals who do not perform any moderate-to-vigorous physical activity, replacing sitting time with light-intensity physical activities, such as walking at 2 miles per hour, dusting or polishing furniture, or easy gardening, reduces the risk of all-cause mortality. Although the risk of all-cause mortality is reduced as the time spent in sedentary behavior is reduced, even the individuals who sit the least have an elevated risk if they perform no moderate-to-vigorous physical activity. High volumes of moderate-to-vigorous physical activity appear to remove the risk of all-cause mortality associated with high volumes of sitting. Very low time spent sitting reduces but does not eliminate the risk of no moderate-to-vigorous physical activity.

The heat map demonstrates that many combinations of less sitting time and more moderate-to-vigorous physical activity are associated with reduced risk of all-cause mortality. Figure D-2 is based on firm evidence for all-cause and cardiovascular mortality, outcomes with well-established dose-response relationships with sedentary behavior and moderate-to-vigorous physical activity. The dose-response relationships for various combinations of sedentary behavior and moderate-to-vigorous physical activity with other health outcomes are unknown. A similar pattern seems likely, but other patterns may emerge as additional research on other outcomes is conducted.

Question 10. How do different types of physical activity contribute to health outcomes?

Aerobic Activity

Although other types of physical activity contribute to positive health outcomes, moderate-to-vigorous aerobic activity is associated with nearly all the benefits listed in Table D-1. Aerobic activity leads to improved cardiorespiratory fitness ($VO_2\text{max}$) with an increase in the capacity and efficiency of the cardiorespiratory system to transport oxygen to skeletal muscles and for muscles to use this oxygen. Cardiorespiratory fitness also is associated with improvements in biomarkers for CVD and type 2 diabetes (e.g., atherogenic lipoprotein profile, blood pressure, insulin sensitivity) in adults and older adults with and without these diseases. Although generally not considered muscle-strengthening behavior, aerobic activity leads to improved strength and endurance of the major muscle groups used to perform the chosen behavior, such as running or swimming. The high impact of some aerobic activities, such as running or playing tennis, and the strong muscular forces of others, such as rowing or wrestling, improve bone health.

Muscle Strengthening

Muscle-strengthening activities involve contracting muscles against resistance. Greater muscular strength is associated with greater ease performing daily tasks for people of all ages, and provides reductions in blood pressure equivalent to aerobic activities. Muscle-strengthening activities for older adults, often in combination with balance training, are associated not only with improved physical function but also with reduced risk of falls and reduced risk of injury due to falls. Muscle-strengthening activities can help maintain lean body mass during a program of weight loss, but by themselves result in little weight loss.

Muscles are strengthened according to the exercise science principles of overload, adaptation, and specificity. *Overload* indicates that a resistance slightly greater than usual is applied. If applied on a regular basis and the overload is not too large, the muscles *adapt* to the new load and become stronger. The improvements in strength are *specific* to the muscles to which the overload has been applied.

Most evidence supports a muscle-strengthening program with the following characteristics: progressive muscle strengthening exercises that target all major muscle groups (legs, hips, back, abdomen, chest, shoulders, arms), performed on two to three nonconsecutive days per week. To enhance muscle strength, 8 to 12 repetitions of each exercise should be performed to volitional fatigue. One set of 8 to 12 repetitions is effective at increasing muscular strength; limited evidence suggests that 2 or 3 sets is more effective.

The most commonly prescribed methods for increasing muscular strength, endurance, and power involve calisthenics (e.g., push-ups, sit-ups, chin-ups) or specific types of equipment, including weight machines, free weights, resistance bands, and similar devices. Essentially all types of aerobic activity, such as walking, swimming, or sporting activities, contribute to the strength of the involved muscles, as do many household activities such as raking leaves, vacuuming, carrying laundry baskets, or lifting heavy packages. The improvements or maintenance of muscular strength are specific to the muscles used during the activity, so a variety of activities is necessary to achieve balanced muscular strength.

Bone Strengthening

Bone-strengthening activities reduce the risk of osteoporosis and fractures. Bone-strengthening activities involve significant impact or muscular forces, both of which apply stress to bone, which adapts by increasing its strength. Activities such as hopping, jumping, skipping, and running provide significant impact forces. Standing on one's toes and suddenly dropping to one's heels also provides helpful impact

forces. Activities such as dancing, stair climbing, or push-ups, all of which require quick and strong muscle contractions, provide significant muscle forces.

Balance Training

Balance training helps maintain a steady posture against anticipated or unanticipated perturbations while walking or standing. It is commonly combined with muscle-strengthening activities, with sessions about 3 times per week, for the prevention of falls and fall injuries among older adults. Examples of balance training activities include standing on one foot, walking heel-to-toe, and using a wobble board.

Flexibility Training (Stretching)

Dynamic and static stretching improve the range and ease of movement around joints. Flexibility training is a common component of multicomponent physical activity programs but has not been sufficiently studied by itself, precluding assessment of its independent benefits, if any, on health. If joint flexibility is limited and impedes the performance of daily activities, flexibility training can increase range of motion, thereby facilitating activities such as getting dressed or getting into and out of cars.

Yoga, Tai Chi, Qigong

These forms of physical activity are potentially beneficial because they typically combine muscle strengthening, balance training, light-intensity aerobic activity, and flexibility in one package. Yoga, tai chi, and qigong each have several forms or styles of activity. Some of the forms include components that emphasize relaxation, mindfulness, meditation, and/or spiritual thinking. The purposeful combination of mental and physical components, sometimes referred to as “mind-body” activity, may provide mental or physical health benefits but prevents an assessment of the contribution of either component by itself.

Question 11. What does the scientific evidence indicate about the association between walking and health benefits?

Walking, the most commonly performed aerobic activity, is associated with the wide range of benefits listed in Table D-1. Although some medical conditions or disabilities prevent individuals from walking, for most people walking is a normal and frequent component of everyday life. Walking is one of the safest and most readily accessible physical activities. Adding 5 to 10 minutes of walking to one’s usual daily physical activities and increasing the time and then intensity (speed) slowly over several weeks or months is an excellent way to become more physically active. Daily step count is another way to monitor gradual increases toward a final goal. Modern technological devices (e.g., pedometers, smart

phones, activity trackers) can help individuals monitor their daily step counts to ensure that they are progressing at a safe and steady pace to meet their goals.

BRAIN HEALTH

Question 12. Is there evidence that moderate-to-vigorous physical activity influences brain-related health outcomes?

Moderate-to-vigorous physical activity positively influences several brain-related health outcomes, including cognition, anxiety, depression, sleep, and quality of life (Table D-2). Tools enabling assessments of the brain's structure and function are progressing rapidly and have enabled much to be learned in the past decade, with more new knowledge expected in the next several years. Current evidence indicates a beneficial effect of regular moderate-to-vigorous physical activity on various components of cognition. The evidence is strongest for a reduced risk of dementia and improved executive function. Single episodes of physical activity promote acute improvements in executive function for a brief period of time. Executive function includes the processes of the brain that help organize daily activities and plan for the future. Tasks such as one's ability to plan and organize, self-monitor and inhibit or facilitate behaviors, initiate tasks, and control emotions all are part of executive function. Physical activity also improves other components of cognition, including memory, processing speed, attention, and academic performance.

Strong evidence demonstrates that moderate-to-vigorous physical activity reduces the risk of developing major depression. It also reduces the symptoms of depression among individuals with and without clinical levels of depression. Similarly, moderate-to-vigorous physical activity reduces general feelings of anxiety (trait anxiety) among individuals with and without anxiety disorders. Acute episodes of moderate-to-vigorous physical activity also can reduce immediate feelings of anxiety (state anxiety). Moderate-to-vigorous physical activity also can raise perceptions of one's quality of life and improves a variety of sleep outcomes among the general population as well as for individuals with symptoms of insomnia or sleep apnea.

Table D-2. Summary of Conclusion Statements Regarding Strength* of the Evidence for Relationships Between Physical Activity and Cognition, Depression, Anxiety, Affect, Quality of Life, and Sleep

Outcome	Population	Benefit	Strength of Evidence
Cognition	General population and children 5 to 13 years of age: habitual moderate-to-vigorous physical activity	Improved cognition	Moderate
		Reduced risk of dementia	Strong
		Improved performance on academic achievement tests	Moderate
Cognition	General population and children 5 to 13 years of age: acute episodes of moderate-to-vigorous physical activity	Improved neuropsychological performance (executive function, processing speed, memory)	Moderate
		Improved cognition (executive function, attention, academic performance, memory, crystallized intelligence, processing speed)	Strong
		Improved cognition	Moderate
Quality of life	Individuals with dementia and some other conditions that affect cognition (attention deficit hyperactivity disorder, schizophrenia, multiple sclerosis, Parkinson's disease, stroke)	Improved cognition	Moderate
	Adults, ages 18 years and older	Improved quality of life	Strong
Quality of life	Individuals with schizophrenia	Improved quality of life	Moderate
	Depressed mood and depression	Adults, ages 18 years and older	Improved quality of life
Reduced risk of depression			Strong
Fewer depressive symptoms for individuals with and without major depression			Strong
Depressed mood and depression	Adults, ages 18 years and older	Dose-related reduction in depressive symptoms (i.e., present at low levels, increases with greater frequency, intensity, volume)	Strong
		Reduced state anxiety	Strong
Anxiety	Adults, ages 18 years and older: Acute episodes of moderate-to-vigorous physical activity	Reduced state anxiety	Strong
	Adults, ages 18 years and older: habitual moderate-to-vigorous physical activity	Reduced trait anxiety for individuals with and without anxiety disorders	Strong

Part D. Integrating the Evidence

Outcome	Population	Benefit	Strength of Evidence
Affect	Adolescents through middle-aged adults	In experimental studies, direct relationship between feelings of negative affect and intensity of moderate-to-vigorous physical activity	Strong
Sleep	Adults, ages 18 years and older: acute and habitual moderate-to-vigorous physical activity	Improved sleep outcomes Size of benefit directly related to duration of episode	Strong Moderate
	Individuals with symptoms of insomnia or sleep apnea	Improved sleep outcomes with greater amounts of moderate-to-vigorous physical activity	Moderate

Note: “Strength of the evidence” refers to the strength of the evidence that a relationship exists and not to the size of the effect of the relationship. Only populations and outcomes with strong or moderate evidence of effect are included in the table.

YOUTH

Question 13. Does current evidence indicate health and fitness benefits from physical activity for children and youth?

In 2008, insufficient evidence was available to comment on the impact of physical activity on the health of children younger than age 6 years. New evidence has emerged since then, and now, strong evidence indicates that greater volumes of physical activity among children ages 3 through 5 years are associated with a reduced risk of excessive weight gain and favorable indicators of bone health.

Among older children and youth through high school age, the evidence continues to demonstrate that moderate-to-vigorous physical activity improves cardiovascular and muscular fitness, bone health, weight status, and cardiometabolic risk factor status. For children ages 5 through 13, the evidence indicates that both acute bouts and regular moderate-to-vigorous physical activity improve cognition, including memory, processing speed, attention, and academic performance. Information on the effect on cognition for younger children and adolescents is not yet sufficient.

Question 14. What does the evidence indicate about the type and dose of physical activity most likely to produce these health benefits among children?

For children 3 through 5 years, little information is available currently on the type or volume of activity most likely to be associated with weight status. Until such information becomes available, a prudent

Part D. Integrating the Evidence

target would be for all children to achieve the current median estimated volume of three hours per day of physical activity at intensities that include light, moderate, and vigorous physical activity. The type of physical activity associated with bone health consists of high-impact, dynamic, short duration exercise, such as hopping, skipping, jumping, tumbling; the volume of such activity needed is not currently known.

For school-aged children, sufficient evidence indicates health benefits accrue with 60 minutes per day of moderate-to-vigorous physical activity. Because different benefits derive from different types of activity, the 60 minutes will be most healthful if different types of activity are performed. Vigorous-intensity physical activity will enhance cardiovascular health. A variety of play, games, exercise, sports, or chores can strengthen major muscle groups, and activities with high-impact forces, such as hopping, skipping, and jumping, will improve bone strength. These findings are consistent with the findings in the *Physical Activity Guidelines Advisory Committee Report, 2008*, and the recommendations in the *2008 Physical Activity Guidelines for Americans* stating that within the 60 minutes of daily physical activity, children and adolescents should engage in muscle-strengthening, bone-strengthening, and vigorous intensity physical activities at least three days per week.¹⁵

OLDER ADULTS

Question 15. Is there evidence that the target range for moderate-to-vigorous physical activity should differ for older adults?

The target range of 150 to 300 minutes per week of moderate relative intensity activities remains an appropriate target for older adults. However, because older adults expend more energy than younger adults for the same task, such as walking, and because aerobic capacity declines with age, relative intensity is a better guide for beneficial activity for older adults than estimates of absolute intensity developed for young and middle-aged adults. The use of relative intensity rather than absolute intensity as a guide to level of effort applies also to individuals who have been very inactive and who have a low aerobic capacity as a result. Activities performed at a moderate relative intensity are commonly described as being “somewhat hard.” (See *Part C. Background and Key Physical Activity Concepts*, for more information about absolute and relative intensity of physical activity and ratings of perceived (relative) exertion. For both older and younger individuals, some activity is better than none, and appreciable benefits accrue from regular physical activity at levels below the target range.

Question 16. Is there evidence of health benefits of particular importance for older adults?

Strong evidence demonstrates that physically active older adults are less likely to experience falls, less likely to be seriously injured if they do fall, and more likely to maintain independence and functional ability compared to those who are inactive. Strong evidence also demonstrates that physically active older adults have a lower risk of dementia, better perceived quality of life, and reduced symptoms of anxiety and depression. Experimental trials have demonstrated that even individuals with frailty and with Parkinson’s disease can improve their physical function, thus minimizing and delaying aging-related declines. Aerobic, muscle-strengthening, and multicomponent physical activity programs all demonstrate benefits. The improvements appear to be somewhat greater with activity programs that include specific muscle strengthening and balance training activities.

SELECTED COMMON CHRONIC CONDITIONS

Question 17. Does the evidence indicate that habitual moderate-to-vigorous physical activity provides preventive health benefits to individuals with some common chronic conditions?

The benefits of habitual physical activity likely vary from condition to condition, but for several prevalent diseases or conditions studied by the Committee, one or more health benefits were evident (Table D-3). For example, for people with colorectal cancer, women with breast cancer, and men with prostate cancer, greater amounts of physical activity are associated with reduced risk of mortality from the original type of cancer; for people with colorectal cancer or women with breast cancer, greater amounts of physical activity are associated with reduced risk of all-cause mortality. Habitual physical activity also reduces the risk of mortality from CVD among people with hypertension or type 2 diabetes. Adults with osteoarthritis who are more physically active experience less pain, improved physical function, and better quality of life relative to less active adults with osteoarthritis. Similarly, more physically active individuals who have Parkinson’s disease, multiple sclerosis, spinal cord injury, stroke, recent hip fracture, and frailty have better physical function, including walking ability, relative to less active adults with the same condition. For individuals with some of these conditions, muscle strength and balance are improved as well (Table D-3). Except for the mortality outcomes, evidence regarding the type of physical activity associated with these reductions often comes from intervention studies in which the physical activity exposure was a multicomponent program including aerobic activity (commonly walking),

Part D. Integrating the Evidence

strength, and balance training. These findings emphasize that preventive effects of physical activity are relevant and important for both healthy adults and for adults with chronic conditions. Indeed, for adults with conditions where physical activity is recommended for its therapeutic effects, the evidence indicates that physical activity typically provides both therapeutic and preventive benefits.

Table D-3. Evidence of Health Benefits from Habitual Physical Activity Among People with One of Several Common Chronic Diseases or Conditions

RISK REDUCTION OUTCOMES INVESTIGATED FOR SURVIVORS OF THREE COMMON CANCERS					
Disease or Condition	Risk of All-cause Mortality	Risk of Cancer-specific Mortality		Risk of Developing Recurrence of Primary Cancer or New Type of Cancer	
Breast cancer	Reduced	Reduced		IE	
Colorectal cancer	Reduced	Reduced		IE	
Prostate cancer	IE	Reduced		IE	
RISK REDUCTION OR HEALTH IMPROVEMENT INVESTIGATED FOR SELECTED COMMON CONDITIONS					
Disease or Condition	Risk of Mortality	Quality of Life	Physical Function	Progression of Disease	Cognition
Osteoarthritis	IE	Less pain, improved quality of life, and improved physical function among people with hip or knee osteoarthritis		No evidence of progression of osteoarthritis up to 10,000 steps per day	-
Hypertension	Reduced cardiovascular mortality	IE	IE	Reduced progression of blood pressure	-
Type 2 diabetes	Reduced cardiovascular mortality	IE	IE	Improved HbA1c, BP, BMI, and lipids IE for neuropathy, nephropathy, retinopathy, foot sores	-
Multiple sclerosis	IE	IE	Improved walking, strength, fitness	IE	Improved cognition
Spinal cord injury	IE	IE	Improved walking, wheelchair skills	IE	-

RISK REDUCTION OR HEALTH IMPROVEMENT INVESTIGATED FOR SELECTED COMMON CONDITIONS					
Disease or Condition	Risk of Mortality	Quality of Life	Physical Function	Progression of Disease	Cognition
Intellectual disabilities	IE	IE	IE	IE	-
Parkinson's disease	-	-	Improved walking, strength, balance	-	Improved cognition
Stroke	-	-	Improved walking	-	Improved cognition
Recent hip fracture	-	-	Improved walking, balance, activities of daily living	-	-
Frailty	-	-	Improved walking, balance, activities of daily living	-	-
Dementia	-	-	-	-	Improved cognition
Schizophrenia	-	Improved quality of life	-	-	Improved cognition
Attention deficit hyperactivity disorder	-	-	-	-	Improved cognition

Legend: IE=Insufficient evidence found in systematic reviews and meta-analyses to reach a conclusion, -=question did not address this outcome for this condition, HbA1c=hemoglobin A1c, BP=blood pressure, BMI=body mass index.

PREGNANCY

Question 18. Is there evidence regarding the benefits or risks of light-to-moderate intensity physical activity during pregnancy and the postpartum period?

Strong evidence demonstrates that more physically active women with a normally progressing pregnancy have a reduced risk for excessive weight gain, gestational diabetes, and postpartum depression relative to their less physically active counterparts. The amount of physical activity in most of the experimental trials included in the evidence consisted of light- to moderate-intensity physical activity accumulating to about 120 to 150 minutes per week. Insufficient information about the adoption of vigorous-intensity physical activity during pregnancy was available to reach a conclusion

about its benefits or risks during pregnancy and the postpartum period. The 2008 Advisory Committee reported that women who habitually performed vigorous-intensity physical activity prior to pregnancy could continue as long as “they remain asymptomatic and maintain open communication with their health care providers.”¹ The 2018 Committee concurs. The 2018 Committee did not perform specific literature searches to investigate the association between physical activity and specific benefits or risks related to labor and delivery, date of delivery, weight status of the newborn, or other outcomes. However, the conclusions and information provided in the *Physical Activity Guidelines Advisory Committee Report, 2008*¹ and the *2008 Physical Activity Guidelines for Americans*⁵ are consistent with the information provided on these topics in the articles included in the specific searches performed by the Committee.

WEIGHT STATUS

Question 19. Does the evidence demonstrate that moderate-to-vigorous physical activity contributes to preventing or minimizing excessive weight gain?

Strong evidence demonstrates that greater volumes of moderate-to-vigorous physical activity are associated with preventing or minimizing excessive weight gain in adults, being able to maintain weight within a healthy range of body mass index, and preventing obesity. The 2018 Advisory Committee did not examine literature addressing the association between physical activity and weight loss or the prevention of weight regain following initial weight loss. The 2008 Advisory Committee,¹ however, did address these important issues and concluded that when a sufficient dose of moderate-to-vigorous physical activity is attained, it will result in weight loss and the prevention of weight regain following initial weight loss. The 2008 Advisory Committee also reported that physical activity has an additive effect on weight loss when combined with moderate dietary restriction compared to moderate dietary restriction alone.¹

Question 20. Does moderate-to-vigorous physical activity provide health benefits for people with overweight or obesity even if their weight status remains the same?

Strong evidence demonstrates that physically active adults with overweight or obesity experience benefits generally similar to those with normal body weight. Regardless of weight status, the relative reduction in risk of all-cause mortality, incidence and mortality of cardiovascular disease, and incidence

of type 2 diabetes are essentially equivalent. For endometrial cancer, the risk reduction is greater for individuals with overweight or obesity than for individuals with normal weight status. Adults with overweight or obesity are more responsive than adults with normal weight to high intensity interval training's effects on improving insulin sensitivity, blood pressure, and body composition.

INFLUENCE OF RACE OR ETHNICITY, AND SOCIOECONOMIC STATUS ON HEALTH OUTCOMES

Question 21. Is there evidence that the volume of moderate-to-vigorous physical activity associated with health benefits differs by race or ethnicity, or socioeconomic status?

Race or Ethnicity

The 2008 Committee reported that “based on the currently available scientific evidence, the dose of physical activity that provides various favorable health and fitness outcomes appears to be similar for adults of various races and ethnicities.”¹ The 2018 Committee concurs. In the studies used to address the questions asked by the 2018 Committee, the effect of race or ethnicity was uncommonly reported and, when it was, the studies showed little evidence of effect modification by race or ethnicity on the relationship between moderate-to-vigorous physical activity and health outcomes.

Socioeconomic Status

Information on the effect of socioeconomic status on the relationship between moderate-to-vigorous physical activity was even more sparse than for race or ethnicity, and, therefore, this Committee was unable to state any conclusions about the role, if any, of socioeconomic status.

ADVERSE EVENTS

Question 22. What does the scientific evidence indicate about the pattern of physical activity that is most likely to produce the fewest adverse medical events while providing benefits?

The 2018 Committee determined that the basic principles and messages in the *Physical Activity Guidelines Advisory Committee Report, 2008* and the *2008 Physical Activity Guidelines for Americans* still apply.^{1,5} The information in those reports indicates that activities with fewer and less forceful contact

Part D. Integrating the Evidence

with other people or objects have appreciably lower rates of musculoskeletal injuries than do collision or contact sports. Walking for exercise, gardening or yard work, bicycling or exercise cycling, dancing, swimming, and golf are popular activities in the United States, and they are associated with the lowest injury rates. Risk of musculoskeletal injury during activity increases with the total volume of activity (e.g., MET-hours per week). Intensity, frequency, and duration of activity all contribute to the risk of musculoskeletal injuries, but their relative contributions are unknown. Sudden cardiac adverse events are rare, are associated with relatively vigorous physical activity, and are inversely associated with the volume of regularly performed vigorous physical activity. The limited data available for medical risks during moderate-intensity activity indicate that the risks are very low for activities like walking and that the health benefits from such activity outweigh the risks.

Question 23. What does the scientific evidence say about actions that can be taken to reduce the risk of injury during physical activity?

Information in the *Physical Activity Guidelines Advisory Committee Report, 2008*, and the *2008 Physical Activity Guidelines* indicates that injuries are more likely when people are much more physically active than they are accustomed to.^{1,5} The key point to remember is that when individuals do more activity than usual, the risk of injury is related to the size of the increase. Gradual progression, a series of small increments in physical activity each followed by a period of adaptation, is associated with less risk of musculoskeletal injuries than an abrupt increase to the same final level. Although the safest method of increasing one's physical activity has not been empirically established, for individuals who have been performing little or no moderate-to-vigorous physical activity, adding a small and comfortable amount of light- to moderate-intensity activity, such as walking an additional 5 to 15 minutes 2 to 3 times per week, has a low risk of musculoskeletal injury and no known risk of sudden severe cardiac events. Frequency and duration should be increased before raising the intensity.

The risk of adverse events is also reduced by using proper equipment, such as helmets, eyewear or goggles, elbow or knee pads; choosing safe environments, such as those with good lighting, smooth surfaces, and away from traffic; following rules and policies; and making sensible choices, such as avoiding extreme heat or cold.

Warming up before and cooling down after exercise are commonly recommended to prevent injuries and adverse cardiac events. Limited evidence does suggest that various combinations of warm up, muscle-strengthening, conditioning, and stretching are associated with lower rates of musculoskeletal

Part D. Integrating the Evidence

injuries. Also based on limited evidence, careful warming up and cooling down are standard practice in cardiac rehabilitation programs. Guidelines typically recommend 10 to 20 minutes of stretching and progressive warm up activity before the main activity session and 10 to 20 minutes of gradually diminishing activity at the end.

Question 24. Is there evidence regarding who should see a physician or have a medical examination before increasing the amount or intensity of physical activity they perform?

The *Physical Activity Guidelines Advisory Committee, 2008*, and the *2008 Physical Activity Guidelines for Americans* noted, and the 2018 Physical Activity Guidelines Advisory Committee agrees, that the protective value of a medical consultation for persons with or without chronic diseases who are interested in increasing their physical activity level is not established.^{1 5} No evidence is available to indicate that people who consult with their medical provider receive more benefits and suffer fewer adverse events than people who do not. Also unknown is whether official recommendations to seek medical advice before augmenting one's regular physical activity practices reduce participation in regular moderate physical activity by implying that being active may be less safe and provide fewer benefits than being inactive.

PROMOTION OF PHYSICAL ACTIVITY

Question 25. What interventions are effective for promoting regular physical activity participation?

The extensive body of evidence in the physical activity promotion field shows that interventions at different levels of impact, including at the individual, community, environment and policy, and information and communication technology levels, can promote increased participation in regular physical activity (Table D-4). For example, at the individual level of impact, interventions that include behavior change theories and techniques as well as interventions specifically targeted at youth and at older adults have demonstrated success in promoting regular physical activity. At the level of community settings, multi-component school interventions and those that have successfully revised the structure of physical education classes are effective in promoting increased school-based physical activity in children and adolescents. At the level of environment and policy, the evidence on physical activity promotion among children and adults supports the utility of built environment characteristics

Part D. Integrating the Evidence

and infrastructure that support active transportation, indoor and outdoor facilities for physical activity, and access to such facilities. At the level of information and communication technologies, the types of technologies that have been found consistently to promote regular physical activity among adults include wearable activity monitors, telephone-assisted interventions, internet-delivered interventions that include educational components, text-messaging programs, and computer-tailored print interventions. Among children and adolescents, information and communication technologies interventions involving systematically developed smartphone applications have been found to be effective.

Table D-4. Summary of Conclusion Statements Regarding Strength* of the Evidence that Varying Types of Interventions Increase the Amount of Physical Activity Among Those Who Are Exposed to the Intervention

Level	Type of Intervention	Strength of Evidence
Individual	Older adults	Strong
	Youth	Strong: Especially when family is included or intervention delivered during school
	Behavior change theories and techniques	Strong
	Peer led	Moderate
Community-based	School-based	Strong: Multiple components Strong: Revised physical education classes
	Community wide	Moderate: If intervention has intensive contact with majority of population over time
Environmental and Policy	Point-of-decision prompts	Strong
	Built environment and infrastructure that promotes active transportation	Moderate
	Community design that supports physical activity, including active transportation	Moderate
	Access to indoor or outdoor facilities	Moderate

Part D. Integrating the Evidence

Level	Type of Intervention	Strength of Evidence
Information and Communications Technologies	Wearable activity monitors (accelerometers and pedometers)	Strong: General adult population Moderate: Individuals who are overweight or obese
	Telephone-assisted	Strong
	Web-based or internet-delivered, with educational component	Strong: General adult population
	Computer-tailored print interventions	Strong
	Mobile phone programs	Strong: Smart phone applications, children and adolescents Moderate: Text messaging, general population
Level	Type of Intervention to Reduce Sedentary Behavior	Strength of Evidence
Community-based	Youth, primarily school-based interventions	Moderate
	Worksite interventions	Moderate

Note: “Strength of the evidence” refers to the strength of the evidence that a relationship exists and not to the size of the effect of the relationship.

Question 26. What interventions are effective for reducing sedentary behavior?

Current evidence indicates that several types of interventions can be effective in reducing sedentary behavior in different age groups. For youth, evidence suggests that school-based interventions targeting reductions in television viewing and other screen-time activities can have a positive impact on reducing sedentary behavior. Among adults working primarily while seated, interventions targeting sedentary activities have resulted in reduced sedentary behavior at the workplace. Effective interventions have included those aimed at physical modifications to work stations (e.g., sit-stand workstations) in combination with educational and behavioral support.

REFERENCES

1. Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington, DC: U.S. Department of Health and Human Services; 2008. <https://health.gov/paguidelines/guidelines/report.aspx>. Published 2008. Accessed September 22, 2017.
2. Arem H, Moore SC, Patel A, et al. Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. *JAMA Intern Med*. 2015;175(6):959-967. doi:10.1001/jamainternmed.2015.0533.
3. Centers for Disease Control and Prevention, National Center for Health Statistics. National Health Interview Survey (NHIS), 1997–2015: 2015 data release. https://www.cdc.gov/nchs/nhis/nhis_2015_data_release.htm. Updated November 3, 2017. Accessed January 11, 2018.
4. Ekelund U, Steene-Johannessen J, Brown WJ. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonized meta-analysis of data from more than 1 million men and women. *Lancet*. 2016;388:1302-1310. doi:10.1016/S0140-6736(16)30370-1.
5. U.S. Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. Washington, DC: U.S. Department of Health and Human Services; 2008. <https://health.gov/paguidelines/guidelines>. Published 2008. Accessed September 22, 2017.