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WHO Guidelines on Physical Activity and Sedentary Behaviour. Geneva: World Health Organization; 2020.

RECOMMENDATIONS

The public health recommendations presented in the *WHO Guidelines on physical activity and sedentary behaviour* are for all populations and age groups ranging from 5 years to 65 years and older, irrespective of gender, cultural background or socioeconomic status, and are relevant for people of all abilities.

The new guidelines are presented by age group and behaviour (physical activity and sedentary). For each set of recommendations, an introductory statement summarizes the health outcomes associated with physical activity and sedentary behaviour respectively; the recommendations then follow. A set of good practice statements is provided to further clarify how the recommendation can be met safely by the target population. These good practice statements are not "graded recommendations" per se, but are derived from scientific evidence and from practical considerations reviewed and recommended by the GDG.

For each set of recommendations, a summary of the supporting scientific evidence is provided, structured by the three PI/ECO questions; presenting first the evidence on the associations with the critical health outcomes, followed by a summary of evidence on dose response. Finally, a summary of evidence on the relationships between different types or domains of exposure and health outcomes is presented, where this exists.

CHILDREN AND ADOLESCENTS (aged 5–17 years)

PHYSICAL ACTIVITY RECOMMENDATION

For children and adolescents, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), physical education, transportation (wheeling, walking and cycling) or household chores, in the context of educational, home, and community settings.

In children and adolescents, physical activity confers benefits for the following health outcomes: improved physical fitness (cardiorespiratory and muscular fitness), cardiometabolic health (blood pressure, dyslipidaemia, glucose, and insulin resistance), bone health, cognitive outcomes (academic performance, executive function), mental health (reduced symptoms of depression); and reduced adiposity.

It is recommended that:

> **Children and adolescents should do at least an average of 60 minutes per day of moderate- to vigorous-intensity, mostly aerobic, physical activity, across the week.**

Strong recommendation, moderate certainty evidence

> **Vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone, should be incorporated at least 3 days a week.**

Strong recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If children and adolescents are not meeting the recommendations, doing some physical activity will benefit their health.
- Children and adolescents should start by doing small amounts of physical activity, and gradually increase the frequency, intensity and duration over time.
- It is important to provide all children and adolescents with safe and equitable opportunities, and encouragement, to participate in physical activities that are enjoyable, offer variety, and are appropriate for their age and ability.

Supporting evidence and rationale

For these guidelines for children and adolescents, systematic reviews (22, 25, 35) were used and updated with 16 new reviews identified that met inclusion criteria. Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In children and adolescents (aged 5–17 years), what is the association between physical activity and health-related outcomes?

A large body of evidence previously established that greater amounts and higher intensities of physical activity in children and adolescents are associated with multiple beneficial health outcomes (1). Recent evidence reaffirms that increased physical activity improves **cardiorespiratory fitness** and **musculoskeletal fitness** in children and adolescents (22, 35). For example, positive impacts are obtained when participating in moderate- to vigorous-intensity physical activity for 3 or more days per week, for 30 to 60 minutes (22, 35).

Regular physical activity, largely aerobic, in children and adolescents is positively associated with beneficial **cardiometabolic health** outcomes, including improved blood pressure, lipid profile, glucose control and insulin resistance (35). Recent reviews examined the effectiveness of school-based physical activity programmes (46), high-intensity interval training (47)and resistance training (48), versus no intervention on measures of cardiometabolic health. Within all 3 reviews, there was consistent evidence that interventions were associated with better cardiometabolic outcome measures, although there was varied precision in effect sizes and few individual trials found statistically significant benefits of physical activity across all cardiometabolic outcomes. One review of 19 RCTs (n= 11 988) (46) reported that school-based physical activity programmes were associated with statistically significant improvements in diastolic blood pressure (ES= 0.21 [95% CI: 0.42 to 0.01]; p= 0.04) and fasting insulin (ES= 0.12 [95% CI: 0.42 to 0.04]; p= 0.03) compared with no physical activity interventions.

Physical activity has been reported to be favourably associated with **adiposity**, and higher levels of activity may be associated with healthy weight status in children and adolescents (22, 35). The results are generally strongest in cross-sectional studies, while the results are more mixed from prospective observational studies, which limits understanding of the directionality of the reported associations. More recent reviews of physical activity interventions trials (laboratory-based high-intensity interval training [HIIT], classroom-based active learning, resistance training) reported

inconsistent results with the majority of the studies included in the reviews not reporting an effect (47, 49, 50). However, a review of longitudinal and cross-sectional studies reported a negative relationship between pedometer- measured physical activity and measures of adiposity, BMI or waist circumference (51). Overall there is low certainty evidence that physical activity is associated with the management of a healthy weight status and more research is needed to determine directionality and strength of association.

There is less evidence examining the association between physical activity and **motor skill development** in children and adolescents, with current reviews demonstrating null findings (22). More research is needed with motor development as an outcome to inform future guidelines.

For children and adolescents, bone-loading activities can be performed as part of playing games, running, turning, or jumping. Physical activity is positively associated with bone mass accrual and/or bone structure, and recent evidence supports that children and adolescents who are more physically active than their peers have greater bone mass, higher bone mineral content or density, and greater bone strength (35). Maximizing **bone health** in childhood and adolescence can help protect from osteoporosis and related fractures later in life.

Developing and maintaining cognitive function is essential across the entire lifespan. In children and adolescents, physical activity has positive effects on **cognitive function** and **academic outcomes** (e.g. school performance, memory and executive function) (22, 35). One recent review (19 RCTs; n= 5038) demonstrated that exercise interventions with multiple sessions per week, for 6 weeks or longer, were associated with greater change in measures of cognitive function such as inhibitory control (SMD 0.26 [95% CI: 0.08 to 0.45], p = < 0.01); working memory (SMD 0.10 [95% CI: −0.05 to 0.25], p = < 0.02), and cognitive flexibility (SMD 0.14 [95% CI: −0.03 to 0.31], p = < 0.04) compared with no exercise interventions (52). Physical activity also reduces the risk of experiencing depression and depressive symptoms in children and adolescents with and without major **depression** (35), and may be comparable to psychological and pharmaceutical therapies in reducing symptoms.

Although all physical activity comes with some **risk of adverse event** (53) there is limited evidence reporting harms associated with physical activity levels recommended for health benefit (35). Based on available evidence and expert opinion, the potential risks associated with the amounts and types of physical activity recommended for children and adolescents were considered to be low (35) and can be reduced by a progressive increase in the activity level and intensity, especially in children and adolescents who are inactive. It is known that participation in some sports increases the risk of injury, as does increasing exercise intensity (53). More research is needed to strengthen the knowledge base in this area.

The GDG concluded that:

- There is moderate certainty evidence that greater amounts of moderate- and vigorous-intensity physical activity are associated with improved cardiorespiratory fitness and muscular fitness, cardiometabolic health and bone health in children and adolescents.
- There is moderate certainty evidence that both short-and long-term moderate- to vigorous-intensity physical activity have positive effects on cognitive function, academic outcomes and mental health.
- There is low certainty evidence that physical activity is favourably associated with the management of healthy weight status in children and adolescents.

- There is low-certainty evidence that the risks for the amounts and types of physical activity recommended for children and adolescents are low and are outweighed by the benefits.

Is there a dose-response association (volume, duration, frequency, intensity)?

Although there is a substantial body of evidence demonstrating a positive association between physical activity and health outcomes in children and adolescents, very few studies have addressed the issue of dose-response. Therefore, the exact shape of the dose-response curve and/or the presence of threshold values (that differentiate lower versus higher risk) for physical activity and specific health outcomes is less well understood in children and adolescents compared with adult populations. Nonetheless, a substantial body of evidence shows that many of the health benefits occur with 60 minutes of physical activity daily (22, 35), and given no contradictory evidence, it was concluded that the updated evidence reaffirms the current WHO recommendation for 60 minutes of moderate- to vigorous-intensity physical activity per day (1).

However, the review of all evidence, including recent results from studies using device-based measures of physical activity, did not support retaining the specification of a "minimum" daily threshold of 60 minutes of moderate- to vigorous-intensity physical activity for health benefits, given that studies broadly used "an average" threshold of 60 minutes per day, not a *minimum* daily threshold of 60 minutes, to assess the benefits of physical activity on health outcomes. The review concluded that the new guideline should be amended to more closely reflect this evidence.

The benefits of regular vigorous-intensity activity on cardiometabolic health outcomes has been previously established (1) and recent reviews provided further supporting evidence (35). For example, a recent review (54) showed that high-intensity interval training, compared with moderate-intensity continuous training, had a moderate beneficial effect on cardiorespiratory fitness (SMD= 0.51 [95% CI: 0.33 to 0.69], $p = < 0.01$; $I^2 = 0\%$). There was no evidence that intervention duration, exercise modality, exercise and rest ratio, and total bouts modified the effect on cardiorespiratory fitness. These results were consistent overall with other recent reviews (22, 35, 47) and provide support to retaining the recommendation that youth and adolescents should do regular vigorous-intensity activity to improve cardiorespiratory fitness.

The GDG concluded that:

- Evidence affirms the previous WHO recommendation for 60 minutes of moderate- to vigorous-intensity physical activity per day.
- Evidence supports amending the previous specification of a minimum daily threshold of 60 minutes of physical activity to an average of 60 minutes per day per week, which more closely reflects the evidence.
- There is moderate certainty evidence that greater amounts of vigorous-intensity physical activity are associated with improved cardiorespiratory fitness.

Does the association vary by type or domain of physical activity?

For children and adolescents, physical activity includes play, games, sports, transportation, recreation, physical education or planned exercise, in the context of family, school, and community activities. However, few studies have directly compared different types or domains of physical activity in children and adolescents and thus there is insufficient evidence to determine if the association between physical activity and health outcomes varies by type of

activity (e.g. aerobic versus muscle-strengthening exercise) or domain of physical activity (e.g. active transport (walking and cycling) versus physical education, versus sports/recreation).

There is evidence showing that both increased levels of aerobic moderate- to vigorous-intensity physical activity are associated with increased cardiorespiratory fitness, and that increased muscle-strengthening activity increases muscular fitness in children and adolescents. This evidence informed the 2010 WHO *Global recommendations on physical activity for health* (1) which recommended incorporating activities that strengthen muscles and bones at least 3 days per week. Updated evidence reaffirmed that regular muscle-strengthening activity 3 times per week was effective for improving indicators of muscular fitness; however, there is insufficient evidence to state specific details of session duration and intensity, largely due to the heterogeneity of exposures assessed in the literature (22, 35). There is less evidence for a protective effect of resistance training on cardiometabolic health. Given the absence of new evidence on characteristics other than the frequency of muscle strengthening activities for children and adolescents, such as duration, it was not possible to specify any further details. Future research should address the health benefits of specific types and domains of physical activity in order to provide more specificity to this component of the guidelines.

The GDG concluded that:

- There is moderate certainty evidence that muscle-strengthening activities should be incorporated at least 3 days a week.

SEDENTARY BEHAVIOUR RECOMMENDATION

Sedentary behaviour is defined as time spent sitting or lying with low energy expenditure, while awake, in the context of educational, home, and community settings and transportation.

In children and adolescents, higher amounts of sedentary behaviour are associated with the following poor health outcomes: increased adiposity; poorer cardiometabolic health, fitness, behavioural conduct/pro-social behaviour; and reduced sleep duration.

It is recommended that:

> **Children and adolescents should limit the amount of time spent being sedentary, particularly the amount of recreational screen time.**

Strong recommendation, low certainty evidence

Supporting evidence and rationale

Sedentary behaviour was not included in the WHO 2010 recommendations, yet during the past decade, there has been a growing body of research examining the health outcomes associated with different measures and types of sedentary behaviours. Technology and digital communications have influenced how people work, study, travel and spend leisure-time. In most countries, children and adolescents are spending greater time engaged in sedentary behaviours, particularly for recreation, such as screen-based entertainment (television and computers) and digital communications, such as mobile phones.

For these guidelines for children and adolescents, systematic reviews (24, 25) were used and updated with seven new reviews identified that met inclusion criteria. Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In children and adolescents (aged 5–17 years), what is the association between sedentary behaviour and health-related outcomes?

Evidence indicates that greater time spent in sedentary behaviour, especially recreational screen time, is related to poorer health outcomes (24, 35). For example, higher duration of screen time (including television viewing) is associated with poorer **fitness** and **cardiometabolic health** (24, 25) in children and adolescents. Evidence from device-based assessment of association with sedentary behaviour and interventions studies showed modest effects, although stronger effects for those already living with obesity (55). There is limited evidence suggesting that sedentary behaviour is not related to bone health in children and adolescents.

Despite more mixed results, evidence also suggests that sedentary behaviour may be associated with unfavourable measures of **adiposity** (24, 25). One review of largely cross-sectional studies, reported that sedentary behaviour (measured as total screen time) of more than 2 hours per day was positively associated with childhood overweight/obesity compared with lower levels (< 2 hours/day) (56). However, another review of 20 cross-sectional studies (57) found no statistically significant association between sedentary video gaming and body mass index among children or adolescents. A large review of 29 systematic reviews concluded that many studies report unfavourable associations between sedentary behaviour and markers of adiposity in young people when the behaviour is self-reported as some form of screen time (55). However, the review noted that the magnitude of such associations was small and, for studies using device-based assessment of sedentary time, largely zero (55). Intervention studies showed modest effects, although stronger effects for those already living with obesity (55). Further research is needed to inform the association between sedentary behaviours and measures of adiposity.

Although still an emerging area of research, some evidence shows that there may be a negative association between sedentary behaviour and **well-being and quality of life**, as well as an unfavourable relationship between **depression** and leisure screen time in children and adolescents (58, 59). For example, higher durations of sedentary behaviour, assessed as screen time, and some aspects of computer use, can be associated with poorer mental health (24). In another recent review, an association between sedentary behaviour and anxiety symptoms was found in 5 of 8 studies, although results were inconsistent across different measures of sedentary behaviour within studies (60). Other evidence demonstrates that higher durations of television viewing and video game use were significantly associated with unfavourable measures of **behavioural conduct/pro-social behaviour** (24); and more screen time and television viewing is associated with shorter **sleep** duration, although there was no association between computer use/gaming and sleep duration (61). Investigations into the relationship between sedentary behaviours and mental health is a rapidly developing field with many unknowns, and reverse causality is likely to be in evidence. Further research is needed to inform on the direction and strength of this association.

The GDG concluded that:

- There is low certainty evidence that higher duration of sedentary behaviour (screen time) is significantly associated with lower physical fitness and cardiometabolic health in children and adolescents.

- There is very low to moderate certainty evidence that higher durations of sedentary behaviour (screen time, television viewing and video game use) are significantly associated with unfavourable measures of mental health and behavioural conduct/pro-social behaviour in children and adolescents.
- There is low certainty evidence that greater time spent in sedentary behaviour (screen time and television viewing) is associated with detrimental effects on sleep duration in children and adolescents.
- The benefits of limiting the amount of sedentary behaviour for children and adolescents outweigh the harms.

Is there a dose-response association (total volume, duration, frequency, intensity of interruption)?

There is insufficient evidence available to determine whether a dose-response relationship exists between sedentary time (including recreational screen time) and health outcomes in children and adolescents. Most of the evidence assessing the associations between sedentary behaviours and health outcomes in children and adolescents is cross-sectional in nature, with low certainty evidence according to GRADE, and a majority of studies relied on self- or parent-reported measures of sedentary time that are subject to measurement errors and recall biases. There is, however, evidence that less time spent in sedentary behaviours appears to be better for health outcomes, and the association between sedentary behaviour and adverse health outcomes is generally stronger for sedentary behaviour when assessed as television viewing or recreational screen time as the exposure variable, than for total sedentary time. However, overall the evidence was considered insufficient to support specifying time limits.

Evidence that sedentary behaviours are linked to adverse health outcomes could be the result of either direct effects of the sedentary behaviours, displacement of time spent in more physically active behaviours, or both. Although there are studies that have reported associations between screen time and adverse health outcomes in children and adolescents, total sedentary time (as assessed in studies using device-based measurements of sedentary behaviour) has consistently not been associated with health outcomes when time in moderate- to vigorous-intensity physical activity is taken into account (62). Conversely, the evidence linking moderate- to vigorous-intensity physical activity to positive health outcomes is strong and well documented across diverse settings; replacing some sedentary behaviour with physical activity (especially moderate- to vigorous-intensity physical activity) may improve health outcomes.

Research investigating the associations and interplay between sedentary behaviour, physical activity and health outcomes is rapidly growing, and evidence from device-based measures of sedentary behaviour and cardiometabolic health show the association is attenuated when moderate- to vigorous-intensity physical activity is taken into account (i.e. statistically adjusted for) (62–64). There is therefore a need for further prospective studies using device-based measures of exposure, to advance knowledge of these associations and inform future recommendations.

The GDG concluded that:

- There is low certainty evidence that greater time spent in sedentary behaviour is related to poorer health outcomes.
- There is insufficient evidence to specify time limits on sedentary behaviour.

- Replacing sedentary time with moderate- to vigorous-intensity physical activity may provide health benefits.

Does the association vary by type or domain of sedentary behaviour?

The study of health effects of sedentary behaviour is a relatively new field of research. As such the findings are from studies using different instruments and measures of exposure. Exposure assessed as "total time spent doing sedentary behaviours" is frequently used, as is sedentary time spent using "screens" or "television viewing". Available evidence suggests that the association between sedentary behaviour and adverse health outcomes is generally stronger for television viewing or recreational screen time than for total sedentary time (24, 35). The increased use of device-based assessment of sedentary behaviour in the more recent research is advancing knowledge, and when combined with standardized reporting will help inform future guidelines.

It is acknowledged that not all sedentary behaviour is harmful. Evidence suggests certain types of sedentary behaviour, such as reading and doing homework outside of school, are associated with higher academic achievement, indicating that there are differences in outcome depending on the activity (24, 25). Sedentary behaviour may include time spent engaged in educational pursuits/study or quiet play, or social interaction without electronic media. These pursuits (e.g. reading, doing puzzles, drawing, crafting, singing, music) are important for child development and have cognitive as well as other benefits.

The GDG acknowledged that:

- Some sedentary activities confer benefits for cognitive function and social interaction in children and adolescents.
- Evidence on the adverse health effects of sedentary behaviour is generally stronger for television viewing or recreational screen time than for total sedentary time.

ADULTS (aged 18–64 years)

PHYSICAL ACTIVITY RECOMMENDATION

For adults, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), transportation (wheeling, walking and cycling), work or household chores, in the context of daily occupational, educational, home and community settings.

In adults, physical activity confers benefits for the following health outcomes: improved all-cause mortality, cardiovascular disease mortality, incident hypertension, incident site-specific cancers, [1] incident type-2 diabetes, mental health (reduced symptoms of anxiety and depression); cognitive health, and sleep; measures of adiposity may also improve.

It is recommended that:

> **All adults should undertake regular physical activity.**

Strong recommendation, moderate certainty evidence

> **Adults should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity;**

or an equivalent combination of moderate- and vigorous-intensity activity throughout the week, for substantial health benefits.

Strong recommendation, moderate certainty evidence

> **Adults should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional health benefits.**

Strong recommendation, moderate certainty evidence

> **Adults may increase moderate-intensity aerobic physical activity to more than 300 minutes; or do more than 150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for additional health benefits.**

Conditional recommendation, moderate certainty evidence

1 Site-specific cancers of: bladder, breast, colon, endometrial, oesophageal adenocarcinoma, gastric, and renal.

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If adults are not meeting these recommendations, doing some physical activity will benefit their health.
- Adults should start by doing small amounts of physical activity, and gradually increase the frequency, intensity and duration over time.

Supporting evidence and rationale

For these guidelines, the synthesis of evidence undertaken by the United States Physical Activity Guidelines Advisory Committee (PAGAC) (35) was used and updated.

The GDG considered the entire body of evidence, including both the findings reported by PAGAC and the 28 reviews and 3 pooled cohort studies, published from 2017 through to November 2019, that met inclusion criteria, and contributed evidence on the association between physical activity and health-related outcomes in adults. In addition, two umbrella reviews were commissioned to address evidence gaps and examine **i)** the relationship between occupational (i.e. work-related) physical activity and health-related outcomes (40); and **ii)** the association between leisure-domain physical activity and adverse health outcomes (41). The umbrella reviews identified 36 and 15 systematic reviews respectively. Evidence from longitudinal observational studies and intervention trials was prioritized, and reviews that solely, or primarily, synthesized cross-sectional evidence were not considered. Greater emphasis was given to evidence provided by reviews graded moderate certainty and above, and to those providing evidence from studies using device-based measures of exposure.

Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In adults (aged 18–64 years), what is the association between physical activity and health-related outcomes?

The association between physical activity and **all-cause mortality and cardiovascular disease mortality** in adults is already well-established (1). Findings from recent reviews reaffirmed that compared with the lowest levels of physical activity, higher levels of physical activity were associated with a lower risk of mortality. New evidence from studies using device-based measures of physical activity reaffirmed and extended the evidence showing that compared with the lowest levels of physical activity, *any* level and *all intensities* (including light intensity) of physical activity, were associated with a lower risk of mortality (65). For example, compared with the least active (referent, 1.00), adjusted HR for quartiles of total physical activity improved across quartiles of physical activity: 2nd quartile (0.48 [95% CI: 0.43 to 0.54]); 3 rd quartile (0.34 [95% CI: 0.26 to 0.45]); and 4th quartile (0.27 [95% CI: 0.23 to 0.32]) (65). New evidence also reaffirmed the well-established (1) inverse relationship between physical activity and **cardiovascular disease mortality** (66).

The benefits of physical activity for reducing cardiovascular disease and hypertension incidence is well-documented (1). Physical activity promotes many physiological responses that cause beneficial short- and long-term autonomic and haemodynamic adaptations, resulting in lowered risk of **hypertension**, which is a key risk factor for **cardiovascular disease**.

Evidence reaffirmed an inverse relationship between physical activity and incident hypertension among adults with normal blood pressure, and that physical activity reduces blood pressure among adults with prehypertension and normal blood pressure (35).

The inverse association between physical activity and developing **type-2 diabetes** in adults is well-established (1). Recent evidence reaffirmed an inverse curvilinear relationship between higher volumes of physical activity and incidence of type-2 diabetes (35), with a decreasing slope at higher levels of physical activity. A new review found that this effect is consistent across individuals of different backgrounds with a reduced risk of developing type-2 diabetes in "highest" versus "lowest" levels of physical activity among non-Hispanic whites (RR= 0.71 [95% CI: 0.60 to 0.85]); Asians (RR= 0.76 [95% CI: 0.67 to 0.85]); Hispanics (RR = 0.74 [95% CI 0.64 to 0.84]); and American Indians (RR = 0.73 [95% CI: 0.60 to 0.88]), although the effect among non-Hispanic blacks was not significant (RR = 0.91 [95% CI: 0.76 to 1.08]) (67). Evidence suggests there is no effect modification by weight status and that the inverse relationship between a higher volume of physical activity and lower incidence of type-2 diabetes exists for people who have normal weight, overweight or obesity (35).

The associations between higher levels of physical activity and reduced risks of **colon cancer and breast cancer** have been well-established (1). In previous reviews of the evidence, higher levels of physical activity have been found to be associated with a reduced risk of developing breast cancer and colon cancer (1). Following an extensive increase in physical activity and cancer research, there is new evidence demonstrating higher levels of physical activity are also associated with reduced risk of developing bladder, endometrial, oesophageal adenocarcinoma, gastric and renal cancers, as well as reaffirming that physical activity is protective for breast cancer and colon cancer (35). Higher levels of physical activity are associated with risk reductions ranging from approximately 10–20% (35). For example, one review reported an

inverse association with liver cancer risk when comparing high levels of physical activity to low levels of physical activity (HR= 0.75 [95% CI: 0.63 to 0.89]) (68). There is insufficient evidence on the association between increased physical activity and decreased risks of hematologic, head and neck, ovary, pancreas, prostate, thyroid, rectal and brain cancer (35). While evidence suggests a reduction in risk of lung cancer between the highest versus lowest levels of physical activity, these findings may be confounded by tobacco use and it was determined that overall there is insufficient evidence to establish an association.

The association between physical activity and **adiposity** in adult populations is less well established despite a large, but heterogenous, body of evidence assessing this relationship across various outcome measures (weight gain, weight change, weight control, weight stability, weight status and weight maintenance) (35, 69, 70). Overall the evidence shows that higher levels of physical activity may be associated with more favourable measures of adiposity and attenuation of weight gain in adults (35). Further research is needed to establish consistent results and strength of associations.

Research on physical activity and **mental health, cognition and sleep** has increased substantially since the development of the 2010 *Global recommendations on physical activity for health* (1). At that time, there was sufficient evidence to conclude only that physical activity may reduce the risk of depression and cognitive decline in adults. New evidence reviewed for these guidelines showed that adults engaging in higher versus lower physical activity are at reduced risk of developing anxiety and depression. For example, adults with high, versus low, levels of physical activity were at reduced odds of developing anxiety (AOR= 0.81 [95% CI: 0.69 to 0.95]) (71) or depression (AOR= 0.78 [95% CI: 0.70 to 0.87) (72). Greater amounts of moderate- to vigorous-intensity physical activity are associated with improvements in cognition (e.g. processing speed, memory, and executive function) (35), brain function and structure, and a reduced risk of developing **cognitive impairment**, including Alzheimer's disease (73–76). The evidence included several adult populations representing a gradient of normal to impaired cognitive health status and the beneficial effects of physical activity were reported across a variety of types, including aerobic activity, walking, muscle-strengthening activity, and yoga (74). There is evidence that both acute bouts and regular physical activity improve **sleep and health-related quality of life** outcomes in adults (35).

Evidence examining physical activity and **symptoms of depression, symptoms of anxiety, and the development of anxiety and depression** indicated that physical activity was associated with reduced symptoms of anxiety (77, 78) and reduced symptoms of depression (77, 79).

All physical activity comes with some risk. Evidence from a commissioned review on the adverse effects, injuries and harms associated with leisure physical activity in adults (41) suggests an unfavourable association between levels of leisure-time physical activity and musculoskeletal injuries, and a favourable relationship between leisure-time physical activity and risk of fracture and onset of knee or hip osteoarthritis. Additional existing evidence (35) indicates sudden cardiac adverse events are rare and associated with acute sessions of relatively vigorous-intensity physical activity. Generally, the risks of adverse events are very low with moderate-intensity physical activity and when increases in physical activity frequency, intensity and duration are gradual (35).

The GDG concluded that:

- There is high certainty evidence that any level and any intensity of physical activity is associated with lower risk of all-cause mortality and cardiovascular disease mortality, incidence of hypertension, cardiovascular disease and type-2 diabetes.
- There is moderate to high certainty evidence on the associations between higher levels of physical activity and lower risk of incidence of site-specific cancers.
- There is moderate certainty evidence supporting an association between physical activity and improvements in mental health, cognitive health and sleep outcomes.
- There is evidence of an association between higher levels of physical activity and more favourable measures of adiposity and attenuation of weight gain in adults.
- There is low certainty evidence that physical activity recommended for adults will not be harmful and that the health benefits from such activity outweigh the risks.

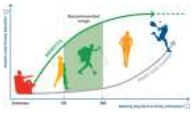

Figure 1

Dose response curve.

Is there a dose-response association (volume, duration, frequency, intensity)?

Overall the evidence across cardiovascular and metabolic health outcomes shows a consistent curvilinear inverse dose-response relationship between physical activity and major outcomes such as all-cause mortality, cardiovascular disease mortality, incident type-2 diabetes (67), and incident site-specific cancers in adults. As described in Figure 1, the shape of the dose-response curve indicates that there is no lower threshold for benefit, and the greatest benefits are seen at the lower end of the dose-response curve (65). The curvilinear inverse association is consistently reported and across studies using different measures of physical activity. Important new evidence was provided in a meta-analysis of eight prospective cohort studies, with mean follow-up of 5.8 years (range 3–14.5 years) (65) that reported the adjusted HR for quartiles of total physical activity using device-based measures of exposure and **all-cause mortality**. The results showed a dose-response with increasing volume of physical activity and benefits of higher levels of *any* intensity of physical activity compared with the least active (referent, 1.00): 2 nd quartile (adjusted HR= 0.48 [95% CI: 0.43 to 0.54]); 3 rd quartile (adjusted HR= 0.34 [95% CI: 0.26 to 0.45]); and 4 th quartile (adjusted HR= 0.27 [95% CI: 0.23 to 0.32]). Maximal risk reductions for moderate- to vigorous-intensity physical activity were observed at 24 minutes per day (equivalent to 168 minutes per week), which closely reflects the recommendation of 150 minutes per week, and provides new device-based evidence reinforcing the existing global guidance to adults of 150–300 minutes of physical activity per week (65). These findings are consistent with the evidence from existing reviews (35) and the other new identified reviews (66).

At the upper end, higher levels of physical activity continue to provide benefits in terms of reduced risk of mortality with no increased risk of harms. For example, evidence from a new review with findings from a meta-analysis of individual data from device-based measures of exposure (65), indicates that although reduced risk of mortality is observed up to 750 minutes of moderate-to vigorous-intensity physical activity per week, the relative risk of mortality levels off beyond 300 minutes per week. These results accord with previous evidence which consistently showed that more physical activity is associated with further health benefits, although the relative benefits are reduced at higher levels of physical activity (35, 80, 81). There is, however,

insufficient evidence to identify the exact physical activity level where diminished returns of health benefits begin for adults.

Evidence also reaffirmed the well-established inverse relationship between physical activity and **cardiovascular disease mortality**, providing additional evidence of a dose-response relationship well beyond current recommended volumes of physical activity.

A meta-analysis of 48 prospective studies assessing physical activity (total, leisure, and occupational) provided additional evidence of a dose-response relationship (66) well beyond current recommended volumes of physical activity. Compared with the recommended level of 750 MET minutes per week, participation in 5000 MET minutes per week (1000 minutes of moderate-intensity activity) resulted in a significantly lower risk for cardiovascular disease mortality (HR= 0.73 [95% CI: 0.56 to 0.95]) (66). Previous WHO recommendations (1) concluded that aerobic activity should be performed in bouts of at least 10 minutes duration. However, new evidence, using device-based assessments, demonstrates that physical activity of *any* duration, without a minimum threshold, is associated with improved health outcomes, including all-cause mortality (65, 82). For example, new evidence from reviews of studies assessing physical activity by accelerometry reaffirms similar associations between all indices of physical activity and all-cause mortality, with hazard ratios of 0.27 for total physical activity, 0.28 for 5-minute bouts, and 0.35 for 10-minute bouts, comparing the highest versus lowest quartiles (83). These results, reaffirmed by findings in the new review by Ekelund et al. 2019 (65), provide evidence that physical activity of any bout duration is associated with improved health outcomes, including all-cause mortality (82). Based on new evidence, the recommendation for bouts of least 10 minutes duration has been removed.

Although evidence showing the associations between higher levels of physical activity and lower risk of incidence of **site-specific cancers** was deemed to be consistent overall, there is insufficient evidence to determine the specific levels of physical activity that correspond to the reported risk reduction due to the large heterogeneity in the assessment and classification of exposure across studies. There is however, no evidence to suggest that there is a lower threshold below which no beneficial effect of physical activity is evident, thus suggesting that any level of physical activity can confer benefit on reducing the risk of site-specific cancers. Future research assessing the nature of the dose-response and using more consistent measures and reporting is needed to inform future guidelines.

Although there is a large body of evidence on the associations between physical activity and various measures of adiposity, weight gain and the management of a healthy weight status (35), currently there is insufficient evidence to describe more specifically the dose-response relationship or identify a threshold of effect. Further research is needed to inform future guidelines.

Greater amounts of moderate- to vigorous-intensity physical activity are associated with improvements in **cognition** (e.g. processing speed, memory, and executive function) (35), brain function and structure, and a reduced risk of developing **cognitive impairment**, including Alzheimer's disease (73–76). There is evidence that both acute bouts and regular physical activity improve **sleep and health-related quality of life** outcomes in adults (35). There is however insufficient evidence to describe more specifically the dose-response relationship between physical activity and individual mental and cognitive health outcomes. Similarly, more evidence is needed to further describe the dose-response relationship between volume and/or intensity of aerobic physical activity and muscle-strength training and specific health outcomes.

Such information is key to establishing minimal effective doses and maximum safety thresholds of physical activity for different population subgroups.

The GDG concluded that:

- There is evidence that more physical activity is associated with larger effects on health outcomes, although the relative benefits level off at higher levels of physical activity. There was insufficient evidence to identify the exact level where diminished returns start to occur.
- There is high certainty evidence that higher levels of physical activity are associated with lower risk of all-cause mortality, cardiovascular disease mortality, cancer mortality, cardiovascular disease incidence, and incidence of hypertension and type-2 diabetes, with no increased risk of harms.
- There is moderate certainty evidence that physical activity of any duration is associated with improved health outcomes, and prior specification that aerobic activity should be performed in bouts of at least 10 minutes duration should be removed.
- There is evidence that higher amounts of physical activity may be associated with more favourable measures of adiposity and attenuation of weight gain in adults and there is a low risk that physical activity will be harmful for the management of healthy weight status in adults.
- There is moderate certainty evidence that 150–300 minutes of moderate intensity aerobic physical activity or equivalent, per week, reduces risk for multiple health outcomes, and risk reduction continues, but starts to plateau, beyond 300 minutes per week.

Does the association vary by type or domain of physical activity?

Evidence shows that different types of physical activity and physical activity undertaken in different domains (i.e. occupation, transport, or leisure) can provide favourable health outcomes. For all-cause and cardiovascular disease mortality, undertaking aerobic physical activity alone, or combining with strength-promoting exercise shows beneficial associations, although performing recommended levels of both types is optimal (84).

More recent moderate certainty evidence indicates that muscle-strengthening physical activity, independent of aerobic physical activity, is also associated with lower risk of all-cause mortality. Results reported by Stamatakis et al. (2018), from a pooled analysis of 11 cohorts examining the 2 days per week muscle-strengthening exercise recommendation against all-cause mortality, showed that undertaking both aerobic and muscle-strengthening physical activity at recommended levels (1) versus not meeting either recommendation (adjusted HR= 0.71 [95% CI: 0.57 to 0.87]) as well as adherence to just the strength exercise recommendation versus not adhering (HR= 0.80 [95% CI: 0.70 to 0.91]) was associated with significantly lower risk of all-cause mortality (84). These data affirm that health benefits associated with muscle-strengthening exercise were independent of aerobic physical activity and also provide evidence to support recommending a frequency of 2 days per week of muscle-strengthening exercise. Other findings reported by Dinu et al. (2019) provided supporting evidence reaffirming that physical activity undertaken in domains other than leisure (or recreation) can be beneficial and specifically showed that active commuting (i.e. walking and cycling for transport) can significantly lower risk of all-cause mortality (RR= 0.92 [95% CI: 0.85–0.98]) (85).

Recent research provides evidence demonstrating that for those who participate in active commuting (i.e. walking or cycling for transport), there is reduced risk of cardiovascular disease (coronary heart disease, stroke and heart failure) compared with those participating in no active commuting (RR= 0.91 [95% CI 0.83 to 0.99]) (85); and that there is sufficient evidence from these health outcomes to conclude that activity in different domains can be beneficial. However, there is insufficient evidence to differentiate the effect of different domains of physical activity on every health outcome. For example, there is insufficient evidence to determine if the association between physical activity and cancer risk or type-2 diabetes incidence varies by type or domain of physical activity.

For mental health outcomes, evidence (35) shows that a variety of types of physical activity, including aerobic activity, walking, muscle-strengthening activity, and yoga can provide beneficial effects for reducing symptoms of depression and development of anxiety (74, 79, 86). For example recent evidence for the beneficial effects of resistance exercise interventions and mental health was provided by two reviews reporting moderately large reductions in symptoms of depression (77) and small reductions in symptoms of anxiety (78) compared with control conditions.

Evidence from a new review affirmed that high levels of occupational physical activity is associated with reduced risk of many cancers, coronary heart disease, and type-2 diabetes (40). However, higher levels of occupational physical activity may also be associated with an increased risk of osteoarthritis, poor sleep quality, and all-cause mortality among males (but not among females). There is insufficient evidence to determine the relationship between occupational physical activity and adiposity, prevention of body weight gain, mental health, and health-related quality of life (40). There is also insufficient evidence to determine if the association between physical activity and cancer risk varies by type or domain of physical activity. There is less evidence on associations by different domains of physical activity, and therefore it was difficult to differentiate the effect of different domains of physical activity on various health outcomes.

The GDG concluded that:

- There is moderate certainty evidence that muscle-strengthening activities undertaken on 2 or more days a week, provide additional health benefits, but there is insufficient evidence to specify a specific duration for optimal health benefits.
- There is moderate certainty evidence that physical activity undertaken in different domains (e.g. leisure, transport, occupational) can provide health benefits, although currently it is not possible to differentiate the effect of different domains of physical activity on various health outcomes.
- Although higher levels of occupational physical activity may be associated with an increased risk of osteoarthritis, poor sleep quality, and all-cause mortality among males (but not among females), overall there is moderate certainty evidence that occupational physical activity can provide health benefits.

SEDENTARY BEHAVIOUR RECOMMENDATION

For adults, sedentary behaviour is defined as time spent sitting or lying with low energy expenditure, while awake, in the context of occupational, educational, home and community settings, and transportation.

In adults, higher amounts of sedentary behaviour are associated with the following poor health outcomes: all-cause mortality, cardiovascular disease mortality and cancer mortality and incidence of cardiovascular disease, cancer and type-2 diabetes.

It is recommended that:

> **Adults should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits.**

Strong recommendation, moderate certainty evidence

> **To help reduce the detrimental effects of high levels of sedentary behaviour on health, adults should aim to do more than the recommended levels of moderate- to vigorous-intensity physical activity.**

Strong recommendation, moderate certainty evidence

Supporting evidence and rationale

For these guidelines, the synthesis of evidence undertaken by PAGAC (35) was used and updated. The GDG considered the entire body of evidence, including both the findings reported by PAGAC and the 13 new reviews that met inclusion criteria, to contribute evidence on the association between sedentary behaviour and health-related outcomes in adults. Investigating the association between sedentary behaviour and health outcomes is a relatively new field of public health compared with that of physical inactivity, yet it has developed rapidly in the past decade. Studies have typically measured sedentary behaviour using either **i)** self-report questionnaires which ask about "total time" spent in sedentary behaviours, or time spent in specific behaviours, such as television viewing, computer/screen use, and sitting; or **ii)** device-based assessments. There are no standardized measures or analytical protocols for sedentary behaviour and thus the reporting of results is heterogeneous. Recent methodological developments include the use of device-based assessment of time spent sedentary which can reduce measurement error and other biases inherent in self-reported recall.

In considering the total body of evidence, the GDG gave greater emphasis to evidence provided by reviews graded moderate and above, taken from reviews providing evidence from studies using measures of total sedentary or sitting time, or device-based measures of sedentary behaviour where available.

Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

Research on the potential adverse health effects associated with sedentary behaviour has rapidly accumulated during the past decade. In more recent studies, notable developments include an increase in evidence reporting on dose-response relationships between sedentary behaviour and multiple health outcomes, and on the interplay between sedentary behaviour and physical activity.

In adults (aged over 18 years), what is the association between sedentary behaviour and health-related outcomes?

Overall, there is evidence of an association between greater time spent in sedentary behaviour (examined mostly via self-reporting or device-based assessments of sitting or television viewing time) and higher all-cause mortality, cardiovascular mortality, cardiovascular disease incidence and type-2 diabetes incidence (8, 35, 65, 87). For example, supporting evidence includes results from a recent large meta-analysis (*n*= 36 383; mean age 62.6 years; 72.8% women) of accelerometer assessed total sedentary time and **all-cause mortality** (65) and showed that increasing time spent in sedentary behaviour was significantly associated with all-cause mortality. Similar findings from a meta-analysis comprising more than 1 million participants (87) showed associations for total sedentary behaviour with **all-cause mortality**, and **cardiovascular disease mortality**, after adjustment for physical activity (87), although in this study the associations with **cancer mortality** were not statistically significant after adjustment for physical activity (87).

Another recent meta-analysis (8) reported significant associations between sedentary behaviour (assessed as sitting) and **cardiovascular disease and cancer mortality**, with results indicating a 9–32% *(p* for trend < 0.001) higher risk of cardiovascular disease mortality with higher levels of sedentary behaviour when measured as sitting time in the "inactive", lowest quartile of physical activity (~ 5 min/day). The study reported that adults who were sedentary (sitting) for more than 8 hours per day had a higher risk of cardiovascular disease mortality, except for those who were "most active" (i.e. > 35.5 MET-hours/week, or ~ 60–75 mins/ day), where the association was mitigated. Results on the associations between sedentary behaviours and **cancer mortality** were generally weaker, although a 6–21% higher dose-related risk was observed with longer sitting time (particularly > 8 hours/day), but only among those in the lowest quartile of physical activity (< 2.5 MET-hours/week) (8).

Evidence supports an association between sedentary behaviour (measured as total sitting time) and increased **incident cardiovascular disease** (HR= 1.29 [95% CI: 1.27 to 1.30]) which was attenuated following adjustment for potential covariates, including level of physical activity (HR= 1.14 [95% CI: 1.04 to 1.23]) (88). A review of studies in south-east Asian populations provided evidence of low certainly that greater sedentary time was associated with an increased likelihood of unfavourable **cardiometabolic indicators** (including type-2 diabetes, higher BMI, higher blood pressure) (89).

Two recent reviews report on the association of total daily sitting time (88) and total sedentary behaviour and television viewing (87) with **type-2 diabetes incidence**. Both studies found a higher level of sedentary behaviour was associated with increased risk of type-2 diabetes incidence. For example, a linear association with type-2 diabetes was observed for total sedentary behaviour (RR= 1.01 [95% CI: 1.00 to 1.01] $p = < 0.001$) and television viewing (RR= 1.09 [95% CI: 1.07 to 1.12] $p = < 0.001$), when adjusted for physical activity (87).

There is also supporting evidence for a significant association between sedentary behaviour (when measured as time spent viewing television) and **cancer mortality** (35, 87). Several more recent reviews, of low and very low certainty, provide supporting evidence for an association between sedentary behaviours and colorectal cancer (90), but no associations with incident prostate, breast or rectal cancer (90–93). Additional evidence (35) reported significant associations between greater time spent in sedentary behaviour and higher risk of developing endometrial, colon and lung cancers (35).

There is low certainty evidence of an unfavourable relationship between time spent in sedentary behaviour and **adiposity** and other indicators of weight status, and whether the relationship

between sedentary behaviour and weight status varies by amount of moderate-to vigorous-intensity physical activity. Overall, it was concluded that there was insufficient evidence to inform these recommendations/guidelines and that further research is needed.

There is limited evidence assessing adverse effects of reducing sedentary time. Expert opinion informed the conclusion that recommending the reduction in sedentary time would be unlikely to increase risk of injury, especially if replaced with light-intensity physical activity.

The GDG concluded that:

- Overall there is sufficient evidence to support the development of a new WHO recommendation to limit sedentary behaviour to reduce health risks.
- There is moderate certainty evidence of an association between greater time spent in sedentary behaviour and higher all-cause mortality, cardiovascular disease mortality, cancer mortality and incidence of cardiovascular disease and type-2 diabetes.
- There is low to moderate certainty evidence of an association between greater time spent in sedentary behaviour and higher risk of incident endometrial, colon, and lung cancers.
- There is insufficient evidence on the association between sedentary behaviour and measures of adiposity and further research is needed.
- The benefits of limiting sedentary behaviour outweigh any potential risks.

Is there a dose-response association (total volume, frequency, duration, intensity of interruption)?

Overall, moderate certainty evidence indicates a nonlinear dose-response relationship between sedentary time (sitting or television viewing time assessed by self-reporting, or by device-based assessments) and all-cause mortality, cardiovascular disease mortality, cancer mortality, and incident cardiovascular disease (8, 35, 87).

A recent meta-analysis provided high certainty evidence on the dose-response relationship between accelerometer assessed total sedentary time and **all-cause mortality** (65) reporting that increasing time spent in sedentary behaviour was significantly associated with all-cause mortality. The hazard ratios for increasing quartiles of sedentary time were 1.00 (referent; least sedentary); 1.28 (1.09–1.51); 1.71 (1.36–2.15); and 2.63 (1.94–3.56), after adjustment for potential confounders including time spent in moderate- to vigorous-intensity physical activity (65). This analysis of dose-response relations between sedentary time and mortality showed risk increased gradually from about 7.5–9 hours and was more pronounced at greater than 9.5 hours. Sedentary behaviour of 10 hours and 12 hours each day were associated with 1.48 (1.22–1.79) and 2.92 (2.24–3.83) higher risk of death, respectively (65).

Another recent meta-analysis assessed dose-response and reported non-linear associations for total sedentary time and **all-cause mortality** (RR per 1 hour/day = 1.01 (1.00–1.01) for ≤ 8 hours/day; and 1.04 (1.03–1.05) for > 8 hours/day of exposure); and **cardiovascular disease mortality** (RR= 1.01 (0.99–1.02) for ≤ 6 hours/day; and RR= 1.04 (1.03–1.04) for > 6 hours/day) after adjustment for physical activity (87). In this same study, a small linear dose-response association between **type-2 diabetes** was observed for total sedentary behaviour (1.01 (1.00–1.01)) when adjusted for physical activity and television viewing (1.09 (1.07–1.12)) (87).

Overall, evidence supports that higher amounts of sedentary behaviour are associated with less favourable health outcomes and it was concluded that there is sufficient evidence to support

minimizing sedentary time to reduce health risks. However, given the considerable variations in how sedentary behaviour was assessed across reviews (via self-reported sitting time, television viewing time, or device-based (accelerometer) assessments) and the probability that thresholds for sedentary time might vary across health outcomes, by levels of moderate- to vigorous-intensity physical activity, and among population subgroups, there is insufficient evidence to set a time-based (quantified) recommendation.

In addition to overall volume of sedentary behaviour, evidence on the patterns by which sedentary behaviour is accrued was reviewed. However, there was limited evidence to make recommendations on the frequency and/or duration of breaks in sedentary behaviour.

The GDG concluded that:

- There is insufficient evidence to set quantified (time-based) recommendations on sedentary behaviours.
- There is insufficient evidence to make recommendations on the frequency and/or duration of breaks in sedentary behaviour.

Does the association vary by type and domain of sedentary behaviour?

Some domains or different types of sedentary behaviour may be more detrimental than others, both in terms of their direct associations and in their potential to displace time spent in more healthful physical activity. Although there has been a rapid growth in research on sedentary behaviour, there is limited evidence available directly comparing the association between different types of sedentary behaviour and different health outcomes. For example, some studies report stronger results with sedentary behaviour measured as television viewing compared with total sitting time (87). This may be due to the differential measurement error or residual confounding associated with self-report measures and instruments. Currently, there is insufficient evidence to determine the different associations with different health outcomes and how these may vary by subpopulation.

A growing number of studies are using device-based measures of physical activity and sedentary time in relation to health outcomes. However, some misclassification may occur from device-based measures of sedentary time as many of these device placements (e.g. wrist, waist) do not currently distinguish between positions (e.g. lying, sitting and standing still). Future research using harmonized reporting, and methods that distinguish between positions, will help to strengthen the knowledge on the patterns of sedentary behaviour.

The GDG concluded that:

- There is insufficient evidence to make recommendations on different types or domains of sedentary behaviour.

Does level of physical activity modify the effect of sedentary behaviour on mortality?

The increased interest in the impact of sedentary behaviour on health outcomes has stimulated investigation into the potential interplay between different levels of physical activity and levels of sedentary behaviour. Based on available research, there is moderate certainty evidence that the relationship between sedentary behaviour and **all-cause mortality, cardiovascular disease mortality** and **cancer mortality** varies by amount of moderate- to vigorous-intensity physical activity (8, 9, 35). Overall findings show that the effect of sedentary behaviour is stronger in

those who do low amounts of moderate- to vigorous-intensity physical activity or, phrased conversely, that higher amounts of moderate- to vigorous-intensity physical activity can mitigate the unfavourable health outcomes associated with higher levels of sedentary behaviours.

The risk associated with sedentary time and all-cause mortality has been shown to be more pronounced at lower levels of physical activity than at higher levels (35). In a harmonized meta-analysis, Ekelund et al. investigated the joint and stratified effects of sedentary behaviour and physical activity with **all-cause mortality** in more than 1 million men and women, and showed that the associations differed depending on the level of physical activity (9). The analyses used quartiles of sedentary behaviour (sitting) and quartiles of moderate- to vigorous-intensity physical activity, and found that compared with the referent (< 4 hours of sitting per day and highest quartile of moderate- to vigorous-intensity physical activity [> 35.5 MET-hours/ week]), there was no increased risk of dying during follow-up in those who sat for more than 8 hours per day but who also reported more than 35.5 MET-hours per week of activity (HR= 1.04 [95% CI: 0.99 to 1.10]). In contrast, those who sat the least (< 4 hours/ day) and were in the lowest (< 2.5 MET-hours/week) physical activity quartile had a significantly increased risk of dying during follow-up (HR= 1.27 [95% CI: 1.22 to 1.31]). The study concluded that levels of moderate-to vigorous-intensity physical activity of about 60–75 minutes per day (the highest quartile) can attenuate, and even eliminate, the detrimental association between sedentary behaviour and health outcomes (9).

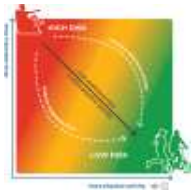

Figure 2

The relationship between levels of sedentary behaviour and physical activity. Adapted from PAGAC

This relationship between levels of sedentary behaviour and moderate- to vigorous-intensity physical activity was summarized in the systematic review by PAGAC (35) as shown in Figure 2.

Another recent study provided new evidence investigating the same associations with cause-specific mortality and showed similar findings (8). In a large harmonized meta-analysis (9 studies, *n*= 850 000, CVD mortality; 8 studies, *n*= 777 000, cancer mortality), results showed that higher levels of moderate- to vigorous-intensity physical activity mitigated the increased risk of **cardiovascular disease mortality** with high levels of sedentary behaviour, whether measured as time spent sitting or time spent viewing television (8). The study showed that in individuals who were sitting for more than 8 hours per day, there was an association with higher risk of death, except in the most active quartile, where the association was mitigated. More specifically, the hazard of cardiovascular disease mortality was 32% higher in those who sat for more than 8 hours per day compared with the reference group (< 4 hours/day) (p for trend < 0.001). The results were less pronounced but remained significant compared with the reference group for the other quartiles of physical activity (2^{nd} quartile, HR= 1.11 [95% CI: 1.03 to 1.20]; 3^{rd} quartile, HR= 1.14 [95% CI: 1.03 to 1.26]). Similar associations were observed for television time and cardiovascular disease mortality across strata of moderate- to vigorous-intensity physical activity (8). The associations for **cancer mortality** were more mixed, although generally showed that higher levels of physical activity attenuated the detrimental effects of sedentary behaviour when assessed as total sitting time.

Based on this evidence, it was agreed that higher levels of moderate- to vigorous-intensity physical activity should be recommended for those individuals who undertake high levels of

sedentary behaviour and that the benefits would outweigh the risks.

The GDG concluded that:

- There is moderate certainty evidence that the relationship between sedentary behaviour and all-cause mortality, cardiovascular disease and cancer mortality varies by amount of moderate- to vigorous-intensity physical activity.
- Higher amounts of moderate- to vigorous-intensity physical activity can attenuate the detrimental association between sedentary behaviour and health outcomes.

OLDER ADULTS (aged 65 years and older)

PHYSICAL ACTIVITY RECOMMENDATION

For older adults, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), transportation (wheeling, walking and cycling), work, or household chores, in the context of daily occupational, educational, home or community settings.

In older adults, physical activity confers benefits for the following health outcomes: improved all-cause mortality, cardiovascular disease mortality, incident hypertension, incident site-specific cancers, incident type-2 diabetes, mental health (reduced symptoms of anxiety and depression), cognitive health, and sleep; measures of adiposity may also improve. In older adults, physical activity helps prevent falls and falls-related injuries and declines in bone health and functional ability.

It is recommended that:

> **All older adults should undertake regular physical activity.**

Strong recommendation, moderate certainty evidence

> **Older adults should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week, for substantial health benefits.**

Strong recommendation, moderate certainty evidence

> **Older adults should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional health benefits.**

Strong recommendation, moderate certainty evidence

> **As part of their weekly physical activity, older adults should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity, on 3 or more days a week, to enhance functional capacity and to prevent falls.**

Strong recommendation, moderate certainty evidence

> **Older adults may increase moderate-intensity aerobic physical activity to more than 300 minutes; or do more than 150 minutes of vigorous-intensity aerobic**

physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week, for additional health benefits.

Conditional recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If older adults are not meeting the recommendations, doing some physical activity will bring benefits to health.
- Older adults should start by doing small amounts of physical activity, and gradually increase the frequency, intensity and duration over time.
- Older adults should be as physically active as their functional ability allows, and adjust their level of effort for physical activity relative to their level of fitness.

Supporting evidence and rationale

For these guidelines, for older adults, the comprehensive synthesis of evidence undertaken by PAGAC (35) was used and updated. Fifteen reviews met the inclusion criteria and informed the examination of the association between physical activity and health-related outcomes specific to older adults (falls prevention, fall-related injuries, physical function, frailty, and osteoporosis).

The evidence for falls prevention used and updated the 2019 Cochrane Collaboration Systematic Review by Sherrington et al. (42), with evidence published from the end search date of their original review, to November 2019 (9 new studies). A search for existing systematic reviews on osteoporosis and sarcopenia was conducted in PubMed for reviews published from 2008 through to November 2019 and identified no new reviews and 8 new studies.

Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In older adults (aged 65 years and over), what is the association between physical activity and health-related outcomes?

The primary evidence base for assessing the associations between physical activity and health outcomes, such as all-cause and cause-specific mortality, cardiovascular disease, type-2 diabetes, cancer incidence, adiposity, mental health, and cognitive outcomes in older adult populations was the same scientific literature collated and reviewed for adult populations. This same body of evidence was accepted and extrapolated to older adults because the majority of studies stated no upper age limit criterion and therefore included adults over the age of 65 years.

A further review of evidence was conducted to examine and inform on the association between physical activity and health-related outcomes specific to older adults, including falls prevention, fall-related injuries, physical function, frailty and osteoporosis.

Declining physical capacity in older people often manifests in falls and fall-related injuries that can have serious consequences. Accidental falls are due to a combination of extrinsic

(environmental) and intrinsic (e.g. musculoskeletal or nervous system abnormalities affecting postural control) factors. Evidence demonstrates that physical activity – in particular multicomponent physical activity programmes that include combinations of balance, strength, endurance, gait, and physical function training – is associated with a reduced rate of **falls** and risk of **injury from falls** in older adults. Recent evidence demonstrates that exercise may reduce the rate of falls by as much as 23% (pooled rate ratio (RaR) 0.77 [95% CI: 0.71 to 0.83]) in older adults, which can significantly reduce the risk of injury from falls, including severe falls that result in bone fracture, head trauma, open wound, soft tissue injury, or any other injury requiring medical care or admission to hospital (42). This evidence was consistent with, and reaffirmed findings in, other reviews (35).

After reaching a peak in early adulthood, muscle and bone mass tends to decline with increasing age (i.e. sarcopaenia and osteopaenia/osteoporosis), and this can be associated with declining strength and physical function. Evidence demonstrates that regular physical activity improves **physical function** and reduces the risk of age-related loss of physical function in older adults. Findings show beneficial effects on dynamic balance (SMD= 1.10 [95% CI: 0.29 to 1.90]); muscle strength (SMD= 1.13 [95% CI: 0.30 to 1.96]); flexibility (SMD= 1.22 [95% CI: 0.39 to 2.04]); and cardiorespiratory fitness (SMD= 1.48 [95% CI: 0.42 to 2.54]) (94). Evidence also shows that higher levels of physical activity may improve bone health and thus prevent **osteoporosis** in older adults (pooled standardized effect size 0.21 [95% CI: 0.06 to 0.36]) (95). Physical activity interventions may improve lumbar spine and femoral neck (hip) bone mineral density.

The GDG concluded that:

- There is moderate certainty evidence that physical activity improves physical function and reduces risk of age-related loss of physical function in the general ageing population.
- There is low-certainty evidence that the risks for the amounts and types of physical activity recommended for older adults are low and are outweighed by the benefits.

Is there a dose-response association (volume, duration, frequency, intensity)?

Evidence shows an inverse relationship between the amount of physical activity performed by older adults and the risk of physical function limitations. In general, more physical activity (frequency, duration and/or volume) is associated with greater benefits (35). Evidence suggests that fast-intended velocity resistance training may be superior to moderate-velocity resistance training for improvements in general functional capacity (SMD= 0.41 [95% CI: 0.18 to 0.65]; and SPPB (SMD= 0.52 [95% CI: 0.10 to 0.94])) (96).

There is limited evidence examining the dose-response relationship between physical activity and prevention of falls; however the majority of studies providing supportive evidence show testing a programme consistent with 3 days per week.

The GDG concluded that:

- There is high certainty evidence of an inverse dose-response relationship between volume of aerobic physical activity and risk of physical functional limitations in the general older adult population.

Does the association vary by type or domain of physical activity?

Physical activity programmes that include combinations of balance, strength, endurance, gait, and physical function training are associated with a reduced rate of falls and risk of injury from falls in older adults.

Evidence from a review of 11 RCT showed that by engaging in a variety of different physical activity interventions (commonly balance and functional exercises plus resistance exercises), older adults can reduce rate of falls by up to 28% (RaR= 0.72 [95% CI: 0.56 to 0.93]) (42). The effect of resistance exercises was uncertain and based on limited data (RR= 0.97 [95% CI: 0.14 to 6.49]; 1 trial; *n*= 73) (42).

Evidence also suggests that programmes which include multiple exercise types have greater positive effects on bone health (standardized effect size 0.45 [95% CI: 0.20 to 0.71]; *p*= 0.001), compared with those which do not (95).

The GDG concluded that:

- There is high certainty evidence that higher levels of physical activity that combines balance, strength, gait, and functional training (e.g. multicomponent physical activity) are associated with a reduced rate of falls and risk of injury from falls in older adults.
- There is moderate certainty evidence that programmes involving multiple exercise types may have significant effects on bone health and osteoporosis prevention.

SEDENTARY BEHAVIOUR RECOMMENDATION

For older adults, sedentary behaviour is defined as time spent sitting or lying with low energy expenditure, while awake, in the context of occupational, educational, home and community settings and transportation.

In older adults, higher amounts of sedentary behaviour are associated with the following poor health outcomes: all-cause mortality, cardiovascular disease mortality and cancer mortality, and incidence of cardiovascular disease, cancer and incidence of type-2 diabetes.

It is recommended that:

> **Older adults should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits.**

Strong recommendation, moderate certainty evidence

> **To help reduce the detrimental effects of high levels of sedentary behaviour on health, older adults should aim to do more than the recommended levels of moderate-to vigorous-intensity physical activity.**

Strong recommendation, moderate certainty evidence

Supporting evidence and rationale

Sedentary behaviour was not included in the 2010 *Global recommendations on physical activity for health* (1). Due to a lack of population-specific evidence, the primary evidence base for

assessing the associations between sedentary behaviour and health outcomes in older adult populations was the same scientific literature collated and reviewed for adult populations because the majority of studies stated no upper age limit criterion and therefore included adults over the age of 65 years. The findings from evidence on sedentary behaviours in the general adult population were reviewed, including assessing if there was evidence that the outcomes would be any different, or would not apply to, or would be contraindicated, for older adults.

Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

PREGNANT AND POSTPARTUM WOMEN

These guidelines address physical activity and maternal and fetal health outcomes during pregnancy and the postpartum period. They are for all pregnant and postpartum women, irrespective of age, cultural background, or socioeconomic status. Pregnancy and the period after delivery are stages in a woman's life, and the benefits of being physically active throughout adulthood are detailed in the recommendations provided for adults.

Pregnant and postpartum women should be under the care of a health-care provider for antenatal and postnatal care who can advise on special considerations given their medical history and any contraindications to participating in physical activity during pregnancy or in the postpartum period. These guidelines are public health and population-based. Clinical guidance should be sought for women with complications associated with pregnancy or delivery.

Pregnant and postpartum women should try to meet these recommendations where possible, as able, and without contraindication.

PHYSICAL ACTIVITY RECOMMENDATION

For pregnant and postpartum women, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), transportation (wheeling, walking and cycling), work, household chores, in the context of daily occupational, educational, home and community settings.

In pregnant and postpartum women, physical activity during pregnancy and postpartum confers benefits on the following maternal and fetal health benefits: decreased risk of pre-eclampsia, gestational hypertension, gestational diabetes, excessive gestational weight gain, delivery complications and postpartum depression, and fewer newborn complications, no adverse effects on birthweight; and no increase in risk of stillbirth.

It is recommended that all pregnant and postpartum women without contraindication should:

> **undertake regular physical activity throughout pregnancy and postpartum;**

Strong recommendation, moderate certainty evidence

> **do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week for substantial health benefits; and**

Strong recommendation, moderate certainty evidence

>

incorporate a variety of aerobic and muscle-strengthening activities. Adding gentle stretching may also be beneficial.

Strong recommendation, moderate certainty evidence

In addition:

> **Women who, before pregnancy, habitually engaged in vigorous-intensity aerobic activity, or who were physically active, can continue these activities during pregnancy and the postpartum period.**

Strong recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If pregnant and postpartum women are not meeting the recommendations, doing some physical activity will benefit their health.
- Pregnant and postpartum women should start by doing small amounts of physical activity, and gradually increase frequency, intensity and duration over time.
- Pelvic floor muscle training may be performed on a daily basis to reduce the risk of urinary incontinence.

Additional safety considerations for pregnant women when undertaking physical activity are:

- Avoid physical activity during excessive heat, especially with high humidity;
- Stay hydrated by drinking water before, during, and after physical activity;
- Avoid participating in activities which involve physical contact; pose a high risk of falling; or might limit oxygenation (such as activities at high altitude, when not normally living at high altitude);
- Avoid activities in supine position after the first trimester of pregnancy;
- When considering athletic competition, or exercising significantly above the recommended guidelines pregnant women should seek supervision from a specialist health-care provider;
- Pregnant women should be informed by their health-care provider of the danger signs alerting them as to when to stop; or to limit physical activity and consult a qualified health-care provider immediately should they occur;
- Return to physical activity gradually after delivery, and in consultation with a health-care provider, in the case of delivery by Caesarean section.

Supporting evidence and rationale

For these *Guidelines on physical activity and sedentary behaviour* (2020) for pregnant and postpartum women, the evidence syntheses from 7 systematic reviews addressing the critical and important outcomes (28–34) were used and updated. Four of the 7 reviews met inclusion criteria.

Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In pregnant and postpartum women, what is the association between physical activity and health-related outcomes?

Physical activity before and during pregnancy can help reduce the risk of common complications of pregnancy. Engaging in physical activity during pregnancy is significantly associated with reduced **gestational weight gain** (MD= 1.14 kg [95% CI: 1.67 to 0.62]) (97), and a reduced risk of **gestational diabetes** (RR= 0.71 [95% CI: 0.57 to 0.89]) (97), as is being physically active before pregnancy (OR= 0.70 [95% CI: 0.57 to 0.85]) (31, 34, 97), including in women with overweight or obesity (97).

Physical activity during pregnancy does not appear to increase the incidence of **gestational hypertension or preeclampsia** (31). Evidence suggests that among pregnant women with overweight or obesity, there is no significant difference in the incidence of gestational hypertension (RR= 0.63 [95% CI: 0.38 to 1.05]) or in preeclampsia (RR= 1.39 [95% CI: 0.66 to 2.93]) between physical activity intervention groups versus standard antenatal care (97).

There have been long-standing concerns about potential adverse effects of maternal physical activity on the developing fetus and delivery. However, recent evidence demonstrates that physical activity is not associated with increased risk of the incidence of **miscarriage, stillbirth or delivery complications** (32). Evidence suggests no difference in the incidence of Caesarean delivery among pregnant women with overweight or obesity between physical activity intervention groups versus standard antenatal care (97).

Physical activity during pregnancy is not associated with increased risk of adverse effects on **birthweight** (98) or preterm birth (32), and may even be protective, reducing the overall risk (98), even among pregnant women with overweight or obesity (RR= 1.02 [95% CI: 0.54 to 1.92]) or large-for-gestational-age babies (RR= 0.90 [95% CI: 0.65 to 1.25]) between physical activity intervention groups versus standard antenatal care) (97).

In the postpartum period, mothers can experience many physical and emotional changes. Evidence demonstrates that physical activity during pregnancy may be inversely associated with **postpartum depression** (29). Evidence from a meta-analysis of 6 trials and 11 observational studies of physical activity during pregnancy (99) showed a significant inverse relationship between physical activity during pregnancy and postpartum depression (SMD= 0.58 [95% CI: 1.09 to 0.08]). The effect was stronger when limited to 5 studies with at least moderate-intensity interventions (SMD= 0.70 [95% CI: 1.19 to 0.22]) (99).

The GDG concluded that:

- There is high certainty evidence that physical activity during pregnancy may reduce gestational weight gain and risk of gestational diabetes mellitus.
- There is moderate to high certainty evidence that physical activity does not increase the incidence of gestational hypertension.

- There is moderate certainty evidence that physical activity does not increase the incidence of miscarriage, stillbirth or delivery complications; and moderate certainty evidence of a reduced risk of preterm birth for mothers engaged in vigorous-intensity physical activity.
- There is low to moderate certainty evidence that physical activity does not increase the risk of low birth weight, or small-for-gestational-age, or large-forgestational-age babies.
- There is low certainty evidence that physical activity during pregnancy is associated with lower levels of postpartum depression.
- The risks for the amounts and types of physical activity recommended for pregnant and postpartum women are low and are outweighed by the benefits.

Is there a dose-response association (volume, duration, frequency, intensity)?

Across the evidence on physical activity during pregnancy and the postpartum period, the interventions varied in the amount (i.e. dose) of physical activity, both in duration in minutes and frequency per week. In general, the evidence available reflected a frequency of aerobic physical activity of at least 3 times per week, typically for between 30 and 60 minutes. This evidence is taken from studies assessing the health impact of a dose broadly consistent with the amount of activity recommended for the general adult population – namely 150 minutes of moderate-intensity physical activity per week.

While more physical activity (frequency, duration and/or volume) is generally found to be associated with greater benefits, further research is needed to understand in more detail the dose-response relationship. Participating in higher versus lower amounts of leisure time physical activity pre-pregnancy is associated with a significantly lower risk of gestational diabetes (OR= 0.54 [95% CI: 0.34 to 0.87]) (100). There is also evidence of a small, but significant, reduced risk of preterm birth in babies of mothers who engaged in vigorous-intensity physical activity (RR= 0.20 [95% CI: 0.36 to 0.03]) (98). No evidence was identified regarding the safety or additional benefit of exercising at levels significantly above the recommendations.

The GDG concluded that:

- There is insufficient evidence to determine a dose-response association between physical activity and specific critical health outcomes during pregnancy and the postpartum period.
- The overall evidence shows benefits to critical health outcomes and is based on interventions that are broadly consistent with the amount of physical activity recommended for the general adult population, namely 150 minutes of moderate-intensity physical activity per week.
- There was no reason to alter the amount or frequency of recommended moderate-intensity physical activity for pregnant and postpartum women compared with the general adult population.
- There is moderate certainty evidence of a reduced risk of preterm birth for mothers engaged in vigorous-intensity physical activity.

Does the association vary by type or domain or timing (pre-pregnancy, antenatal or postnatal) of physical activity?

Evidence is available from studies that mostly assessed leisure domain physical activity; the type of activity was mostly aerobic (such as walking or swimming), although there is some evidence from studies assessing interventions that also included strength training (e.g. circuit training), or combinations of aerobic and muscle-strengthening exercise. However, overall there is insufficient evidence to determine if the associations between physical activity and health outcomes vary by type or domain or timing (pre-pregnancy, antenatal or postnatal) of physical activity.

The GDG concluded that:

- There is moderate certainty evidence that pregnant and postpartum women should incorporate a variety of aerobic and muscle-strengthening activities. Gentle stretching may also be beneficial.

SEDENTARY BEHAVIOUR RECOMMENDATION

For pregnant and postpartum women, sedentary behaviour is defined as time spent sitting or lying with low energy expenditure while awake, in the context of occupational, educational, home and community settings and transportation.

In pregnant and postpartum women, as in all adults, higher amounts of sedentary behaviour are associated with the following poor health outcomes: all-cause mortality, cardiovascular disease mortality and cancer mortality and incidence of cardiovascular disease, cancer and incidence of type-2 diabetes.

It is recommended that:

> **Pregnant and postpartum women should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits.**
>
> *Strong recommendation, low certainty evidence*

Supporting evidence and rationale

Sedentary behaviour was not included in the 2020 *Global recommendations on physical activity for health* (1). Due to a lack of population-specific evidence, the primary evidence base for assessing the associations between sedentary behaviour and health outcomes in pregnant and postpartum women was the scientific literature collated and reviewed for adult populations.

The findings from evidence on sedentary behaviours in the general adult population were reviewed, including assessing whether the outcomes would be any different, or would not apply to, or would be contraindicated, for pregnant and postpartum women.

Based on available evidence and expert opinion, the evidence was extrapolated to inform the new WHO recommendations on sedentary behaviour for pregnant and postpartum women for the common set of critical health outcomes. Due to indirectness of the evidence, the level of certainty was downgraded.

Given the lack of evidence specific to this population, and that pregnant women were excluded from studies, the recommendation to increase levels of physical activity beyond recommended levels to counter the detrimental effect of high sedentary behaviour was not extrapolated for women during pregnancy and the postpartum period.

The GDG concluded that:

- The evidence on sedentary behaviours in the general adult population could be extrapolated to inform recommendations for pregnant and postpartum women for the common set of critical health outcomes.
- The benefits of minimizing sedentary behaviour outweigh the risks for pregnant and postpartum women.
- The certainty of the evidence should be downgraded due to indirectness.

ADULTS AND OLDER ADULTS WITH CHRONIC CONDITIONS (aged 18 years and older)

To date, most physical activity guidelines for people with chronic conditions have been limited to clinical or therapeutic guidance. For example, there are clinical practice recommendations and resources developed by the professional medical associations for oncology (101), *type-2 diabetes* (102), *hypertension* (103), *and other chronic diseases* (104). *WHO also has clinical practice guidance which includes recommending physical activity to patients with chronic disease* (17).

These guidelines are the first WHO population-based guidelines on physical activity for people living with chronic conditions, specifically those living with cancer (from here on referred to as "cancer survivors"), hypertension, type-2 diabetes, and HIV.

Given the advances of effective and widely available antiretroviral treatment for HIV, this condition is now also considered a chronic condition. For patients undergoing acute treatment (e.g. chemotherapy), or not yet stabilized on their chronic medication, health-care providers should also refer to clinical practice guidelines relevant to each chronic condition.

PHYSICAL ACTIVITY RECOMMENDATION

For adults living with chronic conditions, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), transportation (wheeling, walking and cycling), work or household chores, in the context of daily occupational, educational, home or community settings.

All adult cancer survivors and those living with hypertension, type-2 diabetes and HIV, should try to meet these recommendations where possible, as able and without contraindication.

Physical activity can confer health benefits for adults and older adults living with the following chronic conditions: for **cancer survivors –** physical activity improves all-cause mortality, cancer-specific mortality, and risk of cancer recurrence or second primary cancer; **for people living with hypertension –** physical activity improves cardiovascular disease mortality, disease progression, physical function, health-related quality of life; **for people living with type-2 diabetes –** physical activity reduces rates of mortality from cardiovascular disease and indicators disease progression; and **for people living with HIV –** physical activity can improve physical fitness and mental health (reduced symptoms of

anxiety and depression), and does not adversely affect disease progression (CD4 count and viral load) or body composition.

It is recommended that:

> **All adults and older adults with these chronic conditions should undertake regular physical activity.**

Strong recommendation, moderate certainty evidence

> **Adults and older adults with these chronic conditions should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate-and vigorous-intensity activity throughout the week for substantial health benefits.**

Strong recommendation, moderate certainty evidence

> **Adults and older adults with these chronic conditions should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional benefits.**

Strong recommendation, moderate certainty evidence

> **As part of their weekly physical activity, older adults with these chronic conditions should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity on 3 or more days a week, to enhance functional capacity and prevent falls.**

Strong recommendation, moderate certainty evidence

> **When not contraindicated, adults and older adults with these chronic conditions may increase moderate-intensity aerobic physical activity to more than 300 minutes; or do more than 150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for additional health benefits.**

Conditional recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- When not able to meet the above recommendations, adults with these chronic conditions should aim to engage in physical activity according to their abilities.
- Adults with these chronic conditions should start by doing small amounts of physical activity and gradually increase the frequency, intensity and duration over time.
- Adults with these chronic conditions may wish to consult with a physical activity specialist or health-care professional for advice on the types and amounts of activity appropriate for their individual needs, abilities, functional limitations/ complications, medications, and overall treatment plan.

- Pre-exercise medical clearance is generally unnecessary for individuals without contraindications prior to beginning light-or moderate-intensity physical activity not exceeding the demands of brisk walking or everyday living.

Supporting evidence and rationale

The scope of these guidelines assessed the associations between physical activity and the following health outcomes: **for cancer survivors –** all-cause mortality, cancer-specific mortality, and risk of cancer recurrence or second primary cancer; **for people living with hypertension –** cardiovascular disease mortality, risk of co-morbid conditions, physical function, health-related quality of life, and disease progression (here defined as the blood pressure response to physical activity); **for people living with type-2 diabetes –** cardiovascular disease mortality, risk of co-morbid conditions, physical function, health-related quality of life, and disease progression; and **for people living with HIV –** physical function (physical fitness, exercise tolerance and strength), health-related quality of life, mental health (symptoms of anxiety and depression), cardiometabolic disease risk indicators (blood lipids, blood glucose and body composition) and adverse effects on disease progression (namely CD4 count and viral load).

The evidence informing these guidelines was the report of PAGAC (35) which was updated with 16 new reviews identified from 2017 to 2019 for cancer (*n*= 1), hypertension (*n*= 2) and type-2 diabetes (*n*= 13). In addition, a commissioned umbrella review on physical activity and health-related outcomes among people living with HIV provided evidence from 19 eligible reviews published 2002–2018. Full details of the methods, data extraction and evidence profiles can be found in the Web Annex: Evidence profiles.

In adults and older adults (aged 18 years and over) living with cancer (cancer survivors), hypertension, type-2 diabetes, or HIV, what is the association between physical activity and health-related outcomes?

Physical activity promotes beneficial short- and long-term changes in metabolic, hormonal, and inflammatory pathways, which are thought to be protective for **cancer** incidence and survival (35). Evidence shows that higher levels of physical activity after cancer diagnosis were found to be protective for all-cause mortality following breast cancer (HR= 0.58 [95% CI: 0.52 to 0.65], 17 studies); colorectal cancer (HR= 0.63 [95% CI: 0.50 to 0.78], 10 studies), female reproductive cancer (HR= 0.66 [95% CI: 0.49 to 0.88], 4 studies); glioma (HR= 0.64 [95% CI: 0.46 to 0.91], 1 study); hematologic cancer (HR= 0.60 [95% CI: 0.51 to 0.69], 2 studies); kidney cancer (HR= 0.60 [95% CI: 0.38 to 0.95], 1 study); lung cancer (HR= 0.76 [95% CI: 0.60 to 0.97], 2 studies); prostate cancer (HR= 0.60 [95% CI: 0.46 to 0.79], 5 studies); and stomach cancer (HR= 0.75 [95% CI: 0.61 to 0.93], 1 study) (105).

Greater amounts of physical activity after cancer diagnosis are also associated with lower risks of cause-specific mortality in breast cancer, colorectal cancer, and prostate cancer survivors. The meta-analysis found reduced hazards of mortality for those in the highest versus the lowest levels of postdiagnosis total physical activity for all cancers combined (HR= 0.63 [95% CI: 0.53 to 0.75], 4 studies); breast cancer (HR= 0.63 [95% CI: 0.50 to 0.78], 13 studies); colorectal cancer (HR= 0.62 [95% CI: 0.44 to 0.86], 6 studies); and prostate cancer (HR= 0.70 [95% CI: 0.55 to 0.90], 4 studies) (105). There was, however, insufficient evidence to determine if physical activity is associated with cancer recurrence or second primary cancer.

Physical activity is important for both the primary prevention and management of **hypertension**, with evidence showing that physical activity improves physical function, cardiovascular disease progression (i.e. blood pressure response to physical activity), and cardiovascular disease mortality in people living with hypertension (35). For example, compared with no exercise control groups, people with hypertension who are physically active can reduce systolic blood pressure by approximately 12mm Hg and diastolic blood pressure by approximately 6mm Hg (SBP MD= 12.26 mm Hg [95% CI: 15.17 to 9.34], $p = < 0.05$; DBP MD= 6.12 mm Hg [95% CI: 7.76 to 4.48], $p = < 0.05$) (106). Emerging evidence demonstrates that people with hypertension who are physically active can significantly improve their health-related quality of life compared with those with hypertension who are inactive (54).

Physical activity, including aerobic activity, muscle-strengthening activity, and aerobic plus muscle-strengthening activity, is associated with improved secondary indicators of risk of progression (HbA1c, blood pressure, BMI, and lipids) in adults with **type-2 diabetes** (35). For example, recent research found that resistance training was associated with greater reduction in HbA1c versus control groups, and that high-intensity resistance training has significant positive effects on fasting insulin (107). There is insufficient evidence to assess the effects of physical activity on health-related quality of life and physical function in adults with type-2 diabetes.

Physical activity in people living with **HIV** improves cardiorespiratory fitness. The interventions studied involved either aerobic exercise, or exercise combined with progressive muscle-strengthening exercise, for at least 30 minutes, 3 times per week (108, 109). There is also evidence that physical activity interventions can improve markers of cardiometabolic risk (e.g. lipids) although results are mixed; no effects were established on insulin concentration, although glucose was lowered after aerobic training (110). Physical activity, whether aerobic, or combined with muscle-strengthening exercise, in people living with HIV is positively associated with health-related quality of life (111) and a reduction in symptoms of depression and anxiety (112). The meta-analysis for depression (9 studies) showed an SMD of 0.84 (95% CI: 1.57 to 0.11) favouring the intervention groups ($p = 0.02$). The SMD for reduction in anxiety (5 studies) was also statistically significant, favouring the intervention (1.23 [95% CI: 2.42 to 0.04], $p = 0.04$) (112). Physical activity is also associated with significant standardized mean increases in lean body mass of 1.75 kg and a significant decrease in percent body fat of 1.12% for participants in the exercising control groups, as well as an increase in peripheral leg and arm muscle area, compared with participants in the non-exercising control groups (111), but is not associated with changes in BMI or waist circumference in people living with HIV (111). Physical activity does not adversely influence markers of HIV disease progression, such as CD4 count (cells/mm^3) or viral load (111). Importantly, this evidence suggests that HIV as a chronic disease will not be adversely affected by physical activity.

The GDG concluded that:

- There is moderate certainty evidence that greater amounts of physical activity after cancer diagnosis are associated with lower risks of all-cause, cause-specific, and cancer-specific mortality in cancer survivors.
- There is high certainty evidence that physical activity reduces the risk of cardiovascular disease progression in adults with hypertension.
- There is moderate certainty evidence that physical activity improves physical function and health-related quality of life outcomes in adults with hypertension.

- There is high certainty evidence that physical activity improves markers of disease progression (HbA1c, blood pressure, BMI, and lipids) in adults with type-2 diabetes.
- There is moderate certainty evidence of an association between physical activity and improvements in fitness (maximal oxygen consumption, exercise tolerance) and muscular strength for people living with HIV, and favourable associations between physical activity and body composition, health-related quality of life, reduced symptoms of depression and anxiety, and no change in viral load or CD4 count in people living with HIV.
- The benefits associated with engaging in regular physical activity in cancer survivors and people living with hypertension, type-2 diabetes, and HIV in relation to specific health outcomes, outweigh the risks.

Is there a dose-response association (volume, duration, frequency, intensity)?

Greater amounts of physical activity after **cancer** diagnosis have been linked with lower risks of all-cause, and cancer-specific mortality. Evidence demonstrates a non-linear relationship between increasing levels of post-diagnosis physical activity and breast cancer-specific and all-cause mortality up to 10–15 MET-hours per week (consistent with 150 mins/week of moderate- to vigorous-intensity physical activity) with no evidence for harms at higher levels (105). There is a suggestion of similar dose-response association for other cancer sites however there were too few studies to permit a formal meta-analysis. Further research is needed to determine strength of association.

There is a clear dose-response relationship between physical activity and cardiovascular disease mortality for people living with **hypertension** (35). Findings show that as systolic blood pressure increases within hypertensive ranges, the risk of cardiovascular disease mortality increases, but this increased risk is attenuated with higher levels of physical activity (35). Similar to recommendations for the general population, most of the traditional interventions are based around 30–60 minutes of moderate-intensity aerobic activity, 3 days per week, and/or 2–3 sessions of resistance training per week.

There is substantial evidence of an inverse curvilinear association between volume of physical activity and risk of cardiovascular mortality in adults with **type-2 diabetes** (113–115). Higher amounts of physical activity (from both below and at, or above the recommended levels of 150 mins/week of moderate-intensity activity) progressively reduce risk. For example, compared with doing no activity, engaging in some activity was associated with a 32% reduction in risk of cardiovascular disease mortality (adjusted HR= 0.68 [95% CI: 0.51 to 0.92]), while engaging in amounts of activity meeting physical activity guidelines or above was associated with a larger 40% reduction in risk of cardiovascular disease mortality (adjusted HR= 0.60 [95% CI: 0.44 to 0.82]) (115). Most interventions are based around 150–300 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity activity, and/ or 2–3 sessions of resistance training per week. For some outcomes (e.g. HBA1c and blood pressure) in adults with type-2 diabetes, there is evidence for a stronger effect with more aerobic activity (i.e. greater than 150 mins/week versus less than 150 mins/week), but limited evidence for intensity (35).

In people living with **HIV**, there is insufficient evidence to establish a dose-response relationship between physical activity and body composition, or for intermediate markers of cardiometabolic diseases (such as blood lipid profiles, insulin resistance, fasting glucose concentrations or blood pressure). The majority of studies providing evidence involved physical activity interventions conducted at least 3 times a week for 12–48 weeks, and involved at least 30 minutes of

moderate- to vigorous-intensity aerobic exercise alone or in combination with progressive resistance training. There is also insufficient evidence to establish more precisely the dose-response relationship for mental health and health-related quality of life outcomes. The available evidence is from studies typically assessing physical activity interventions of 3 or more times weekly.

Overall there was evidence ranging from moderate to high certainty to support a physical activity recommendation of 150–300 minutes of moderate-intensity physical activity (or equivalent) for the specified populations of people living with chronic disease and the specific set of health outcomes. There was clearer evidence of higher levels of activity being associated with greater benefits in the evidence addressing people living with hypertension, type-2 diabetes and cancer survivors. The variations in the certainty and directness of the evidence according to the specific chronic condition and specific outcomes examined was acknowledged. Where evidence showed positive outcomes from strength training exercise, the frequency of activity was 2 or 3 sessions of resistance training per week.

The GDG concluded that:

- There is moderate certainty evidence of a dose-response relationship between physical activity and decreased all-cause mortality and cancer-specific mortality in cancer survivors.
- There is high certainty evidence of a dose-response relationship between physical activity and cardiovascular disease mortality for adults with hypertension.
- There is evidence of an inverse, curvilinear dose-response relationship between activity volume and risk of cardiovascular mortality among adults with type-2 diabetes.
- There is insufficient evidence for a dose-response relationship between physical activity and intermediate markers of cardiometabolic diseases, body composition, and health-related quality of life symptoms of anxiety and depression in people living with HIV.
- Interventions in the range of 150–300 minutes of moderate-intensity aerobic activity (or equivalent) provided favourable health outcomes, and positive outcomes from strength training exercise, where noted, with 2 or 3 sessions of resistance training per week.

Does the association vary by type or domain of physical activity?

There is evidence that different types and domains of physical activity provide favourable health outcomes. **Cancer survivors** who are meeting recommended levels of aerobic and muscle-strengthening physical activity, versus not meeting either recommendation, have significantly lower risk of cancer mortality (adjusted HR= 0.70 [95% CI: 0.50 to 0.98]) (84). Evidence demonstrates that adhering solely to muscle-strengthening physical activity recommendations versus not adhering is also beneficial in improving cancer mortality outcomes (HR= 0.66 [95% CI: 0.48 to 0.92]) (84). A meta-analysis also reported these associations by physical activity domain and found the most consistent reductions in mortality for all cancers, breast cancer, and colorectal cancer-specific mortality for recreational physical activity (105). For adults living with **hypertension**, evidence supports aerobic activity, muscle-strengthening activity, and combinations of the two for improving cardiovascular disease progression. The blood pressure lowering effects between traditional modes of physical activity (i.e. aerobic and resistance activity) do not appear to vary significantly among people with hypertension (35); however, this evidence is not based on direct comparisons between activity types. There is also emerging

evidence to support beneficial effects of other forms of exercises in people living with hypertension (e.g. Tai Chi, yoga, Qigong), however further research is needed to explore these specific types of activity to determine strength of association.

Aerobic activity, muscle-strengthening activity, or a combination of both, is associated with improved secondary indicators of risk of progression (HbA1c, blood pressure, BMI, and lipids) among adults with **type-2 diabetes** (35, 107). One review of 24 RCTs (*n*= 962) reported that resistance training was associated with greater reduction in HbA1c versus control groups (MD= 0.45 [95% CI: 0.65 to 0.25], 20 trials; *n*= 824). Statistically significant effects were found for high-intensity resistance training versus control groups on fasting insulin (MD= 4.60 [95% CI: 7.53 to 1.67], 5 trials; *n*= 174) (107). Another review of 7 RCTs (*n*= 189) reported that interval training (2–5 times/week; intervals 1–4 mins duration; total session lengths 20–60 mins) was associated with statistically significantly decreased HbA1c by 0.26% (95% CI: 0.46 to 0.07%, 5 RCTs) compared with MICT, and by 0.83% (95% CI: 1.39% to 0.27%, 4 RCTs) compared with no-exercise control groups (116). As with recommendations for the general population, most of these interventions are based around aerobic activity consistent with the recommendation of 150–300 minutes of moderate-intensity aerobic activity (or 75 minutes of vigorous-intensity activity) and muscle-strengthening activity conducted 2–3 sessions per week. For some outcomes (e.g. HBA1c and blood pressure), there is evidence for a stronger effect with more aerobic activity (i.e. greater than 150 mins/week versus less than 150 mins/ week), but limited evidence for intensity. More recent studies provide evidence that traditional Chinese exercise, such as Tai Chi may have glycaemic benefits, but these were of moderate and variable certainty (i.e. risk of bias or inconsistency). Further research is needed to determine these associations.

Multiple types of physical activity, including aerobic and resistance-training, have been shown to have positive effects on health-related quality of life in people living with **HIV** (111). Recent research examining changes in health-related quality of life in response to aerobic, progressive resistance exercise, or a combination of both, demonstrates significant improvements in general health, and mental health. There is also evidence that both aerobic and multicomponent activity is related to a reduction in symptoms of depression and anxiety in people living with HIV (112). Evidence for the effects of physical activity on mental health symptoms has involved aerobic or aerobic combined with progressive muscle-strengthening activity, or yoga. Evidence also demonstrates that aerobic exercise alone, or when combined with resistance exercise, does not result in any significant change in viral load or CD4 count in people living with HIV (111).

Direct evidence, from both the existing and updated literature, supports the inclusion of the recommendations for people living with type-2 diabetes and hypertension to undertake aerobic and muscle-strengthening physical activity. Although there is a lack of published evidence, there is biological plausibility for the benefits of aerobic and muscle-strengthening physical activity for adults living with HIV and cancer survivors. Furthermore, as noted by the GDG, established international clinical practice guidelines recommend aerobic and muscle-strengthening physical activity for these populations (for example ACSM “Moving Through Cancer” guidelines (101) based on a systematic review of evidence (3)). Recognizing this evidence base is still emerging, the level of certainty was downgraded.

The GDG concluded that:

- There is moderate certainty evidence for combined or additive effects of aerobic or muscle-strengthening activity for reduced cancer mortality, improvements in blood pressure among those with hypertension.

- There is high certainty evidence that aerobic activity, muscle-strengthening activity, and aerobic plus muscle-strengthening activity improve markers of disease progression (HbA1C, blood pressure, BMI, and lipids) in adults with type-2 diabetes.
- There is moderate certainty evidence that regular aerobic exercise alone, or combined with resistance exercise, does not result in any significant change in viral load or CD4 count in people living with HIV.
- There is insufficient evidence for an effect of strength training alone on health-related quality of life in people living with HIV.

SEDENTARY BEHAVIOUR RECOMMENDATION

Sedentary behaviour was not included in the 2010 *Global recommendations on physical activity for health* (1). The scope of this new recommendation on sedentary behaviours in cancer survivors and those people living with hypertension, type-2 diabetes and HIV.

Sedentary behaviour is defined as time spent sitting or lying with low energy expenditure, while awake, in the context of occupational, educational, home and community settings, and transportation.

In adults, including **cancer survivors** and people living with **hypertension, type-2 diabetes** and **HIV**, higher amounts of sedentary behaviour are associated with the following poor health outcomes: all-cause mortality; cardiovascular disease mortality; cancer mortality; incidence of cardiovascular disease; cancer; and type-2 diabetes.

For cancer survivors, and adults living with hypertension, type-2 diabetes and HIV, it is recommended that:

> **Adults and older adults with chronic conditions should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits.**

Strong recommendation, low certainty evidence

> **To help reduce the detrimental effects of high levels of sedentary behaviour on health, adults and older adults with chronic conditions should aim to do more than the recommended levels of moderate- to vigorous-intensity physical activity.**

Strong recommendation, low certainty evidence

Supporting evidence and rationale

Due to a lack of population-specific evidence, the primary evidence base for assessing the associations between sedentary behaviour and health outcomes in adults and older adult cancer survivors and those adults and older adults living with hypertension, type-2 diabetes, and HIV, was the scientific literature collated and reviewed for adult populations.

The findings from evidence on sedentary behaviours in the general adult population were reviewed, including assessing if there was evidence that the outcomes would be any different, or

would not apply to, or would be contraindicated, for adults and older adults living with chronic conditions.

Based on available evidence and expert opinion, the evidence was extrapolated to inform the new WHO recommendations on sedentary behaviour for adults living with chronic conditions for the common set of critical health outcomes. The extrapolation of evidence is supported largely by the assessment that the majority of studies imposed no upper age limit criterion, included adults over the age of 65 years and may have included adults with chronic conditions, such as cancer survivors, those living with hypertension or type-2 diabetes. For people living with HIV, no reasons were identified as to why the evidence on the health impacts of sedentary behaviours would not apply. Due to indirectness of the evidence to develop these recommendations, the level of certainty was downgraded.

The applicability of evidence on the benefit of undertaking more moderate- and vigorous-intensity physical activity to help counteract the potential risks of high levels of sedentary behaviour was also considered and was also extrapolated to inform recommendations for adults with chronic conditions for the common set of critical health outcomes. Given the indirectness, the certainty of the evidence was downgraded.

The GDG concluded that:

- The evidence on sedentary behaviours in the general adult population could be extrapolated to inform recommendations for adult and older adult cancer survivors and those adults and older adults living with hypertension, type-2 diabetes, and HIV for the common set of critical outcomes, with the level of certainty of the evidence downgraded due to indirectness.
- The evidence on the benefits of undertaking more moderate- and vigorous-intensity physical activity to help counteract the potential risks of high levels of sedentary behaviour in the general adult population could be extrapolated to inform recommendations for adult and older adult cancer survivors and those adults and older adults living with hypertension, type-2 diabetes, and HIV for the common set of critical outcomes, with the level of certainty of the evidence downgraded due to indirectness.
- The benefits for minimizing sedentary behaviours outweigh the harms for cancer survivors and those people living with hypertension, type-2 diabetes, and HIV.

CHILDREN AND ADOLESCENTS (aged 5–17 years) AND ADULTS (aged 18 years and older) LIVING WITH DISABILITY

PHYSICAL ACTIVITY RECOMMENDATION

Children, adolescents and adults living with disability can achieve important health benefits from physical activity. Children, adolescents and adults with disability should try to meet these recommendations where possible and as able.

For children, adolescents and adults living with disability, physical activity can be undertaken as part of recreation and leisure (play, games, sports or planned exercise), physical education, transportation (wheeling, walking and cycling) or household chores, in the context of home, educational, occupational and community settings. It is important to provide all children, adolescents and adults living with disability with opportunities and encouragement to participate

in physical activities appropriate for their age and ability, that are enjoyable, and that offer variety.

Many of the health benefits of physical activity for children and adolescents, as set out in the section above, also relate to those children and adolescents living with disability. Additional benefits of physical activity to health outcomes for those living with disability include: improved cognition in individuals with diseases or disorders that impair cognitive function, including attention-deficit/hyperactivity disorder (ADHD); improvements in physical function may occur in children with intellectual disability.

It is recommended that:

> **Children and adolescents living with disability should do at least an average of 60 minutes per day of moderate-to vigorous-intensity, mostly aerobic, physical activity, across the week.**

Strong recommendation, moderate certainty evidence

> **Vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone should be incorporated at least 3 days a week.**

Strong recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If children and adolescents living with disability are not meeting these recommendations, doing some physical activity will bring benefits to health.
- Children and adolescents living with disability should start by doing small amounts of physical activity and gradually increase the frequency, intensity and duration over time.
- There are no major risks for children and adolescents living with disability engaging in physical activity when it is appropriate to an individual's current activity level, health status and physical function; and the health benefits accrued outweigh the risks.
- Children and adolescents living with disability may need to consult a health-care professional or other physical activity and disability specialist to help determine the type and amount of activity appropriate for them.

Many of the health benefits of physical activity for adults, as set out in the section above, also relate to adults living with disability. Additional benefits of physical activity to health outcomes for those living with disability include the following: **for adults with multiple sclerosis –** improved physical function, and physical, mental, and social domains of health-related quality of life; **for individuals with spinal cord injury –** improved walking

function, muscular strength, and upper extremity function; and enhanced health-related quality of life; **for individuals with diseases or disorders that impair cognitive function** – improved physical function and cognition (in individuals with Parkinson's disease and those with a history of stroke); beneficial effects on cognition; and may improve quality of life (in adults with schizophrenia); and may improve physical function (in adults with intellectual disability); and improves quality of life (in adults with major clinical depression).

It is recommended that:

> **All adults living with disability should undertake regular physical activity.**

Strong recommendation, moderate certainty evidence

> **Adults living with disability should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for substantial health benefits.**

Strong recommendation, moderate certainty evidence

> **Adults living with disability should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional health benefits.**

Strong recommendation, moderate certainty evidence

> **As part of their weekly physical activity, older adults living with disability should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity on 3 or more days a week, to enhance functional capacity and prevent falls.**

Strong recommendation, moderate certainty evidence

> **Adults living with disability may increase moderate-intensity aerobic physical activity to more than 300 minutes; or do more than 150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for additional health benefits.**

Conditional recommendation, moderate certainty evidence

GOOD PRACTICE STATEMENTS

- Doing some physical activity is better than doing none.
- If adults living with disability are not meeting these recommendations, doing some physical activity will bring benefits to health.
- Adults living with disability should start by doing small amounts of physical activity, and gradually increase the frequency, intensity and duration over time.
- There are no major risks to adults living with disability engaging in physical activity when it is appropriate to the individual's current activity level, health status and

physical function; and when the health benefits accrued outweigh the risks.

- Adults living with disability may need to consult a health-care professional or other physical activity and disability specialist to help determine the type and amount of activity appropriate for them.

Supporting evidence and rationale

For these guidelines for children, adolescents and adults living with disability, the comprehensive evidence synthesis undertaken by PAGAC (35) was used and updated. Full details of the methods, data extraction and summary evidence tables of this existing evidence on physical activity and health outcomes is available (35) and was reviewed by the GDG in addition to the findings of the updated search.

The update conducted for these guidelines identified 39 reviews published from 2017 to 2019. Of these, 27 met the inclusion criteria and informed the examination of the association between physical activity and health-related outcomes among children, adolescents and adults living with disability.

Full details of the methods, data extraction and summary evidence portfolios can be found in the Web Annex: Evidence profiles.

The evidence reviewed considered the association between physical activity and health-related outcomes in children, adolescents and adults living with disability resulting from the following health conditions: multiple sclerosis, spinal cord injury, intellectual disability, Parkinson's disease, stroke, major clinical depression, schizophrenia, and attention-deficit/hyperactivity disorder (ADHD). The four health-related outcomes examined included risk of co-morbid conditions, physical function, cognitive function and health-related quality of life, although not all outcomes were explored for each condition. The impact of environmental factors on disability in the context of physical activity was beyond the scope of these guidelines and was not analysed.

In children and adolescents (aged 5–17 years) and adults (aged over 18 years) living with disability, what is the association between physical activity and health-related outcomes?

For people living with **multiple sclerosis**, physical activity improves physical function, functional mobility, walking speed and endurance, and cardiorespiratory fitness, strength and balance. For example, high-intensity interval training over 3–12 weeks demonstrated improvements in cardiorespiratory fitness or muscle strength (117) and lower limb strength training found strength increased by 23.1% (95% CI: 11.8 to 34.4) over an average training period of 13.2 weeks (118) over an average of 13 weeks resulted in increases in strength, and dance interventions studies reported improvements in functional mobility and balance (119). As well as physical health benefits, existing evidence demonstrates that physical activity can benefit cognition in people living with multiple sclerosis (35). Newer research reveals that aerobic exercise has a small yet significant effect on physical, mental and social domains of health-related quality of life (including symptoms of fatigue and depressive symptoms) (35, 120).

For people living with **spinal cord injury**, physical activity can improve walking function, muscular strength and upper extremity function (35). Physical activity may also reduce shoulder pain, improve vascular function and enhance health-related quality of life (35).

For people living with **Parkinson's disease**, physical activity can improve motor symptoms, functional mobility and performance, endurance, freezing of gait and velocity of forward and backward movement (35, 121, 122). New evidence suggests that exercise can also help global cognitive function in individuals with Parkinson's disease (123).

For people with a history of **stroke**, physical activity can improve physical function, notably upper limb function, sensory motor function of the lower limb, balance, walking speed, distance, ability and endurance, cardiorespiratory fitness, mobility and activities of daily living. Existing evidence suggests that physical activity may also have beneficial effects on cognition (35).

For people with **major clinical depression**, new reviews (124, 125) supported existing evidence (35) that physical activity can improve health-related quality of life (35, 124, 125).

For individuals with **diseases or disorders that impair cognitive function, including schizophrenia**–physical activity can have beneficial effects on cognition, working memory, social cognition and attention/vigilance (35, 126). One review found that moderate- to vigorous-intensity physical activity delivered significant improvements in health-related quality of life and disability (35, 124).

For people living with **intellectual disability**, physical activity has been shown to improve physical function. The interventions reviewed largely focused on balance and strength activities over 6–24 weeks and reported significant improvement in static balance, dynamic balance and static-dynamic balance compared with controls (35, 127, 128).

For children with **attention-deficit/hyperactivity disorder**, evidence, including one review of 5 RCTs involving ADHD (129), demonstrates a positive association between exercise and attention, executive function and social disorders (35, 129).

The GDG considered the evidence from the general population of children, adolescents and adults and concluded that as there is no reason to believe that there would be an effect modification due to impairment and that the same health physiological benefits will be conferred by being physically active. The GDG acknowledged that few studies include people living with disability, and that effect modification is seldom tested.

This evidence in the area disability, combined with the broader evidence for the general population, supported the general population recommendation being inclusive of people with disability, noting reference to "all adults", "all older adults" and "people of all abilities".

The GDG concluded that:

In individuals with spinal cord injury, there is:

- low certainty evidence that physical activity reduces shoulder pain and improves vascular function in paralysed limbs and enhances health-related quality of life; and
- moderate certainty evidence that physical activity improves walking function, muscular strength, and upper extremity function.

In individuals with diseases or disorders that impair cognitive function, including Parkinson's disease, there is:

- high certainty evidence that physical activity improves a number of functional outcomes including walking, balance, strength, and disease specific motor scores; and

- moderate certainty evidence that moderate- to vigorous-intensity physical activity can have beneficial effects on cognition.

In individuals with a history of stroke, there is:

- moderate certainty evidence that mobility-oriented physical activity can have beneficial effects on physical function and cognition.

In individuals with diseases or disorders that impair cognitive function, including schizophrenia, there is:

- moderate certainty evidence that physical activity improves quality of life; and
- high certainty evidence that moderate- to vigorous-intensity physical activity can have beneficial effects on cognition, working memory, social cognition and attention.

In adults with major clinical depression there is:

- moderate certainty evidence that physical activity improves quality of life.

In adults with multiple sclerosis, there is:

- high certainty evidence that physical activity, particularly aerobic and muscle-strengthening activities, improves physical function, functional mobility, walking speed and endurance, and cardiorespiratory fitness, strength and balance;
- moderate certainty evidence that physical activity can have a beneficial effect on cognition; and
- low certainty evidence that physical activity improves quality of life including symptoms of fatigue and depressive symptoms.

In children and adults with intellectual disability, there is:

- low certainty evidence that physical activity improves physical function.

In children and adolescents with ADHD, there is:

- moderate certainty evidence that moderate- to vigorous-intensity physical activity can have beneficial effects on cognition, including attention, executive function, and social disorders.

The GDG further concluded that there is sufficient scientific evidence on the positive impact of physical activity on a variety of health outcomes across a broad range of impairment areas, and that the benefits of physical activity for people living with disability outweigh the potential harms.

Due to indirectness of the evidence to develop these recommendations, the level of certainty was downgraded.

SEDENTARY BEHAVIOUR RECOMMENDATION

For children, adolescents and adults living with disability, sedentary behaviour is defined as time spent sitting or lying with low energy expenditure, while awake, in the context of educational,

home and community settings, and transportation. It is possible to avoid sedentary behaviour and be physically active while sitting or lying, through, for example, upper body led activities, inclusive and/or wheelchair-specific sport and activities.

In children and adolescents, higher amounts of sedentary behaviour are associated with the following poor health outcomes: increased adiposity; poorer cardiometabolic health, fitness, and behavioural conduct/pro-social behaviour; and reduced sleep duration.

It is recommended that:

> **Children and adolescents living with disability should limit the amount of time spent being sedentary, particularly the amount of recreational screen time.**

Strong recommendation, low certainty evidence

In adults, higher amounts of sedentary behaviour are associated with the following poor health outcomes: all-cause mortality, cardiovascular disease mortality and cancer mortality, and incidence of cardiovascular disease, cancer and type-2 diabetes.

It is recommended that:

> **Adults living with disability should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light-intensity) provides health benefits.**

Strong recommendation, low certainty evidence

> **To help reduce the detrimental effects of high levels of sedentary behaviour on health, adults living with disability should aim to do more than the recommended levels of moderate- to vigorous-intensity physical activity.**

Strong recommendation, low certainty evidence

Supporting evidence and rationale

Sedentary behaviour was not included in *The Global recommendations on physical activity for health (2010)*.

Due to a lack of population-specific evidence, the primary evidence base for assessing the associations between sedentary behaviour and health outcomes in children, adolescents and adults living disability was the scientific literature collated and reviewed for populations without disability.

The findings from evidence on sedentary behaviours in the general population were reviewed including assessing if there was evidence that the outcomes would be any different, or would not apply to, or would be contraindicated for children, adolescents and adults living with disability.

Based on available evidence and expert opinion, the evidence was extrapolated to inform new WHO recommendations on sedentary behaviour for individuals living with disability for the

common set of critical health outcomes, recognizing that certain population groups, such as wheelchair users, unavoidably sit for long periods of time and sitting may therefore be the norm. For these groups, sedentary behaviour should be defined as time spent with low energy expenditure, e.g. moving in a power chair or being pushed while sitting in a manual wheelchair. There is a lack of research on the association between sedentary behaviour and health outcomes in individuals living with disability. However, based on expert opinion, there are no reasons to believe that there would be an effect modification due to impairment, and therefore the same physiological health benefits will be conferred by limiting sedentary behaviour in individuals living with disability. Due to indirectness of the evidence to develop these recommendations, the level of certainty was downgraded.

The applicability of evidence on the benefit of adults undertaking more moderate- and vigorous-intensity physical activity to help counteract the potential risks of high levels of sedentary behaviour was also considered and was also extrapolated to inform recommendations for adults living with disability for the common set of critical health outcomes. Given the indirectness, the certainty of the evidence was downgraded.

The GDG concluded that:

- The evidence on sedentary behaviours in child and adolescent populations could generally be extrapolated to children and adolescents living with disability, according to their specific ability.
- The evidence on sedentary behaviours in the general adult population, including the benefit for adults of undertaking more moderate- to vigorous-intensity physical activity to help counteract the potential risks of high levels of sedentary behaviour, could generally be extrapolated to adults and older adults living with disability, according to their specific ability. However, the certainty of the evidence was downgraded due to indirectness.
- The benefits of minimizing sedentary behaviour in children, adolescents, adults and older adults living with disability outweigh the harms.

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