THE EVIDENCE

The revision of the 2010 WHO recommendations on physical activity was conducted by identifying, and then updating, the most recent, relevant umbrella reviews related to the scope of these guidelines.

This approach was adopted due to an extensive body of recent systematic reviews which were conducted to inform the development of several national physical activity guidelines. The additional updating was undertaken to ensure the new WHO guidelines reflect the most recent available data in a rapidly developing field of public health.

Umbrella reviews were selected if they met the following three criteria: **i)** the evidence reviews had been conducted according to standard systematic processes that were well documented; **ii)** the assessment of the certainty of the evidence used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method or an equivalent methodology that was clearly described and documented; and **iii)** the evidence reviews addressed the populations of interest with no restrictions to country or country income level.

The PI/ECO questions and the critical and important health outcomes were mapped against existing evidence reviews and, where needed, additional new reviews were commissioned to address gaps. The GDG requested that the evidence reviews be updated, using the same search terms, search languages, and databases as the original reviews.

The following evidence reviews were identified as meeting the above three criteria and were chosen for recency and comprehensiveness:

- A systematic review of the literature conducted by Poitras et al. (2016) on the association between physical activity and health indicators in school-aged children and youth *(22)* as part of the process for developing the *Canadian 24-hour movement guidelines for children and youth (23)*. This review focused solely on studies that used objective measurements of physical activity. A total of 162 studies were included, representing 204 171 participants from 31 countries.
- A systematic review of the literature of the association between sedentary behaviour and health indicators in school-aged children conducted by Carson et al. (2016) *(24)*, as part of the process for developing the *Canadian 24-hour movement guidelines for children and youth (23)*. A total of 235 studies (194 unique samples) were included representing 1 657 064 unique participants from 71 countries.
- A systematic review conducted by Okely et al. (2019) *(25)* undertaken to update Poitras et al. (2016) *(22)* and Carson et al. (2018) *(24)* as part of the development of the 2019 *Australian 24-hour movement guidelines for children and young people* (aged 5–17 years) *(26)*. This report identified an additional 42 studies on physical activity, and 32 on sedentary behaviour, published through to July 2918 *(25)*. The GRADE tables developed by Okely et al. were used as the basis for the commissioned update conducted for WHO. The GRADE tables along with the evidence profiles are presented in the Web Annex: Evidence profiles.
- The 12 systematic reviews conducted and synthesized as part of the development of the *2019 Canadian guideline for physical activity throughout pregnancy (27)*. These 12 reviews assessed over 25 000 related studies in English, Spanish and French language on maternal physical activity during pregnancy that reported on maternal, fetal, or neonatal morbidity, or fetal mortality outcomes. Seven of these systematic reviews addressed outcomes deemed critical and important by the GDG *(28–34)* The GRADE tables from these evidence reviews were used as the basis for the literature search conducted to update and inform the development of WHO recommendations. The updated evidence profiles are presented in the Web Annex: Evidence profiles.
- The scientific report of the Physical Activity Guidelines Advisory Group (PAGAC) *(35)* which provides a systematic update of evidence on physical activity and sedentary behaviours and health outcomes published 2008–2016 as part of the development of the 2018 *Physical activity guidelines for Americans, 2nd Edition (36)*. The evidence summarized addressed a total of 38 main research questions and 104 subquestions selected for their public health relevance. The evidence comprised results from systematic reviews which consisted of a total of 1130 articles, each abstracted to answer the 38 research questions *(35)*. The protocols used a modified version of "A Measurement Tool to Assess Systematic Reviews" (AMSTARExBP) to assess the methodological quality of systematic reviews and meta-analyses. Risk of bias, or internal validity, was assessed for each original study using an adapted version of the USDA NEL Bias Assessment Tool (BAT) *(37)*. The new evidence identified in the updated searches conducted for these WHO guidelines is presented in the evidence profiles in the Web Annex: Evidence profiles; links are provided to the report and supplementary materials of PAGAC *(35)*.

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Methods for updating the evidence and data extraction

A search for systematic reviews and pooled analyses of cohort studies was conducted for studies published from the date of the last searches carried out for each of the included reviews (listed above) to September 2019; standardized data extraction protocols were developed and employed.

To update the searches conducted by Poitras et al. (2016) *(22)*, Carson et al. (2016) *(24)*, and Okely et al. (2019) *(25)*, the databases MEDLINE, EMBASE, PsycINFO, and SportDiscus were searched to identify reviews that were peer-reviewed, written in English or French. To update the searches conducted by PAGAC *(35),* PubMed, CINAHL and Cochrane databases were searched to identify reviews that were peer-reviewed, written in English. A de novo search for important outcomes, where these were not included by PAGAC *(35)*, was not conducted due to resource constraints.

Searches were performed with no restriction by country or country income status, and inclusive of reviews addressing any subjectively or objectively measured physical activity or sedentary behaviour. It was decided not to conduct searches in languages other than those of the original searches, due to resource constraints and previous experience in the field indicating that such searches yielded very few, if any, additional reviews. Reviews were considered that examined an association between physical activity or sedentary behaviour and health-related outcomes (based on levels above or below a threshold of physical activity or sedentary behaviour), and that explored the dose-response relationship between these and health-related outcomes.

An external team of reviewers used the AMSTAR 2 (Assessment of Multiple Systematic Reviews) instrument to rate the credibility of the systematic reviews under consideration for inclusion *(38)*. The AMSTAR 2 tool contains 16 items that relate to the planning and conduct of the review. The overall confidence in the results of each review was rated according to published guidance: a rating of "high" reflects that the review had zero or one noncritical weakness; "moderate" indicates the review was judged to have more than one noncritical weakness; "low" means the review was judged to have one critical flaw with or without noncritical weaknesses, or multiple noncritical weaknesses; and "critically low" signifies that more than one critical flaw was present. One reviewer completed the AMSTAR 2 tool for all provisionally included reviews. Reviews that were rated critically low by one reviewer were reviewed by a second reviewer using the same tool. Reviews ultimately rated as critically low were excluded because they were judged to be too unreliable to provide an accurate and comprehensive summary of the available evidence, unless it was the only review available for a particular outcome.

This body of evidence also included pooled cohort studies. An external team of reviewers used the Newcastle-Ottawa Scale to assess the quality of the studies *(39)*. Each study was given a quality rating of "good", "fair", or "poor". In general, a good-quality study met all criteria on the Newcastle-Ottawa scale. A fair-quality study did not meet, or it was unclear whether it met, at least one criterion, but also had no known important limitations that could invalidate its results. A poor-quality study had a single fatal flaw, or multiple important limitations. Poor-quality studies were excluded.

There was an assessment for overlap, recognizing potential for duplication of studies in multiple reviews. Reviews containing redundant bodies of evidence, overviews of reviews, and some pooled cohort studies were excluded, where other more comprehensive and/or recent reviews were identified.

Methods for new reviews

Where gaps in existing evidence were identified, new umbrella reviews were commissioned to examine:

1. the relationship between occupational (i.e. work-related) physical activity and health-related outcomes *(40);* and
2. the association between leisure-domain physical activity and adverse health outcomes *(41)*.

(For numbers 1 and 2 above, searches were undertaken using PubMed, SportDiscus and EMBASE for reviews published from 2009 to December 2019.)

3. the association between physical activity and falls prevention; the 2019 Cochrane Collaboration Systematic Review by Sherrington et al. *(42)* was used, and updated with evidence published from the end search date of their original review, through to November 2019.
4. the association between physical activity and osteoporosis and sarcopenia. The search for existing systematic reviews on osteoporosis and sarcopenia, conducted in PubMed for reviews published from 2008 up to November 2019, identified no new reviews and eight new primary studies.
5. the evidence on associations between physical activity and health outcomes in people living with HIV. A scoping review ascertained the availability of

evidence on physical activity and health-related outcomes among people living with HIV to support conducting an umbrella review which was conducted for evidence published up to October 2019 with no start date limitation using PubMed, CINAHL and Web of Science.

Summary of characteristics of the evidence and assessment methods of physical activity and sedentary behaviour

Until recently, the primary methods for measuring physical activity and sedentary behaviours in adults has been by self-report (i.e. survey) and, for children, either self-report or parental recall. Although these methods have well-established strengths, limitations include being prone to reporting bias and measurement error *(43)*. In recent years, with digital technology rapidly growing in this area, there has been an increase in the use of device-based measures for assessing physical activity and sedentary time and their associations with health outcomes. However, challenges remain in comparing results between studies due to differences between the technical features and placement of different devices (accelerometers), and differences in the analyses and reporting of the data. For example, when measuring sedentary time with device-based measures, miscalculation may occur as many of the devices do not currently distinguish between positions (e.g. lying, sitting and standing still). Difficulties also exist when comparing findings from studies using device-based measures with those reporting results from self-report measures.

Self-report instruments vary in content, in the examples of physical activity, response options and domains covered. Until recently, studies focused primarily on assessing either total physical activity, or physical activity in the leisure/recreation domain only, but now increasingly include other domains such as physical activity for transport (e.g. walking and cycling), at work, and in the household. The majority of evidence reports on associations between aerobic physical activity and health outcomes, however studies are now assessing the benefits of muscle-strengthening exercise, as well as combinations of different types of activity and other domains.

Results on the association between physical activity levels and health outcomes are reported and compared in different ways. Many studies report comparisons between quartiles or quintiles of physical activity, other studies compare those "meeting" versus "not meeting" national guidelines. Calculation of total physical activity, when reported, is usually estimated in MET-hours per week and some studies compare "highest" versus "lowest", although categories also vary across studies. The literature frequently reports results from analyses that apply data cut points based on an existing guideline, or the current WHO Global recommendation, or metrics from previous research (for example the cut points of 60 minutes per day in research on youth populations, or the frequency of 2–3 times per week for strength training intervention). When such cut points become commonplace the building of evidence on the associations of higher or lower levels of physical activity exposure on health outcomes can be limited.

Most of the evidence assessing the associations between sedentary behaviours and health outcomes for children and adolescents is cross-sectional in nature, and a majority of studies rely on self- or parent-reported measures of sedentary time that are subject to measurement errors and recall biases.

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.

Grading the body of evidence

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) method was used to rate the certainty of the evidence for each PI/ECO *(44)*, based on the underlying evidence in the reviews. When available, the GRADE "Evidence Profiles" or "Summary of Findings" tables from each review, were used as a starting point. If no table was available within the existing systematic reviews, "Evidence Profile" tables for each population and outcome of interest were constructed.

The GRADE method was used to rate the certainty of the evidence for each PI/ECO *(44)* with the following criteria considered: study design; risk of bias; consistency of effect; indirectness; precision of effect; and other limitations, including publication bias and factors for upgrading observational evidence (magnitude of effect, dose-response, and effects of confounders). Observational evidence from well-conducted longitudinal studies was also upgraded to reflect more appropriately the increased certainty in findings regarding associations between physical

activity or sedentary behaviour and outcomes from such studies. Studies that evaluated intermediate/indirect outcomes were not necessarily downgraded, as the outcomes (including intermediate outcomes) were prioritized by the GDG; the GRADE rating reflects the certainty in effects on those outcomes. In some cases, the GRADE ratings from existing reviews were modified to ensure consistency in application of GRADE methods. The certainty in the body of evidence for each outcome was assigned based on the following guidance *(45):*

High	Very confident that the true effect lies close to that of the estimate of the effect.
Moderate	Moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low	Confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very low	Very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

Going from evidence to recommendations

The GDG employed the GRADE Evidence to Decisions (EtD) framework for generating question-specific recommendations. The EtD framework is a systematic, structured and transparent approach to decision-making. The framework uses explicit criteria for generating guideline recommendations considering research evidence, certainty of evidence and, where required, expert opinion and topical knowledge from the perspective of the target audience. The criteria elicit judgments about the balance between the observed evidence of desirable and undesirable outcomes, overall certainty of evidence, relative values of patients for desirable and undesirable outcomes, resource use (cost considerations) where applicable, potential impact on inequities in health, acceptability and feasibility of recommendations.

The GDG considered the body of evidence in totality for each recommendation for all critical outcomes, and all available important outcomes. For a particular exposure/intervention and outcome link, studies differed widely in the specific exposure/intervention assessed, outcomes assessed, study design, and analytic methods, resulting in heterogeneity in the available evidence. Therefore, it was not possible to apply the classic GRADE approach to each specific exposure/intervention and outcome link; rather, GRADE was applied for the overall body of evidence addressing each exposure/intervention and outcome link, across study design types and variations in exposure/intervention measurements and analyses. When these factors resulted in concerns regarding the coherence of the evidence (i.e. that the evidence for a particular exposure/intervention and outcome link did not correspond when looked at in different ways), the panel downgraded the certainty of evidence *(21)*.

The GDG prioritized the following health outcomes to consider the effects of physical activity and sedentary behaviour: reduced all-cause and cause-specific mortality (cardiovascular disease and cancer); reduced incidence of cardiovascular disease; cancer (site-specific); type-2 diabetes; improved physical fitness (e.g. cardiorespiratory, motor development, muscular fitness); improved cardiometabolic health (e.g. blood pressure, dyslipidaemia, glucose, insulin resistance); bone health; mental health (e.g. reduction in depressive symptoms, self-esteem, anxiety symptoms, ADHD); and improved cognitive outcomes (e.g. academic performance, executive function); and reduced adiposity. Adverse effects (e.g. injuries and harms) were also considered.

Additional considerations

For each population and all PI/ECO questions, the GDG also considered values and preferences of those affected by the guidelines; the resource implications of the recommendations; the impact on health equity; and the acceptability and feasibility of the recommendations. As there was considerable duplication in these considerations, and in the GDG's assessment, for each population group, a summary of the discussions regarding assessments for these elements are described in the "Evidence to recommendations" section.

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.

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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.

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