

Expert Working Group Working Paper

Children and Young People

UK physical activity guidelines: draft review and recommendations for Children and Young People

October 2018

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Background

UK Physical activity guidelines

The first UK physical activity guidelines were produced in 1996 following the 1994 Ascot Meeting of UK and international experts, who agreed recommendations for adults (1, 2). These recommendations were then extended to include new recommendations for children and young people in 1998 (3). These recommendations included suggestions about the frequency, intensity and time of aerobic physical activity needed for each age group but also included the first recommendation for muscle strengthening, flexibility and bone health for children and young people only. In 2004 the English Chief Medical Officer formally endorsed these recommendations and thus began a continuing relationship with their production and dissemination that has continued to today. At the same time Scotland and Wales had adopted similar guidelines and following the publication of the 2008 USA physical activity guidelines (4), the UK CMOs harmonised and produced the current physical activity guidelines, published in 2011 (5). These included, for the first time, recommendations for Under 5s and for all age groups, sedentary behaviour (6).

Benefits of physical activity for children and young people

Physical activity is associated with better physiological, psychological and psychosocial health among children and young people (7, 8). Global and UK specific evidence has shown that boys are more active than girls at all ages and that physical activity levels decline from mid-childhood and into adolescence (9-11). There is also some evidence to suggest that physical activity tracks from childhood into adulthood (12). As such, ensuring that all children are as active as possible throughout childhood is important for population health. This evidence-based review informed the UK specific physical activity guidelines, which will serve as the reference point for national estimates of the proportion of children and young people meeting national guidelines.

The key aim of this working paper is to present potential recommendations for changes to the existing 2011 UK CMO physical activity guidelines (13). The working papers present the findings of each Expert Working Group (EWG) in relation to their area. The document answers a set of questions about potential changes to current physical activity guidelines, by expert scrutiny of the most up to date scientific reviews, and other international guidelines.

Outline of CMO Process

This work was conducted in three phases (summarised in Figure 1). Phase One (now complete) saw the construction of each EWG, selection of international experts, formal purposive systematic reviews of the existing and new evidence, a website for a national consultation on the current UK CMO guidelines and their implementation, and production of working group papers. All Chairs and Expert Panel members completed a statement of their declarations of interest.

In Phase Two, draft working papers were developed (this being one of the six papers). The draft papers were circulated to participants attending two Scientific Consensus Meetings (SCM) in Edinburgh and London, during June and July of 2018, respectively. This document has been revised in two ways: i) to reflect the feedback received from both consensus meetings; ii) in response to the updated evidence base. As a result, the phrasing of the two physical activity guidelines for children and young people have been altered.

Phase Three will include a second national consultation on the draft physical activity recommendations, and a final round of review and revision. EWGs will then produce a final technical report for the UK CMOs with final recommendations for new physical activity guidelines. If the CMOs sign off the suggested recommendations, then the CMO Guidelines Writing Group will support the production of a final CMO Physical Activity Guidelines Report.

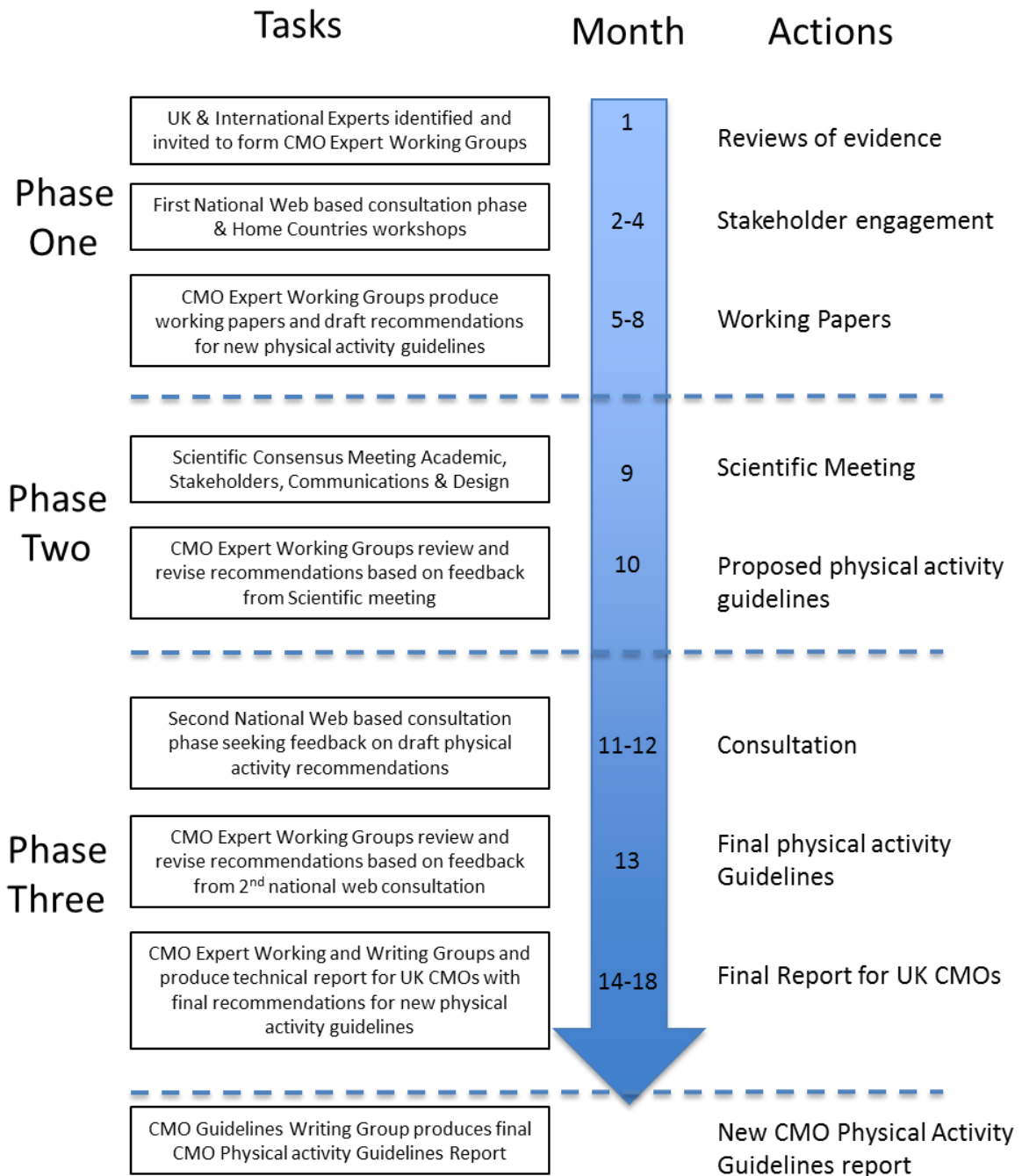


Figure 1 UK Physical activity guidelines review process

Methods for CMO Physical Activity Guidelines Update

Based on the experience of updating guidelines in 2011, as well as resources and time it was deemed impractical to undertake a full review of the primary literature. It was agreed by the EWG Chairs that to identify a set of key review documents to be the primary sources of evidence underpinning the UK review work.

The process to update the 2011 CMO physical activity guidelines drew upon three types of evidence (detailed below): (A) recent published evidence reviews used to construct or update international physical activity guidelines; (B) the most recent pooled analyses, meta-analyses and systematic reviews from prospective and RCT research published since the most recent reviews used to update international guidelines; and (C) any additional relevant papers identified by each EWG. In addition, comments and suggestions about the current 2011 CMO physical activity recommendations were identified for each EWG from the first National Consultation.

Each EWG adopted the same principle, namely, to identify whether there was any new evidence to suggest a change to the existing 2011 guidelines based on the GRADE-ADOLOPMENT process (14). Using the GRADE-ADOLOPMENT process, the most recent international physical activity guidelines for children and young people were identified, these were from the Netherlands. Together with the existing 2011 UK guidelines, this formed the starting point of the review.

The current UK physical activity guidelines were constructed as advice to the general population about the recommended frequency, intensity, time and types of physical activity required to prevent major chronic disease and to maintain health. In the UK, the diseases refer specifically to mortality, years of life lost, and disease burden (coronary heart disease, stroke, heart failure, diabetes mellitus type 2, chronic obstructive pulmonary disease (COPD), breast cancer, colorectal cancer, lung cancer, osteoarthritis, dementia and cognitive decline, and depression and depressive symptoms). The guidelines also focus on preventing premature (or all-cause) mortality and fractures, disabilities in the elderly, injuries and, in children, attention deficit hyperactivity disorder (ADHD) symptoms. Four risk factors were also included (systolic blood pressure, LDL cholesterol, body weight (BMI Z-score in children), and insulin sensitivity), which have a causal relationship with these chronic diseases. For the children and young people expert review, muscle strength, cardiorespiratory fitness, bone health, cognitive functioning and academic performance were included as key health indicators for this age group.

The specific steps that were followed to address items A-C that were highlighted above are described in detail below.

A. Identifying recent national evidence reviews used to construct or update physical activity guidelines

We used Google and targeted public health bodies (i.e. National Centre for Health and Clinical Excellence, Centre for Disease Control) to search for evidence reviews of physical activity that had been used to construct national physical activity guidelines and recommendations

(published since 2010). We also contacted international experts who had authored recent national guidelines to identify further examples of relevant reviews from Australia, Canada and the Netherlands (7, 15, 16). National evidence reviews for the construction of children’s physical activity guidelines were found for 15 European countries and four other worldwide countries. Twelve of these evidence reviews were eligible for inclusion based on publication date (7, 15-25).

B. Identifying the most recent pooled analyses, meta-analyses and systematic reviews from prospective and RCT research to answer the specific questions posed?

We undertook purposive searches to identify relevant literature on the relationship between physical activity and health outcomes. Our searches primarily focused on review-level evidence for longitudinal cohort studies examining the relationship between physical activity and health outcomes. Systematic reviews and meta-analyses were also examined for randomised controlled trials to identify what types and volume of physical activity were used in effectiveness studies. We searched PubMed using a tailored set of broad MeSH terms (Medical Subject Headings) to capture the most current studies published, relevant to the needs of each EWG. For example, “resistance training”, “muscle”, “bone”, “balance” AND “physical activity” AND “adults”. Full search terms are presented in Table 1.

Table 1. Search Terms for Children & Young People

Mortality	Breast Cancer	Physical Activity
Morbidity	Lung Cancer	Exercise
Health Outcomes	Prostate Cancer	Sedentary
Coronary Heart Disease	Mental Health	Behaviour
Cardiovascular Disease	Dementia	Fitness
Stroke	Cognitive	Muscle
Heart Failure	Depression	Bone
Diabetes	Quality Of Life	Balance
Chronic Obstructive Pulmonary Disease	Happiness	Sitting
Osteoarthritis	Sleep	Screen Time
Sarcopenia	Attention Deficit Hyperactivity Disorder	Children
Strength	Blood Pressure	Young People
Function	Hypertension	Adolescents
Anxiety	Cholesterol	
Brain	Obesity	English
Behaviour	Insulin Sensitivity	Review
Academic Performance	Body Weight	Meta Analysis
Fractures	Body Composition	Individual Patient
Accidents	Fat Mass	Data
Falls	Adiposity	
Disability	Aerobic	
Injury	Balance	
Cancer	Strength	
Colorectal Cancer		

The terms of the searches and their dates reflected the most recent international evidence reviews searches. For example, the Netherlands searches were truncated at 1 October 2016, so searches include all publications from January 1st, 2016 (in case of delayed archiving) to 1st January 2018. EWGs synthesised the effectiveness of the evidence across their health outcomes using this process.

A total of 42 publications were identified via the PubMed search. Studies were excluded if they were outside of the date range, included 'at risk' populations or focussed solely on sedentary behaviour. The central review team research associate removed duplicates and assessed the eligibility of the studies against the key questions outlined below and via this process a total of 14 publications were eligible for inclusion (26-39).

C. Identifying any additional relevant papers by each EWG.

We also asked each EWG to identify any relevant outcomes and primary papers from their own sources and networks. EWGs identified the most relevant and up to date high quality reviews from these sources and summarised the effectiveness of the evidence across their health outcomes.

Key questions

There were seven specific questions that the EWG were asked to consider in relation to children and young people. These questions arose from the national consultation and the previous update of the UK guidelines in 2011. For each of these questions, a summary statement of the expert response and a commentary of the evidence that underpinned that response is outlined below.

Question 1: Does the scientific evidence continue to support the current PA guidelines for the children and young people population?

Statement 1: The current evidence broadly supports the guideline of at least 60 minutes of moderate-to-vigorous physical activity (see questions 2 and 3 below).

Commentary 1: The current guideline is consistent with the guidelines from the Netherlands (16) that we were following as part of the GRADE-ADOLPMENT process (14). We found no high-quality evidence published since the reviews used for the Netherlands guideline which would suggest a different threshold in relation to either the number of minutes per day or the intensity of physical activity. The second part of the 2011 UK guideline states that “Vigorous intensity activities, including those that strengthen muscle and bone should be incorporated at least three days per week”. While there are studies that support the promotion of vigorous activity for bone health (40-45), we could not find high quality evidence to support the three times per week guideline.

Question 2: Based on the current evidence what, if any, modifications to the current physical activity guidelines should be considered? Please make recommendations on any modifications to the stated characteristics of how physical activity can be undertaken and accumulated for optimal prevention of chronic disease?

Statement 2: We recommend that the current guideline is modified to “Children and young people (5-18 years of age) should engage in moderate-to-vigorous intensity physical activity for an average of 60 minutes per day across the week”. We recommend that the second guideline is changed to encourage activities that strengthen muscle and bone but the specific number of days per week is modified.

Commentary 2: The current evidence base does not support a specific threshold of 60 minutes moderate-to-vigorous intensity physical activity every day per se. Current studies (40, 46) have broadly used an average of 60 minutes per day to assess the benefits of physical activity on health outcomes. As such, we are unable to assess whether a 60-minute threshold per day confers health benefits. Current literature suggests that greater benefits occur with a greater volume of physical activity (i.e. more is better), particularly for less active people, but there is no strong evidence to support a change in the guideline. In terms of muscle and bone, while there are clear benefits for vigorous physical activity for bone health (40), the 2011

guideline does not provide guidance on the duration of muscle strength and bone, just the frequency (three times per week) (13). This lack of specificity means that it is not possible to assess compliance against the guideline and as such, interpretation of the guideline can be confusing. The EWG group felt that a broader message to encourage a variety of activities across the week, which included activities to strengthen muscle and bone would be helpful and we have therefore suggested a modification to the guidelines (see recommendation 2).

Question 3: Please comment specifically on the available evidence related to the accumulation of physical activity in multiple short periods and its distribution throughout the week.

Statement 3: The current evidence suggests that the overall volume of physical activity as opposed to specific bout duration is important for children and young people's health with daily physical activity preferable.

Commentary 3: There was no strong evidence for specific bouts of moderate-to-vigorous intensity physical activity, either in terms of number or duration of bouts per day, undertaken by children and young people. In contrast, a recent analysis of nearly 30,000 children suggests that time spent in physical activity with increasing intensity was favourably associated with cardiometabolic risk markers in youth irrespective of bout-duration. Furthermore, a recent paper showed that children rarely accumulated physical activity in long bouts, also showing that the total time in moderate-to-vigorous intensity physical activity, rather than time spent in specific bouts, was important for health outcomes (47) (48).

Question 4: Is there any evidence to suggest (with regards physical activity and its effects on health outcomes) that the age cut-offs for the children and young peoples, and adults' group should be modified or an additional age category for 16-18-year olds should be considered?

Statement 4: There is no strong evidence to support an age cut-off for the transition to the adult guidelines.

Commentary 4: It is known that growth and maturation continue for some people into their early twenties with physiological changes not necessarily synchronised with chronological age (49). This is particularly the case for late-maturing males who may not reach full adult stature until their early twenties. It has been suggested that adolescence could range between 10 and 24 years of age (50). However, there is no robust evidence to either confirm or refute the use of age 18 years as a threshold for physical activity guidelines in children and young people, which is used globally for physical activity guidelines (15, 17, 25, 51, 52). Therefore, to be consistent with current and international guidelines we propose that the current threshold remains at 18 years, but the messaging around the guidance should recognise the transition from childhood to adulthood and focus on ensuring the maximum level of physical activity for as long as possible.

Question 5: Is there any evidence to suggest other health or related areas should be considered in the physical activity guidelines?

Statement 5: We found some evidence that: a) the movement quality of physical activity (i.e. how proficient children and young people are at performing specific movements and skills which, is sometimes referred to as a component of physical literacy) may be important for children and young people; b) physical activity may aid cognitive development and academic achievement; c) evidence for the relationship between physical activity and mental health is accumulating but there are still substantial gaps in the evidence base; and d) while there is review level evidence that High-Intensity Interval Training (HIIT) for children can have positive impacts on children and young people's cardio-respiratory fitness and body composition, there are a number of inconsistencies in the literature in terms of the duration, frequency and intensity of the sessions (53). These inconsistencies, in terms of how HIIT can best be operationalised for children and young people, means that it is currently premature to recommend a specific form of HIIT for children and young people.

Commentary 5: A summary of the evidence in relation to the four issues raised in statement 5 is presented below.

a) In children and young people, there is evidence that physical activity is positively associated with increased proficiency in motor/movement skills (which is sometimes referred to as a component of physical literacy), and that this relationship is reciprocal (27). Physical activity performed at moderate and vigorous intensities is most likely to confer the greatest benefits on movement proficiency, and there is no evidence of harm in this area. Indeed, diversity of movements can enhance bone and muscle strength, and decrease injury, which is one of the primary cited reasons for decreasing early specialisation in sport. Moreover, exposure to different types of activities is implicated with higher perceptions of competence, which are also associated with higher physical activity levels (54). Physical education is likely to play a key role in the development of movement skills and supporting the promotion of high quality physical education provision is important for the development of children's skills and confidence to be physically active. However, there is insufficient evidence to specify the intensity or amount required to accrue such benefits, nor for specifying movements that contribute to fitness improvements. The current evidence, does, however, suggest that developing a broader, more diverse range of movement skills, and inherently the variety in the types of physical activity in which children and young people engage in, is likely to be beneficial, but more high-quality evidence in this area is required (27, 55).

b) There is some evidence that physical activity may aid cognitive development and academic achievement. The evidence is inconclusive for cognitive development and overall academic achievement, but there is strong evidence that physical activity has beneficial effects on performance in mathematics (56-58). We therefore conclude that, based on the current

evidence, physical activity is important for mathematics performance and may provide benefits for broader academic achievement and cognition, but more research in these areas is warranted.

c) A recent systematic review of prospective cohort studies reported a protective effect of self-reported physical activity for depression (59). Other review level evidence indicates that there is a lack of high quality evidence on the link between physical activity and other aspects of mental health in children and young people, with a particular gap in relation to the different types and intensities of physical activity (often phrased as the differences between the quantity and quality of physical activity) (60-64). This research gap means that it is not possible to recommend specific types (duration, frequency and duration) of physical activity to improve mental health, but overall the evidence suggests potential benefits of physical activity for several mental health outcomes.

d) There is evidence that HIIT can provide physiological benefits to children but differences in HIIT protocols, definitions, and study designs make assessing the overall evidence-base challenging (53, 65-67). Based on the current, albeit limited, literature there is no evidence that HIIT is harmful for children and young people. In some ways, HIIT may be directly aligned with children's natural movement patterns (68) that are often typified by short bursts of playful, intense physical activity interspersed by rest. Some authors have suggested that HIIT could be considered a more effective and time-efficient intervention for improving blood pressure and cardio-respiratory fitness levels in obese youth in comparison to other types of exercise (66), but the implications for this kind of intervention in real-world settings is unclear. It is also important to highlight that the 2009 Cochrane review on school-based physical activity interventions (69) reported challenges to exercise adherence for vigorous-intensity physical activity interventions in adolescents. As such, it is currently too early to make any specific statements in relation to HIIT in children and young people, as more work, particularly from high quality randomised controlled trials with standardised HIIT definitions, is needed to inform implementation strategies.

Question 6: If the evidence points to a revision of the current guidelines, are the advantages of making such a change likely to outweigh the disadvantages (for example confusion amongst healthcare practitioners still relatively unfamiliar with the 2011 Guidelines)?

Statement 6: Although we have considered issues surrounding the potential for confusion and attempted to keep the guidelines as close to the original as possible, we think that some small changes to the physical activity guidelines would help to provide clearer messages to the public, policy makers, health professionals and aid in researchers' understanding and interpretation.

Question 7: What are the data limitations and implications for surveillance for this age group?

In conducting this update of the UK physical activity guidelines, we have outlined several limitations in relation to the current national data that are available to inform surveillance. These are outlined below:

- A. There is a shortage of large-scale prospective data. While national data from representative surveys such as the Health Survey for England and the Scottish Health Survey can provide insight into secular change it cannot provide detail on the within person change which is important for assessing associations with health outcomes. Several other countries (e.g. USA) have nationally representative surveys that include objective assessments of physical activity for children and young people and it would be helpful to have comparable UK data. As such, large scale, prospective studies and nationally representative surveys with objective assessments of the physical activity of children and young people with information on health outcomes and/or the ability to link to routine data should be prioritised.
- B. Changes to population-level physical activity measurement protocols preclude long-term comparisons and make interpretation of secular trends difficult. It would be preferable to collect objective accelerometer data in nationally representative samples with data stored and shared in both raw and processed formats. For processed data, clear protocols for cut-points (where applicable), sampling frequency, placement, make and model of accelerometer, epoch length, and single vs. multiple axes would be developed to facilitate comparisons with other national and international datasets. Use of raw data would facilitate subsequent reprocessing as new methods become available.
- C. Considering the potential importance of maturation status that is outlined above, it would be helpful to have more information on participants' biological age in national survey and large cohort studies.
- D. More information on physical activity settings (i.e. mode, duration, and timing across the week) is needed to identify when there may be opportunities for public health interventions.
- E. Current surveillance data provides limited opportunities to assess important proximal health outcomes such as mental health and academic attainment. Further information on proximal health outcomes would be helpful for identifying the potential of more immediate benefits of physical activity. These proximal outcomes are likely to be particularly relevant to facilitate behaviour change for young people.

Limitations of findings

- The review has been based on a GRADE-ADOLPMENT process using the 2011 UK guidelines and the recent Netherlands guidelines. As such, we have not reviewed all original underpinning research and we have not been able to triangulate or repeat the original methods used.
- All reviews were limited to studies published in English and it may mean that key information published in other languages is missing.
- This review has focussed on the physical activity guidelines for children and young people. A separate review is focussing on the sedentary behaviour guidelines. In the overall guidelines the evidence from the two groups will need to be combined to provide physical activity and sedentary behaviour guidelines for children and young people.
- This review has not assessed the benefits or recommendations for physical activity for children with disabilities. There is a need for specific and focussed piece of work by experts in this field to complement the current document.

Draft recommendations

Recommendation 1: The UK physical activity guidelines for children and young people should be revised to highlight that children and young people should engage in moderate-to-vigorous intensity physical activity daily and that physical activity can be accumulated sporadically or in bouts across the day and week with an average of 60 minutes of moderate-to-vigorous physical activity per day.

Supporting evidence: Evidence is based on the review of systematic reviews and cohort studies and reflects current uncertainties in the literature that are discussed in response to questions 1-3 above.

Revised recommendation: Children and young people (5-18 years of age) should engage in moderate-to-vigorous intensity physical activity for an average of 60 minutes per day across the week. (This activity can include all forms of activity such as physical education, active travel, activity after-school school, play and sports).

Recommendation 2: The UK physical activity guidelines for children and young people should build on the current recommendation to include muscle strength and bone activities, by integrating a variety of different activities to develop and enhance movement skills.

Supporting evidence: The Netherlands recommendation incorporates “Do activities that strengthen your muscles and bones at least three times a week” and “the more, the better” (16). We found no evidence to contradict these guidelines. However, as noted above in response to question 5a, there is some evidence that engaging in a variety of different types of physical activity will enhance movement quality. Although the evidence-base needs to be more robust to prescribe specific recommendations, there is no evidence of harm. Therefore, encouraging children and young people to engage in a variety of different activities, which develop a range of movement skills and strengthen muscle and bone, is likely to be beneficial for children’s overall life-long physical activity levels.

Revised recommendation: Children and young people (5-18 years of age) should engage in a variety of types and intensities of physical activity to develop movement skills, muscular fitness, and bone strength across the week.

Research recommendations

We have identified nine key evidence gaps that need to be addressed, along with proposed research recommendations (Table 2).

Table 2: Current evidence gaps and research recommendations for children and young people

Evidence gap	Research recommendation
1) There is a lack of nationally representative physical activity data which uses objective measurements of physical activity for children and young people	1) Include objective measurements of physical activity for children and young people into nationally representative surveys. The ability to link new surveys to routine data (e.g. health and education) would be particularly advantageous.
2) There is a lack of information on the benefits of meeting the 60 minutes moderate-to-vigorous intensity physical activity guideline <i>every day</i> vs. <i>an average</i> per day.	2) Longitudinal studies that examine the impact of meeting the national guidelines on each day vs. on average are needed in relation to all major health outcomes for children and young people.
3) There is a lack of evidence about the benefits of light-intensity physical activity among children and young people	3) Work is needed to examine the impact of light-intensity physical activity on health outcomes in children and young people using contemporary analysis approaches. Specific information on the impact of displacing sedentary or moderate-to-vigorous intensity physical activity time with light-intensity physical activity on a number of health outcomes is needed.
4) There is a lack of evidence on the dose-response relationship between physical activity and health outcomes.	4) Research is needed to examine the health benefits of higher- and lower-intensity physical activity in children and young people at different developmental stages. This will necessitate rigorously controlled experimental studies in which the dose of physical activity is externally managed and confounding variables are controlled.
5) There is a lack of high quality evidence on the effect of physical activity on cognitive development and academic attainment.	5) Well-controlled randomised controlled trials and high quality prospective data are needed to assess the impact of physical activity on cognitive development and academic attainment.
6) There is a lack of high quality evidence on the association between physical activity and mental health in children.	6) Well-controlled randomised controlled trials and high quality prospective data are needed to assess the impact of physical activity on mental health-related outcomes in children and young people, with additional information specifically warranted on the benefits of different types (including quality) and the quantity of physical activity. Ideally, these studies would be sufficiently data rich to control for potential confounders which may mask or amplify important effects.
7) There is a lack of evidence to identify the optimal age threshold for the adult physical activity guidelines, or indeed the age for the transition from the early years to children and young people.	7) Research is needed to examine whether there should be a fixed transition between the children and young people's and adults' physical activity guidelines and, if so, what the age threshold should be. Specifically, work that considers the merits of a transition between the different age recommendations and the implications of later or earlier maturation on fixed or transition thresholds is specifically needed. Similarly, more evidence is needed on how to manage the transition from the early years guidelines to the children and young people thresholds.

<p>8) There is a lack of information on the benefits of different strategies to improve motor competence and the effects of those strategies on physical activity levels across childhood.</p>	<p>8) There is a need for randomised controlled trials to assess the impact of different types of skill development programmes on fundamental movement skills and motor competency. There is also a need to examine whether increasing these skills has long-term impacts on physical activity levels.</p>
<p>9) There is a lack of high quality evidence in relation to the benefits of High-Intensity Interval Training (HIIT) for children and young people.</p>	<p>9) High quality randomised controlled trials, with standard definitions of HIIT. These should include evaluation of the acceptability and sustainability of HIIT-type exercise to identify feasibility of implementing and identify best practice principles for children and young people.</p>

Next steps

A second national consultation on the draft physical activity recommendations will be undertaken. This report will then be reviewed and edited where appropriate. A final technical report will then be produced for the UK CMOs with final recommendations for new physical activity guidelines. If the CMOs sign off the suggested recommendations, then the CMO Guidelines Writing Group will support the production of a final CMO Physical Activity Guidelines Report.

Acknowledgments

We would like to thank Dr Lisa Barnett (Deakin University), Dr Helen Elizabeth Brown (MRC Epidemiology Unit & Centre for Diet and Activity Research (CEDAR), University of Cambridge), and Philip Hill (Swansea University) for assisting with the identification and interpretation of the additional searches that were undertaken during this process.

References

1. Health Education Authority. Moving On: International perspectives on promoting physical activity. London: 1994.
2. Department of Health. Strategy Statement on Physical Activity. London: 1996.
3. Health Education Authority. Young and Active? London: H.E.A., 1998.
4. US Department of Health and Human Services. Physical Activity Guidelines for Americans: Be Active, Healthy and Happy. Washington DC: 2008.
5. Department of Health PA, Health Improvement and Protection. Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. In: Department of Health PA, Health Improvement and Protection, editor. London: Department of Health; 2011.
6. Milton K, Bauman A. A critical analysis of the cycles of physical activity policy in England. *Int J Behav Nutr Phys Act.* 2015;12:8. Epub 2015/02/02.
7. Poitras VJ, Carson, V., Chaput, J.P., Saunders, T.J., Connor Gorber, S., Kho, M.E. and Tremblay, M.S. Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep. Guideline Development Report. Ottawa: 2016.
8. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, et al. Evidence based physical activity for school-age youth. *J Pediatr.* 2005;146(6):732-7. Epub 2005/06/24.
9. Cooper AR, Goodman A, Page AS, Sherar LB, Esliger DW, van Sluijs EM, et al. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). *Int J Behav Nutr Phys Act.* 2015;12:113.
10. Jago R, Solomon-Moore E, Macdonald-Wallis C, Sebire SJ, Thompson JL, Lawlor DA. Change in children's physical activity and sedentary time between Year 1 and Year 4 of primary school in the B-PROACT1V cohort. *Int J Behav Nutr Phys Act.* 2017;14(1):33.
11. Farooq MA, Parkinson KN, Adamson AJ, Pearce MS, Reilly JK, Hughes AR, et al. Timing of the decline in physical activity in childhood and adolescence: Gateshead Millennium Cohort Study. *Br J Sports Med.* 2017. Epub 2017/03/16.
12. Telama R, Yang X, Leskinen E, Kankaanpaa A, Hirvensalo M, Tammelin T, et al. Tracking of physical activity from early childhood through youth into adulthood. *Med Sci Sports Exerc.* 2014;46(5):955-62. Epub 2013/10/15.
13. Department of Health PA, Health Improvement and Protection, . Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers. London: Department of Health, , 2011.
14. Schunemann HJ, Wiercioch W, Brozek J, Etxeandia-Ikobaltzeta I, Mustafa RA, Manja V, et al. GRADE Evidence to Decision (EtD) frameworks for adoption, adaptation, and de novo development of trustworthy recommendations: GRADE-ADOLPMENT. *J Clin Epidemiol.* 2017;81:101-10. Epub 2016/10/08.
15. Okely AD, Salmon, J., Vella, S.A., Cliff, D., Timperio, A., Tremblay, M., Trost, S.G., Shilton, T., Hinkley, T., Ridgers, N., Phillipson, L., Hesketh, K., Parrish, A-M., Janssen, X., Brown, M., Emmel, J. and Marino, N. A Systematic Review to update the Australian Physical Activity Guidelines for Children and Young People. In: Health AGDo, editor. Canberra: Australian Government Department of Health; 2012.
16. Netherlands HCot. Physical Activity Guidelines 2017. Health Council of the Netherlands, 2017 Contract No.: 2017/08e.
17. Bachl N, Bauer, R., Dorner, T.E., Gäbler, C., Gollner, E., Halbwachs, C., Lercher, P., Miko, H., Ring-Dimitriou, S., Samitz, G., Schober, P.H., Stein, K.V., Titze, S. and Windhaber, J. Österreichische Empfehlungen für gesundheitswirksame Bewegung. Vienna: Arbeitsgruppe Körperliche Aktivität/Bewegung/Sport der Österreichischen Gesellschaft für Public Health, 2010.
18. Group TFE. Flemish Health Recommendations for Physical Activity and Sedentary Behaviour. Brussels: 2017.
19. Pedersen BKaA, B. Physical Activity - Handbook on Prevention and Treatment. Copenhagen: 2011 22/12/11. Report No.

20. Pfeifer K, Banzer, W., Ferrari, N., Füzéki, E., Geidl, W., Graf, C., Hartung, V., Klamroth, S., Völker, K., Vogt, L., Rütten, A., Abu-Omar, K., Burlacu, I., Gediga, G., Messing, S. and Ungerer-Röhrich, U. National Recommendations for Physical Activity and Physical Activity Promotion. Erlangen: Federal Ministry of Health, 2016.
21. Musumeci G. Physical Activity for Health - An Overview and an Update of the Physical Activity Guidelines of the Italian Ministry of Health. *Journal of Functional Morphology and Kinesiology*. 2016;1:269-75.
22. Owe K, Ekelund, U. and Ariansen, I. Physical Activity Public Health Report. Folkehelseinstituttet; 2014 [updated 27/09/17; cited 2018 25/04/18]; Available from: <https://www.fhi.no/nettpub/hin/levevaner/fysisk-aktivitet-i-noreg---folkehel/#om-artikkelen>.
23. Ministry of Health SSaE. Physical Activity for Health and Sedentary Reduction. Recommendations for the population. Strategy of Health Promotion and Prevention in the SNS. Madrid: 2015.
24. Federal Office of Sport FOSPO FOoPHF, Health Promotion Switzerland, bfu - Swiss Council for Accident Prevention, Swiss Accident Insurance Fund (Suva). Health-Enhancing Physical Activity. Core document for Switzerland. Magglingen: 2013.
25. Health Mo. Food and Nutrition Guidelines for Healthy Children and Young People (Aged 2–18 years): A background paper. Wellington: 2012 Partial revision: 2015. Report No.
26. Al-Khudairy L, Loveman E, Colquitt JL, Mead E, Johnson RE, Fraser H, et al. Diet, physical activity and behavioural interventions for the treatment of overweight or obese adolescents aged 12 to 17 years. *Cochrane Db Syst Rev*. 2017(6).
27. Barnett LM, Lai SK, Veldman SLC, Hardy LL, Cliff DP, Morgan PJ, et al. Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Med*. 2016;46(11):1663-88. Epub 2016/02/20.
28. Braaksma P, Stuive I, Garst RME, Wesselink CF, van der Sluis CK, Dekker R, et al. Characteristics of physical activity interventions and effects on cardiorespiratory fitness in children aged 6-12 years-A systematic review. *J Sci Med Sport*. 2018;21(3):296-306. Epub 2017/09/14.
29. Catala-Lopez F, Hutton B, Nunez-Beltran A, Page MJ, Ridao M, Macias Saint-Gerons D, et al. The pharmacological and non-pharmacological treatment of attention deficit hyperactivity disorder in children and adolescents: A systematic review with network meta-analyses of randomised trials. *PLoS One*. 2017;12(7):e0180355. Epub 2017/07/13.
30. Cattuzzo MT, Dos Santos Henrique R, Re AH, de Oliveira IS, Melo BM, de Sousa Moura M, et al. Motor competence and health related physical fitness in youth: A systematic review. *J Sci Med Sport*. 2016;19(2):123-9. Epub 2015/01/03.
31. Dennison M, Sisson SB, Morris A. Obesogenic behaviours and depressive symptoms in children: a narrative literature review. *Obes Rev*. 2016;17(8):735-57. Epub 2016/05/04.
32. Donnelly JE, Hillman CH, Castelli D, Etnier JL, Lee S, Tomporowski P, et al. Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. *Med Sci Sports Exerc*. 2016;48(6):1223-4. Epub 2016/05/18.
33. Lozano-Berges G, Matute-Llorente A, Gonzalez-Aguero A, Gomez-Bruton A, Gomez-Cabello A, Vicente-Rodriguez G, et al. Soccer helps build strong bones during growth: a systematic review and meta-analysis. *Eur J Pediatr*. 2018;177(3):295-310. Epub 2017/12/29.
34. Marques A, Santos, D.A., Hillman, C.H., Sardinha, L.B. How does academic achievement relate to cardiorespiratory fitness, self-reported physical activity and objectively reported physical activity: a systematic review in children and adolescents aged 6–18 years. *British Journal of Sports Medicine*. 2017. Epub 14/10/17.
35. Martin R, Murtagh EM. Effect of Active Lessons on Physical Activity, Academic, and Health Outcomes: A Systematic Review. *Res Q Exerc Sport*. 2017;88(2):149-68. Epub 2017/03/23.
36. Ng QX, Ho CYX, Chan HW, Yong BZJ, Yeo WS. Managing childhood and adolescent attention-deficit/hyperactivity disorder (ADHD) with exercise: A systematic review. *Complement Ther Med*. 2017;34:123-8. Epub 2017/09/18.

37. Santana CCA, Azevedo LB, Cattuzzo MT, Hill JO, Andrade LP, Prado WL. Physical fitness and academic performance in youth: A systematic review. *Scand J Med Sci Sports*. 2017;27(6):579-603. Epub 2016/10/08.
38. Saunders TJ, Gray CE, Poitras VJ, Chaput JP, Janssen I, Katzmarzyk PT, et al. Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016;41(6 Suppl 3):S283-93. Epub 2016/06/17.
39. Sibley KM, Beauchamp MK, Van Ooteghem K, Paterson M, Wittmeier KD. Components of Standing Postural Control Evaluated in Pediatric Balance Measures: A Scoping Review. *Arch Phys Med Rehabil*. 2017;98(10):2066-78 e4. Epub 2017/04/26.
40. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput JP, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Me*. 2016;41(6):S197-S239.
41. Gunter K, Baxter-Jones AD, Mirwald RL, Almstedt H, Fuchs RK, Durski S, et al. Impact exercise increases BMC during growth: an 8-year longitudinal study. *J Bone Miner Res*. 2008;23(7):986-93. Epub 2007/12/13.
42. Hind K, Burrows M. Weight-bearing exercise and bone mineral accrual in children and adolescents: a review of controlled trials. *Bone*. 2007;40(1):14-27. Epub 2006/09/08.
43. Tan VP, Macdonald HM, Kim S, Nettlefold L, Gabel L, Ashe MC, et al. Influence of physical activity on bone strength in children and adolescents: a systematic review and narrative synthesis. *J Bone Miner Res*. 2014;29(10):2161-81. Epub 2014/04/17.
44. Vlachopoulos D, Barker AR, Williams CA, SA AR, Knapp KM, Metcalf BS, et al. The Impact of Sport Participation on Bone Mass and Geometry in Male Adolescents. *Med Sci Sports Exerc*. 2017;49(2):317-26. Epub 2016/09/16.
45. Deere K, Sayers A, Rittweger J, Tobias JH. Habitual levels of high, but not moderate or low, impact activity are positively related to hip BMD and geometry: results from a population-based study of adolescents. *J Bone Miner Res*. 2012;27(9):1887-95. Epub 2012/04/12.
46. O'Donovan G, Lee IM, Hamer M, Stamatakis E. Association of "Weekend Warrior" and Other Leisure Time Physical Activity Patterns With Risks for All-Cause, Cardiovascular Disease, and Cancer Mortality. *JAMA Intern Med*. 2017;177(3):335-42. Epub 2017/01/18.
47. Tarp J, Child A, White T, Westgate K, Bugge A, Grontved A, et al. Physical activity intensity, bout-duration, and cardiometabolic risk markers in children and adolescents. *Int J Obes (Lond)*. 2018. Epub 2018/07/15.
48. Chinapaw M, Klakk H, Moller NC, Andersen LB, Altenburg T, Wedderkopp N. Total volume versus bouts: prospective relationship of physical activity and sedentary time with cardiometabolic risk in children. *International Journal of Obesity*. 2018. Epub 01/05/2018.
49. Tanner JM. *Foetus into Man*. London: Castlemead; 1989.
50. Sawyer SM, Azzopardi PS, Wickrenarathne D, Patton GC. The age of adolescence. *Lancet Child Adolesc Health* 2018;2(3):223-8.
51. Ahonen T, Hakkarainen, H., Heinonen, O.J., Kannas, L., Kannas, L., Kantomaa, M., Karvinen, J., Laakso, L., Lintunen, T., Lahdesmaki, L., Maenpaa, P., Pekkarinen, H., Saakslahiti, A., Stigman, S., Tammelin, T., Telama, R., Vasankari, T. and Vuori, M. Physical Activity Recommendations for School-leavers 7-18 years of age. 2006.
52. Children TDoHa. *The National Guidelines on Physical Activity for Ireland*. 2009.
53. Costigan SA, Eather N, Plotnikoff RC, Taaffe DR, Lubans DR. High-intensity interval training for improving health-related fitness in adolescents: a systematic review and meta-analysis. *Br J Sports Med*. 2015;49(19):1253-61. Epub 2015/06/20.
54. Sebire SJ, Jago R, Fox KR, Edwards MJ, Thompson JL. Testing a self-determination theory model of children's physical activity motivation: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2013;10:111. Epub 2013/09/27.

55. Lima RA, Pfeiffer K, Larsen LR, Bugge A, Moller NC, Anderson LB, et al. Physical Activity and Motor Competence Present a Positive Reciprocal Longitudinal Relationship Across Childhood and Early Adolescence. *J Phys Act Health*. 2017;14(6):440-7. Epub 2017/02/09.
56. Chalkley A, Milton, K. and Foster, C. . Change4Life evidence review: Rapid evidence review on the effect of physical activity participation among children aged 5-11 years. London: 2015.
57. Li JW, O'Connor H, O'Dwyer N, Orr R. The effect of acute and chronic exercise on cognitive function and academic performance in adolescents: A systematic review. *J Sci Med Sport*. 2017;20(9):841-8. Epub 2017/02/12.
58. Singh AS, Saliassi E, van den Berg V, Uitdewilligen L, de Groot RHM, Jolles J, et al. Effects of physical activity interventions on cognitive and academic performance in children and adolescents: A novel combination of a systematic review and recommendations from an expert panel. *BJSM*. 2018.
59. Schuch FB, Vancampfort D, Firth J, Rosenbaum S, Ward PB, Silva ES, et al. Physical Activity and Incident Depression: A Meta-Analysis of Prospective Cohort Studies. *Am J Psychiatry*. 2018:appiajp201817111194. Epub 2018/04/25.
60. Bailey AP, Hetrick SE, Rosenbaum S, Purcell R, Parker AG. Treating depression with physical activity in adolescents and young adults: a systematic review and meta-analysis of randomised controlled trials. *Psychol Med*. 2018;48(7):1068-83. Epub 2017/10/11.
61. Becker C, Lauterbach G, Spengler S, Dettweiler U, Mess F. Effects of Regular Classes in Outdoor Education Settings: A Systematic Review on Students' Learning, Social and Health Dimensions. *Int J Environ Res Public Health*. 2017;14(5). Epub 2017/05/06.
62. Den Heijer AE, Groen Y, Tucha L, Fuermaier AB, Koerts J, Lange KW, et al. Sweat it out? The effects of physical exercise on cognition and behavior in children and adults with ADHD: a systematic literature review. *J Neural Transm (Vienna)*. 2017;124(Suppl 1):3-26. Epub 2016/07/13.
63. Herbert A, Esparham A. Mind-Body Therapy for Children with Attention-Deficit/Hyperactivity Disorder. *Children (Basel)*. 2017;4(5). Epub 2017/04/26.
64. Sjowall D, Hertz M, Klingberg T. No Long-Term Effect of Physical Activity Intervention on Working Memory or Arithmetic in Preadolescents. *Front Psychol*. 2017;8.
65. Logan GR, Harris N, Duncan S, Schofield G. A review of adolescent high-intensity interval training. *Sports Med*. 2014;44(8):1071-85. Epub 2014/04/20.
66. Garcia-Hermoso A, Cerrillo-Urbina AJ, Herrera-Valenzuela T, Cristi-Montero C, Saavedra JM, Martinez-Vizcaino V. Is high-intensity interval training more effective on improving cardiometabolic risk and aerobic capacity than other forms of exercise in overweight and obese youth? A meta-analysis. *Obes Rev*. 2016;17(6):531-40. Epub 2016/03/08.
67. Eddolls WTB, McNarry MA, Stratton G, Winn CON, Mackintosh KA. High-Intensity Interval Training Interventions in Children and Adolescents: A Systematic Review. *Sports Med*. 2017;47(11):2363-74. Epub 2017/06/24.
68. Bailey RC, Olson J, Pepper SL, Porszasz J, Barstow TJ, Cooper DM. The level and tempo of children's physical activities: an observational study. *Med Sci Sports Exerc*. 1995;27(7):1033-41. Epub 1995/07/01.
69. Dobbins M, De Corby K, Robeson P, Husson H, Tirilis D. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. *Cochrane Database Syst Rev*. 2009(1):CD007651. Epub 2009/01/23.