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GRADE ADOLOPMENT Process to Develop 24-Hour Movement Behavior Recommendations and Physical Activity Guidelines for the Under 5s in the UK, 2019

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ABSTRACT

Background: Physical activity guideline developers are faced with demands to produce guidelines quickly and at low cost. This paper summarises a new, efficient, approach taken to develop UK Chief Medical Officers' (CMOs) Guidelines for the Under 5s, 2019.

Methods: The Grading of Recommendations Assessment, Development and Evaluation (GRADE) Adaptation, Adoption, De Novo Development (ADOLOPMENT) approach was used, based on 24-hour movement behavior guidelines from Canada and Australia in 2017, with a systematic review update in 2018. Draft recommendations were based on (a) the influence of time spent asleep, sedentary, and in physically activity on 10 health outcomes and (b) the influence of PA and sedentary behaviour (including screen time) on sleep outcomes (e.g. duration, latency).

Results: There was consistent evidence of links between the 24-hour movement behaviors and all outcomes, and a high degree of UK stakeholder support for all draft recommendations. UK Guidelines for the Under 5s will be published in 2019 with new guidance on infant tummy time and moderate-to-vigorous-intensity physical activity in pre-schoolers, but draft recommendations on sleep and screen time were not accepted by the CMOs.

Conclusions: This was the first time that the GRADE ADOLOPMENT process has been used in Europe to develop physical activity guidelines. It permitted a rapid and inexpensive production of the UK Physical Activity Guidelines for the Under 5s.

1 INTRODUCTION

2 The UK first published guidance on physical activity for the early years (birth-school-entry) in 2011¹.
3 This 2011 ‘Start Active, Stay Active’ guidance was based largely on expert opinion, and limited to only
4 a single quantitative recommendation, that 3-4 year olds should spend a minimum of 180 minutes in
5 physical activity every day¹. By 2018, there was a larger body of evidence on the benefits of physical
6 activity for growth and development in the Under 5s than was available to inform ‘Start Active, Stay
7 Active’²⁻⁷. There has also been a substantial shift in the way physical activity is understood by
8 academics in this field- it is no longer seen in isolation from the other ‘24-hour movement behaviors’^{2,8}
9 (sedentary behaviour including screen time, and sleep, and arguably time spent standing). In a fixed 24-
10 hour day the time spent in one of these behaviors must inevitably influence the others, and by the time
11 children go to school physical activity declines with increasing age, and is displaced by time spent
12 sedentary⁹⁻¹¹. Sedentary time continues to increase with age, producing further declines in physical
13 activity. Although sleep requirements naturally decrease with age, sleep duration is also affected by
14 time spent in physical activity and sedentary behavior^{12,13}. These movement behaviors each influence
15 health and development, and the combination of behaviors also matters^{2,7,8}, so that evidence-based
16 recommendations for the full 24-hour period can now be made.

17

18 The WHO Ending Childhood Obesity (ECHO) Reports^{14,15} concluded that improving 24-hour
19 movement behaviors in the early years was central to the global prevention and treatment of obesity
20 and related non-communicable diseases (NCDs). The first evidence-based ‘24-Hour Movement
21 Behaviour Guidelines’ for the early years (prior to school entry) were published in 2017 in Canada,
22 Australia, and New Zealand^{2,3}. Evidence-based national guidelines on 24-hour movement behaviors
23 were released in 2018 in South Africa¹⁶, and international guidance on physical activity, sedentary and
24 sleep behaviors from the World Health Organisation (WHO) was published in 2019¹⁷. The process of
25 updating UK 2011 guidance started at the end of 2017.

26

1 The aim of this manuscript is to describe the guideline development process for the Under 5s in the UK,
2 highlighting both the strengths and weaknesses of this process, and the evidence base used to develop
3 the recommendations. The UK guideline development process was based on the principle that the most
4 recent and relevant guidelines should be adapted so that new UK guidelines could be developed
5 relatively quickly and at low cost.

6

7 **METHODS**

8 The process of updating the UK Physical Activity Guidelines 2011-‘Start Active, Stay Active’- was
9 conducted in three phases. Phase 1 saw an initial web consultation to assess support for the guideline
10 update and to take suggestions as to format and content; the construction of Expert Working Groups
11 (for the Under 5s; for school-age children and adolescents; for adults; for older adults; for sedentary
12 behavior from age 5 to old age; for guideline communication and implementation); the selection of
13 international experts for each working group; formal evidence review and synthesis during 2018, and a
14 website for national consultations on the new UK CMOs (for Scotland, Northern Ireland, Wales and
15 England) guidelines (<http://www.bristol.ac.uk/sps/research/projects/current/physical-activity/>). In
16 Phase 2, draft recommendations were developed and circulated to participants attending two scientific
17 consensus meetings in Edinburgh and London, during June and July of 2018, respectively. Draft
18 recommendations were revised following feedback from the scientific consensus meetings, and
19 responses to end-user or stakeholder feedback were provided. Phase 3 included further national online
20 consultation on the draft recommendations, and a final round of review and revision in response to that
21 consultation. The expert working group concluded their work by producing a technical report with
22 recommendations for the content and wording of new guidelines which were submitted to the CMOs
23 of Scotland, England, Wales, and Northern Ireland in November 2018. The expert working group was
24 responsible for recommending what the guidelines should contain and how they should be worded. In
25 the UK the guideline development process is conducted under the auspices of the Health Departments
26 and so they alone were responsible for accepting or rejecting the draft recommendations. A UK CMOs

1 Guidelines Writing Group supported the production of a final CMO Physical Activity Guidelines
2 Report in 2019.

3

4

5 **Initial Scoping and Planning of the Work for the Under 5s**

6 Phase 1 began with the formation of the Expert Working Group for the Under 5s at the end of 2017,
7 from a combination of open advertising/competition, and invitation. The aim was to have group
8 members, including early and mid-career academics, with the following characteristics: experience of
9 the UK Start Active Stay Active process 2009-2011; content expertise in the age groups for all three
10 behaviors (sleep, sedentary behavior, physical activity); expertise in guideline development
11 methodology; or experience of other ongoing/recently completed Early Years physical activity
12 guidelines internationally.

13

14 The Expert Working Group received feedback from a UK-wide online consultation (the first of three
15 stages of consultation required in the UK process) in January 2018. This initial consultation supported
16 a guideline update using the concept of 24-hour movement behaviors, emphasised the value of
17 harmonisation with international guidelines (particularly from Canada and Australia), and
18 recommended publication of a summary of the process in the peer-reviewed literature.

19

20 The Under 5s Expert Working Group outlined a schedule of approximately monthly online meetings
21 starting in January 2018, identified tasks and milestones required if the project was to be completed on
22 time, and formed sub-groups for specific tasks. The Expert Working Group was represented on the
23 wider Chairs Panel of UK Expert Working Groups (led by the University of Bristol) which also had
24 monthly online meetings to guide and co-ordinate the work of the UK Expert Working Groups.

25

1 A number of practical and scientific considerations underpinned the guideline development work
2 described in this manuscript. First, in common with the other Expert Working Groups, the work of the
3 Under 5s Expert Working Group was based on the best (most recent, relevant, evidence-based) existing
4 guidelines internationally. Thus, the starting point for the UK guideline update for the Under 5s was the
5 24-hour movement behavior approach^{2,3}, and this was approved in principle by the UK CMOs in early
6 2018. Second, and also in common with the other Expert Working Groups, a default position was agreed
7 by the authors (supported by national consultations) that the UK draft recommendations should be as
8 consistent as possible with the best available international guidance, departing from it only where there
9 was new evidence and/or compelling argument for doing so^{2,3}.

10

11 Implementing these early working group decisions was possible with the support of the other national
12 and international guideline development groups. Most notably, our work in 2018 was informed by a)
13 the WHO guideline development group (up to February 2018), and b) by the inclusion of international
14 experts who led the South African and Australian processes in the UK Expert Working Group.
15 Implementing these early decisions was also possible because of Grading of Recommendations
16 Assessment, Development and Evaluation (GRADE) Adaptation, Adoption, De Novo Development
17 (ADOLOPMENT) approach¹⁸. The GRADE ADOLOPMENT approach is an evidence-based, and
18 efficient (relatively quick and low cost) process for developing guidelines by
19 adapting/adopting/developing existing guidelines. Recently, the Australian 24-Hour Movement
20 Behaviour Guidelines were developed by the process of ADOLOPMENT of the Canadian Guidelines³.
21 The UK Under 5s Expert Working Groups therefore used the GRADE ADOLOPEMENT approach to
22 develop the new draft recommendations.

23

24 **The GRADE ADOLOPMENT Process**

25 The GRADE ADOLOPMENT process involves a series of steps leading to adoption, adaptation, and/or
26 de novo development of an existing guideline. The first task of the Expert Working Group, guided by

1 our GRADE methodologist (AM) was to translate these steps into a series of tasks, summarised in brief
2 here, and in **Table 1**.

3

4 It is worth noting that the process of updating the “Start Active Stay Active” 2011 guideline for the
5 Under 5s in the UK followed GRADE ADOLPMENT, but in the UK different individuals and groups
6 are responsible for different stages of the guideline development process. The Expert Working Group
7 was responsible for making draft scientific recommendations by the end of May 2018, for consultation
8 (online and via two Scientific Consensus Meetings attended mainly by academics and policymakers) in
9 June and July 2018. The Expert Working Group then responded to all points raised in this second
10 consultation process and produced revised draft recommendations taking account of scientific review
11 and stakeholder feedback. Beyond this point, the final guideline content, wording, launch, and
12 implementation was the responsibility of the four UK CMOs as noted above. The CMOs were therefore
13 responsible not only for deciding on whether the draft recommendations would become guidelines, but
14 also for some tasks which are essential to the GRADE-ADOLPMENT process, including: the
15 development of strategies and materials for dissemination of the new guidelines; consideration of issues
16 such as equity of the new guidelines (the extent to which new guidelines might disadvantage groups
17 defined by age, gender, ethnicity, or socio-economic status); costs of disseminating and implementing
18 the new guidelines, and a third and final stage of consultation on the final guidelines (with wider
19 lay/public stakeholders). This manuscript focuses on the Expert Working Group responsibilities, up to
20 the point where final draft recommendations were made as to the content of the guidelines to the four
21 UK CMOs in November 2018, after all feedback from stakeholders up to that point had been considered.

22

23 Some of the tasks undertaken by the Expert Working Group were essential but relatively simple (e.g.
24 establishing a shared folder for access to files; declaration of competing interests) while others required
25 more discussion and judgement. The first major task was to agree on the source guideline(s)^{3,18} on which
26 the new UK guideline should be based (Table 1, item 2). A search for recent relevant guidelines had

1 been carried out by the Bristol Co-ordinating Centre in 2017 and this did not identify any recent relevant
2 guidelines for the early years. We updated the Bristol search with knowledge of the Canadian and
3 Australian Early Years Guidelines^{2,3} (published 20th November 2017) and the ongoing South African
4 and WHO Guidelines (which also had the intention to use GRADE-ADOLPMENT based on the
5 Canadian and Australian Guidelines). In addition, the US Guideline Development Process Evidence
6 Synthesis became available in March 2018, though the US guideline was not published until November
7 2018. The comparison of candidate guidelines against criteria for selecting a source guideline is
8 summarised in **Table 2**, and supported our judgement that our source guideline would be the Canadian
9 24-Hour Movement Behaviour Guidelines for the Early Years (<https://csepguidelines.ca/early-years-0-4/>)². The Australian 2017 Guidelines were largely adopted from the Canadian guidelines³.

11

12 The second task (**Table 1**, item 3) was to agree that the PICOs (Population, Intervention/Exposure,
13 Comparator, Outcomes) which had been used in the Canadian/Australian and WHO systematic
14 review/evidence synthesis (which was shared by WHO in February 2018) were appropriate to our UK
15 guideline update. The PICOs were agreed by the Expert Working Group and are summarised in **Table**
16 **3**.

17

18 The next task (Table 1, items 4, 7-9) was to compile GRADE Summary of Findings Tables for each of
19 the target behaviors (time spent asleep, in sedentary behavior including screen time, and in physical
20 activity). As recommended by GRADE, separate tables for different exposures of the 24-hour
21 movement behaviors were generated from the original versions of the GRADE tables shared with us.
22 **Table 4** gives an overview of the type and number of exposures for the three 24-hour movement
23 behaviors, indicating that in the literature each 24-hour movement behavior is assessed and reported in
24 a number of ways. For example, 13 exposures for physical activity were identified, three exposures for
25 sedentary time, and seven exposures for sleep. The quality of evidence was then assessed for each of
26 the three age groups (infants, up to age 1.0 year; toddlers 1.0 to 2.9 years; pre-schoolers 3.0 to 4.9 years)

1 separately within a particular exposure. Separating the evidence for each exposure-outcome
2 relationship, and also presenting it separately by the three age groups provided a much better
3 understanding of the quantity, quality, and consistency of evidence of the associations with health of
4 24-hour movement behaviors in the early years than had been available previously. This detailed
5 consideration also made it easier to both draft and explain the recommendations, for example it was
6 possible to make explicit reference to time spent in physically active play in the draft recommendations
7 (rather than just in future public health ‘messaging’ of the guidelines) because physically active play
8 was an exposure identified in the revised GRADE tables.

9

10 The GRADE ADOLPMENT process requires a consensus on the balance of adoption, adaptation, and
11 de novo creation of recommendations^{3,18}. The de novo creation of a recommendation in the UK 2018
12 Under 5s guideline development process arose from the desire of the UK Expert Working Group to go
13 beyond the work done by guideline development groups in Canada, Australia, South Africa, and the
14 WHO in order to provide new guidance on sleep as an *outcome* with physical activity and sedentary
15 behavior as the exposure variables (**Table 1**; items 6, 10). Previous 24-hour movement behavior
16 guidelines only considered sleep duration as an *exposure* on outcomes including physical activity and
17 sedentary behavior. This was a gap in the international guideline development work to date, was
18 considered important by UK stakeholders, and had emerged as a major influence on important health
19 and developmental outcomes in recent years^{6,19,20}. One of our sub-groups carried out the systematic
20 review/evidence synthesis necessary to make recommendations based on the influence of physical
21 activity and sedentary time on sleep outcomes (e.g. sleep duration, latency of sleep onset, sleep
22 disturbance). The details of this work, with sleep as an outcome variable (rather than as an exposure
23 variable), are beyond the scope of the current manuscript and so are reported elsewhere.²¹

24

25 Consensus around adoption and adaptation of the Canadian guideline in order to produce draft
26 recommendations for the UK was achieved at two online meetings of the Expert Working Group in

1 April 2018. Draft recommendations and an accompanying draft technical report (explaining the basis
2 of the draft recommendations) were shared with the stakeholders (**Table 1**, items 12-13) using an online
3 consultation in June and July 2018, and face-to-face consultation in the form of the two Scientific
4 Consensus meetings noted above.

5

6 **RESULTS**

7 There was consistent evidence that time spent in physical activity, sleep, and sedentary behavior was
8 associated with a range of health and developmental outcomes in the Under 5s. A summary of this
9 evidence base is provided in **Table 5**. The Expert Working Group made draft 24-hour movement
10 behavior recommendations which were supported by a UK consensus and which were intended to
11 become UK 24-hour movement guidelines. The *de novo development* part of the process produced draft
12 recommendations on the avoidance of screens before bedtime. This was based on a combination of
13 mechanistic studies on the impact of light exposure on sleep, and observational evidence that screen
14 use before bedtime was associated with shorter sleep duration, more night waking, and longer sleep
15 latency (delayed onset of sleep) in Toddlers, and later bedtimes in Pre-schoolers²¹. Consultation
16 responses suggested that advice to families around avoiding screens before bedtime would be valuable
17 and appreciated, and there was some evidence that a period of around one hour before bedtime was
18 optimal.

19

20 The UK Expert Working Group attempted to clarify exposure-outcome relationships in the evidence
21 base, and this led to three main recommended adaptations of the Canadian and Australian guidelines:

- 22 1. It was possible for us to include a draft recommendation for active and outdoor play for
23 Toddlers and Pre-Schoolers, since that was one of the specific physical activity exposures for
24 which evidence was available (this type of physical activity was not referred to specifically in
25 the Canadian or Australian guidelines). This type of physical activity has many benefits and
26 few risks²²⁻²⁴ and was valued highly by the Expert Working Group and by stakeholders.

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2. A specific draft recommendation for moderate-to-vigorous-intensity physical activity (MVPA) was made, referred to as ‘energetic play’ in the Canadian and Australian guidelines. Inclusion of MVPA was possible because there was evidence with MVPA as the exposure in Pre-schoolers, and respondents in the second stage of the consultation welcomed the continuity between the MVPA recommendation for pre-schoolers and that for older children.
3. The Expert Working Group felt that the screen time guidance for Toddlers in the Canadian and Australian guidelines (‘For those younger than two years screen time is not recommended’) should be adapted rather than adopted, with a relaxation in the UK: ‘screen time should be no more than one hour’. The rationale for this adaptation arose from limitations in the evidence around the precision of the 1 hour per day exposure (but good evidence that less screen time was better), the possibility that newer forms of sedentary screen time may be less harmful, and may be more beneficial than the more traditional forms (TV/DVD exposure) which dominated the evidence base, and the pragmatic consideration that recommending a limited amount of exposure may be seen as more helpful, and realistic, to modern families than recommending no exposure.

These draft recommendations derived from the GRADE ADOLOPMENT process are summarised in **Table 6**. In December 2018 the UK CMOs decided to not include the draft recommendations for time spent in sedentary behavior and time spent asleep, as well as screen time in relation to sleep outcomes, and so the final UK 2019 guidelines will be based on physical activity only, excluding the recommendations made by the Expert Working Group in relation to sedentary behavior and sleep. The new physical activity guidelines by age group are shown in **Table 7**.

1 **DISCUSSION**

2 The UK guideline on Physical Activity for the Early Years will be published in 2019. The new guideline
3 is an advance on its predecessor in the UK as it includes more evidence based, quantitative
4 recommendations (facilitating future surveillance), and has new guidance for both tummy time in
5 infancy and MVPA in pre-schoolers. Subjective (parent-report) methods will be required for
6 surveillance, at least initially, though the reliability and validity of existing methods are unclear²⁵.
7 Future surveillance of quantitative recommendations may require objective measurement.

8

9 The work described in this manuscript could have led to the first ‘integrated’ 24-hour movement
10 behaviour guideline for Europe, rather than the physical activity guideline update which was published
11 in 2019. Since the proposed 24-hour movement behavior guidelines were not adopted in the UK, it is
12 worth a brief restatement of the rationale for the approach. First, the approach used to develop draft
13 recommendations was evidence-based, following a rigorous, published, and transparent GRADE
14 ADOLOPMENT process which produces robust guidelines at low cost and relatively quickly. The
15 evidence base for sedentary behavior and sleep guidelines was not weaker than that for physical activity
16 guidelines, and an opportunity for up-to-date, inexpensive, evidence-based guidelines for sedentary
17 behavior and sleep in the UK was lost. Second, at numerous points in the stakeholder consultation
18 processes in the UK a wide variety of individuals and organisations supported the 24-hour approach
19 taken by the Expert Working Group. Evidence from the other countries with recently published 24-hour
20 movement behavior guidelines for the early years supports the view that stakeholder (academic,
21 policymaker, practitioner, family) acceptance of the 24-hour approach is high, and successful public
22 health messaging of 24-hour movement behavior guidelines is a realistic objective^{26,27}. Third, the
23 approach would have been consistent with a number of other countries and the WHO guidelines which
24 were published in 2019. International consistency was prioritised by the Expert Working Group, and
25 supported by stakeholders during the consultations. Fourth, obesity prevention is high on the public
26 policy agenda in the UK and the need for a shift in how infants, toddlers, and pre-schoolers spend their
27 24 hours was emphasised as central to obesity prevention in the WHO ECHO reports in 2016 and

1 2017^{14,15}. Time spent in movement behaviors over 24 hours in the early years appears to be a major
2 driver of the obesity epidemic^{2,3,14,15,19}. Furthermore, shorter sleep duration in the pre-school years
3 predicts higher adiposity at school age^{28,29}. Thus 24-hour movement guidelines would have supported
4 new obesity strategies in the UK. Finally, an emerging body of evidence from Canada, Australia, and
5 Belgium shows that many infants, toddlers, and pre-schoolers do not meet the new 24-hour movement
6 behavior guidelines, and these behaviors may be socially patterned.³⁰⁻³⁴ As childhood obesity is highly
7 socially patterned in the UK and social patterning is increasing³³, there is a need for 24-hour movement
8 behavior guidelines in the UK in order to reduce social inequalities in health.

9
10 As the evidence base improves, guidelines will evolve, but guidelines are required now given the
11 importance of the 24-hour movement behaviors in the early years to child health and development, and
12 to the global public health and economic crisis caused by obesity and related NCDs^{8,14,15}. Gaps in the
13 evidence in the Under 5s should also be seen in the context of these behaviors later in childhood and
14 adolescence: there is a more substantial evidence base on the benefits of adequate physical activity and
15 sleep, and risks of some sedentary behaviors in school-age children³⁴⁻³⁷; levels of the behaviors in the
16 pre-school period are closely related to later levels in school-aged children, and time spent sedentary
17 increases steadily from the age of school entry. This contextual evidence complemented the evidence
18 on the health and developmental impact of the time spent in 24-hour movement behaviors and provided
19 impetus for recommendations for 24-hour movement guidelines for the Under 5s.

20
21 Some issues were beyond the scope of the Expert Working Group. In particular, the *content* of screen
22 time was not considered. There were also some gaps and weaknesses in the evidence base. First,
23 recommending precise amounts of all of the 24-hour movement behaviors was problematic. Precise
24 amounts/durations were included in draft recommendations where possible, but expert opinion and
25 other factors influenced these where appropriate (e.g. for consistency with international guidelines; need
26 for a time-specific guideline so that surveillance can take place; the need to provide a foundation for

1 future guidelines; guideline updates/upgrades are implicit in guideline production, and in the absence
2 of an initial 24-Hour Movement Guideline for the UK there may not be an update/upgrade). Second,
3 one component of the 24-hour day not measured/recognised by recent studies is standing. Since
4 standing was not measured in most studies, it does not appear in the literature and may be misclassified
5 in accelerometry studies. This misclassification may obscure associations with health outcomes, and
6 produce biases in estimates of the levels of these behaviors. For example, our unpublished data from
7 postural monitoring of pre-school children suggests that they typically spend around 3 hours per 24
8 hours standing, but this behavior may be misclassified as light intensity physical activity by
9 accelerometry. Finally, while TV and DVD were the main sources of screen time for the Under 5s, at
10 least until recently⁴⁰, there is a need for more evidence on the health and developmental impact of time
11 spent using newer devices which became widely available more recently. Some forms of modern
12 screen-based technology are potentially less harmful, and may bring greater benefits, than the kinds of
13 sedentary behavior used to inform the new draft recommendations.

14
15 The GRADE ADOLOPMENT process facilitated a rapid and inexpensive revision of 24-hour
16 movement guidelines from Canada and Australia to the UK. The work did not proceed to 24-hour
17 movement guidelines as intended by the Expert Working Group, the UK academic community, and
18 stakeholders. However, the evidence adaptation/ adoption processes undertaken clarified the complex
19 associations between time spent in the 24-hour movement behaviors and important health and
20 developmental outcomes, and the development process provided new insights into the impact of
21 physical activity, sedentary behavior and screen time on sleep outcomes in early life.

22

23 **ACKNOWLEDGEMENTS**

24 We acknowledge the help of the WHO, both for funding an updated literature review and appraisal
25 using GRADE methodology in February 2018, and for agreeing to share the literature search results
26 with the Under 5s Expert Working Group. We also thank the many stakeholders who took part in the
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8 Trust (107337/Z/15/Z).

9

10

1 **List of Tables**

2

3 Table 1 Tasks in the guideline development process using the GRADE-ADOLOPMENT approach

4 Table 2 Population, intervention/exposure, comparators, and outcomes (PICOs) used in the guideline
5 development process (*Could be presented as supplementary online material*)

6 Table 3 Choice of source guidelines from candidate guidelines

7 Table 4 Breakdown of exposure types for physical activity, sedentary behaviour, and sleep.

8 Table 5 Summary of evidence on the influence of time spent in sleep, sedentary behaviour, and
9 physical activity on health and developmental outcomes

10 Table 6 Draft recommendations made by the Expert Working Group

11 Table 7. The UK physical activity guidelines for the Under 5s, 2019.

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1 **Table 1. Steps and timeline in the guideline development process using the GRADE-**
 2 **ADOLOPMENT approach¹⁸**

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Tasks		Timeline
1	Decision and stakeholder approval of the 24-hour movement behaviour approach	January 2018
2	Identification of appropriate source guidelines	14 February 2018
3	Feedback and agreement on WHO literature search strategy (PICOS), and 'grading' of importance of outcomes	1 st March 2018
4	Review of GRADE Summary of Findings table from Canadian 2017 guideline	22 March 2018
5	Identification of appropriate source systematic reviews on sleep outcomes	22-26 March 2018
6	Assessment of need and decision for de novo systematic review on sleep outcomes	26 March 2018
7	Re-structuring the Canadian 2017 GRADE Summary of Findings table by outcome, movement behaviour and age group (infants, toddlers, pre-schoolers)	23 March – 13 June 2018
8	Inclusion of updated WHO systematic reviews to GRADE Summary of Findings table	29 March – 13 June 2018
9	Conducting de novo systematic review and evidence synthesis for the association of screen time, sedentary time and physical activity with sleep	17 April – 17 June 2018
10	Initial decision on adoption, adaptation and de novo creation of recommendations through consensus in April 2018	8 May 2018
11	Submission of progress report with a rationale as to whether and how the UK 2011 guidelines should change	15 May 2018

12	Final decision on adoption, adaptation and de novo creation of recommendations through Expert Group consensus	14-17 May 2018
13	Write-up of draft recommendations for scientific consensus meetings	7 June 2018
14	Add evidence from #10 to GRADE Summary of Findings table	17 June 2018
15	Revision of draft recommendations based on feedback at scientific consensus meeting	6 July – 5 September 2018
16	Submission of revised recommendations for UK-wide national consultation	6 September 2018
17	Revision of draft recommendations based on UK-wide national consultation	26 October 2018
18	Consideration of UK 24-Hour Movement Behaviour Guidelines for the Under 5s by the UK Health Departments (Chief Medical Officers)	30 November 2018

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Table 2 Choice of Source Guidelines from Candidate Guidelines, Adapted from Okely et al³

Criterion	Canadian Guideline 2017	Australian Guideline 2017	US Physical Activity Guideline for Americans 2018
Published in last 5 years	Yes	Yes	Not yet published as a guideline, just the evidence synthesis
Followed GRADE	Yes	Yes	No, but used an analogous process
Addressed Clear Questions	Yes	Yes	Yes, but not the same questions or range of questions required by the UK process
Assessed Harms/Benefits	Yes	Yes	No
Assessed Using AGREE	Yes	Yes	No
Suitable for Updating	Yes	Yes	Yes
Access to evidence tables and summaries	Yes	Yes	Yes
Had risk of bias assessment	Yes	Yes	Yes

Were integrated (24 hours)	Yes	Yes	yes
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Table 3 Basis of the Literature Searches and Evidence Syntheses: the PICOs (Population, Intervention/.Exposure, Comparator, Outcome)

Table 3A. PHYSICAL ACTIVITY

In children under 5 years of age what dose (i.e. volume, duration, frequency, pattern, type, and intensity) of physical activity, as measured by objective and subjective methods, is associated with favourable health indicators? (holistic definition of health applies)

Population: Apparently healthy children (i.e., general population, including overweight/obese) aged birth-59 months.

Intervention (Exposure):

- Objective (e.g. actigraphy, accelerometer) or subjective (e.g., proxy-report) measure of physical activity. Physical activity is defined as any bodily movement generated by skeletal muscles that results in energy expenditure above resting levels (>1.5 METs).
- “Prone position” or “tummy time” is considered an appropriate physical activity exposure in infants (up to 12 months of age).
- For experimental studies, interventions must target physical activity exclusively and not multiple health behaviours (e.g. both physical activity and diet) to provide clear evidence on the association between physical activity and the outcomes.

Comparator: Lower volumes, durations, frequencies, patterns, types and intensities of physical activity.

1 **Outcomes (Health indicators):**

2 *Critical:*

- 3 1. Adiposity
- 4 2. Motor development
- 5 3. Psychosocial health
- 6 4. Cognitive development
- 7 5. Fitness (cardiovascular and musculoskeletal)
- 8 6. Harms (i.e. injuries)

9 *Important:*

- 10 7. Skeletal health
- 11 8. Cardiometabolic health

12

13 **Table 3B SEDENTARY BEHAVIOR**

14

15 In children under 5 years of age what dose (duration, pattern, i.e. frequency and interruption), and
16 type of sedentary behavior, as measured by objective and subjective methods, is associated with
17 favourable health indicators?

18

19 **Population:** Apparently healthy children (i.e. general populations, including those with
20 overweight/obesity) aged birth-59 months.

21

22 **Intervention (Exposure):**

- 23 • Objective (e.g. accelerometry, direct observation) or subjective (e.g., proxy-report) measure of
24 sedentary behaviour time
- 25 • Sedentary behavior is defined as any waking behavior characterized by an energy expenditure of
26 ≤ 1.5 METs while in a sitting or reclining posture

- 1 • For infants, sedentary behavior is operationally defined as any waking behavior characterized by
- 2 low energy expenditure while restrained or when sedate.
- 3 • Time spent in the prone position (“tummy time”), and time spent being held without restraint are
- 4 not considered sedentary exposures.
- 5 • For experimental studies, interventions must target sedentary behavior exclusively and not
- 6 multiple health behaviours (e.g. both sedentary behavior and diet) to provide clear evidence on the
- 7 association between sedentary behavior and the outcomes.

8

9 **Comparator:** Higher durations, patterns (frequency, interruptions), and types of sedentary behaviors.

10

11 **Outcomes (Health indicators):**

12 *Critical:*

- 13 1. Adiposity
- 14 2. Motor development
- 15 3. Psychosocial health
- 16 4. Cognitive development
- 17 5. Injuries or harms

18 *Important:*

- 19 6. Skeletal health
- 20 7. Cardiometabolic health
- 21 8. Fitness (cardiovascular and musculoskeletal)

22

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24 **Table 3C SLEEP**

25

26 In children under 5 years of age what duration of sleep, as measured by objective and subjective
27 methods, is associated with favourable health indicators?

1 (preamble should mention healthy sleep habits as well)

2

3 **Population:** Apparently healthy children (i.e. general populations, including those with
4 overweight/obesity) aged birth-59 months.

5

6 **Intervention (Exposure):**

7 • Objective (e.g. polysomnography, actigraphy) or subjective (self-report, proxy-report) measures
8 of sleep duration.

9 • Sleep duration defined as activity monitor (e.g. accelerometer) “non-wear” time is not considered
10 a relevant exposure because this is not a valid measure of sleep.

11 • For experimental studies, interventions must target sleep exclusively and not multiple health
12 behaviours (e.g. both sleep and diet) to provide clear evidence on the association between sleep
13 and the outcomes.

14

15 **Comparator:** Lower sleep duration.

16

17 **Outcomes (Health indicators):**

18 *Critical:*

19 1. Emotional regulation

20 2. Cognitive development

21 3. Motor development

22 4. Growth

23 5. Adiposity

24 *Important:*

25 6. Cardiometabolic health

26 7. Physical activity and sedentary behaviours

27 8. Quality of life/well-being

1 9. Harms (i.e. injuries such as SIDS)

2

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4 **Table 3D INTEGRATED MOVEMENT BEHAVIORS**

5

6 In children under 5 years of age what are the relationships between each of the following
7 combinations of movement behaviors and health indicators?

8 • Sleep and sedentary behavior

9 • Sleep and PA

10 • Sedentary behavior and PA

11 • Sleep, sedentary behavior and PA

12

13 **Population:** Apparently healthy children (i.e. general population, including overweight/obese) aged
14 birth-59 months.

15

16 **Intervention (exposure):** The combination of two or three movement behaviors (i.e. sleep, sedentary
17 behavior, and physical activity) as defined previously

18

19 **Comparator:** Various levels and combinations of movement behaviors.

20

21 **Outcomes (Health indicators):**

22 *Critical:*

23 1. Adiposity

24 2. Motor development

25 3. Psychosocial health/emotional regulation

26 4. Cognitive development

27 5. Growth

28 6. Fitness (cardiovascular and musculoskeletal)

1 7. Harms(i.e. injuries)

2 *Important:*

3 8. Skeletal health

4 9. Cardiometabolic health

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1 **Table 4: Different Exposures by Type within the 24-Hour Movement Behavior Framework**

Physical Activity	Sedentary time	Sleep
Total Physical Activity	Screen time	Sleep duration (total daily sleep)
Light physical activity intensity	Evening screen time	Night time sleep duration
Moderate physical activity intensity	Device measured sedentary time	Sleep restriction
Moderate-to-vigorous physical activity intensity		Nap duration
Vigorous physical activity intensity		Increasing hours of sleep per bout
Active/Outdoor/Indoor/Exercise Play		Cortisol awakening response
Prone position		Sleep Trajectories
Outdoor PA (incl. bike riding, walking, active transport)		
Home/Leisure/extracurricular physical activity		
Aerobic physical activity		
Organised sport/sport participation		
Weight bearing activity		

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3

1 **Table 5. Summary of Evidence Quality, Quantity, and Generalisability**

Type of Evidence	Generalisability & Directions of Associations with Outcomes	Comments on Evidence
Physical Activity (PA)		
<p>Experimental/quasi experimental studies: 14 RCT (n 4,199); 3 cross-over trials (n 182); 11 non randomised controlled trials (n 1,654)</p> <p>Observational studies: 9 case control (n 2,404); 16 longitudinal (n 18,354;)63 cross-sectional (n 77,452)</p>	<p>High generalisability to UK-evidence largely from high-income western countries</p> <p>More PA is associated with improved: adiposity (infants); motor development (infants, toddlers, pre-schoolers); cognitive development (infants, pre-schoolers); fitness (pre-schoolers); bone/skeletal health (pre-schoolers); cardiometabolic health (pre-schoolers).</p>	<p>Evidence for specific amounts/types of PA not clear /conclusive for all populations, but clear that ‘more is better’.</p> <p>New evidence for benefits of higher intensity (MVPA) in pre-schoolers, and ‘dose’ of tummy-time in infants, and active/outdoor play.</p>
Sedentary Behavior (SB)		
<p>Experimental/quasi experimental studies: 2 RCT (n 482)</p> <p>Observational studies: 7 case-control (n 2,374); 34 longitudinal (n 78,100); 79 cross-sectional (n 167,946)</p>	<p>High generalisability to UK-as noted above for PA.</p> <p>More SB is associated with: higher adiposity (infants, toddlers, pre-schoolers); poorer motor development (toddlers), poorer cognitive development (infants,</p>	<p>Most of the evidence is on screen time (duration), mainly TV/DVD viewing.</p> <p>Evidence for specific amounts inconclusive,</p>

	toddlers, pre-schoolers); poorer psychosocial health (pre-schoolers).	but clear that ‘less is better’.
Sleep		
Experimental/quasi-experimental studies: 2 RCT/controlled trials (n 67); 3 cross-over trials (n 45) Observational studies: 3 case-control (n 810); 27 longitudinal (n 98,340); 48 cross-sectional (n 90,834)	High generalisability to UK-as noted above for PA. Shorter sleep duration is associated with: higher adiposity (pre-schoolers); poorer emotional regulation (infants, toddlers, pre-schoolers); poorer cognitive development (pre-schoolers).	Increased sleep duration within a currently recommended range seems to have little evidence of harm. Evidence largely on duration of sleep rather than related behaviours (e.g. sleep environment and routine). Evidence for specific amounts inconclusive

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2 **Table 6 The Draft UK 24-Hour Movement Behaviour Recommendations for the Under 5s, 2018**3 **Infants (less than 1 year)** For infants, a healthy 24 hours includes:

- 4 • Being physically active several times in a variety of ways, including interactive floor-based
5 activity *e.g. crawling. For infants not yet mobile, this includes at least 30 minutes of tummy*
6 *time^{Footnote1} spread throughout the day while awake (and other movements such as reaching*
7 *and grasping, pushing and pulling); more is better.*
- 8 • Minimising the amount of time restrained (e.g., in a pram or high chair). Screen time is not
9 recommended. When sedentary, engaging in pursuits such as reading and storytelling with a
10 caregiver is encouraged.
- 11 • 14 to 17 hours (for those aged 0-3 months) or 12 to 15 hours (for those aged 4-11 months) of
12 sleep, including naps.

13 **Toddlers (1-2 years)** For toddlers, a healthy 24 hours includes:

- 14 • At least 180 minutes spent in a variety of physical activities at any intensity, including active
15 and outdoor play, spread throughout the day—more is better.
- 16 • Not being restrained (e.g., in a pram/buggy or high chair) or sitting for extended periods
17 (except when sleeping). Sedentary screen time should be no more than 1 hour; less is
18 better^{Footnote2}. When sedentary, engaging in pursuits such as reading and storytelling with a
19 caregiver is encouraged.
- 20 • 11 to 14 hours of good-quality sleep^{Footnote3}, including naps, with consistent bedtimes and
21 wake-up times, avoiding use of screens for at least one hour before bed-time.

22

1 **Pre-schoolers (3-4 years)** For pre-schoolers, a healthy 24 hours includes:

- 2 • At least 180 minutes spent in a variety of physical activities spread throughout the day,
3 including active and outdoor play,—more is better; the 180 minutes should include at least 60
4 minutes of moderate-vigorous intensity physical activity (MVPA).
- 5 • Not being restrained (e.g. in a buggy or car seat) or sitting for extended periods. Sedentary
6 screen time should be no more than 1 hour; less is better^{Footnote2}. When sedentary, engaging in
7 pursuits such as reading and storytelling with a caregiver is encouraged.
- 8 • 10 to 13 hours of good-quality sleep^{Footnote3}, which may include a nap, with consistent
9 bedtimes and wake-up times, avoiding use of screens for at least one hour before bed-time.

10

11 **Footnote 1.** Tummy time may be unfamiliar to babies at first, but can be increased gradually-starting
12 from a minute or two at a time-as the baby becomes used to it Babies should not sleep on their
13 tummies.

14 **Footnote 2** The historical evidence on screen time was largely from studies of the duration of screen
15 time exposure to TV and DVD screens. These studies tend not to measure the type of content, nor the
16 nature of the child’s engagement with it. While it is generally assumed that the child is sedentary
17 during screen time, some research suggests this is not always the case. There was a lack of evidence
18 on the health and developmental impact of more recent screen-based technology, especially that
19 which involves or requires interaction with other individuals (e.g. family members). The Expert
20 Working Group felt that accompanied/interactive screen-time had less potential for harm and greater
21 potential for benefit than solitary or sedentary screen time

22 **Footnote 3** Good quality sleep is not excessively restless or broken by long periods of wake. Note
23 children normally have brief wakings during the night but learn to settle themselves back to sleep
24 within a few minutes.

25

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1 **Table 7 The UK 2019 Physical Activity Guidelines for the Under 5s**

2 **Infants.** Being physically active several times in a variety of ways, including interactive
3 floor-based activity e.g. crawling. For infants not yet mobile, this includes at least 30 minutes
4 of tummy time^{Footnote} spread throughout the day while awake (and other movements such as
5 reaching and grasping, pushing and pulling); more is better.

6
7 **Toddlers.** At least 180 minutes spent in a variety of physical activities at any intensity,
8 including active and outdoor play, spread throughout the day—more is better.

9
10 **Pre-Schoolers.** At least 180 minutes spent in a variety of physical activities spread
11 throughout the day, including active and outdoor play,—more is better; the 180 minutes
12 should include at least 60 minutes of moderate-vigorous intensity physical activity (MVPA).

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16 **Footnote.** Tummy time may be unfamiliar to babies at first, but can be increased gradually-starting
17 from a minute or two at a time-as the baby becomes used to it Babies should not sleep on their
18 tummies.

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