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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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1   **ABSTRACT**

2   **Background:** This paper summarises the approach taken to develop UK Chief Medical Officers'

3   (CMOs) Physical Activity Guidelines for the Under 5s, 2019.

4   **Methods:** The Grading of Recommendations Assessment, Development and Evaluation (GRADE)

5   Adaptation, Adoption, De Novo Development (ADOLOPMENT) approach was used, based on

6   guidelines from Canada and Australia, with evidence updated to February 2018. Recommendations

7   were based on associations between (a) time spent in sleep, sedentary time, physical activity and 10

8   health outcomes, and (b) time spent in physical activity and sedentary behavior on sleep outcomes

9   (duration, latency).

10 **Results:** For many outcomes more time spent in physical activity and sleep (up to a point) was

11 beneficial, as was less time spent in sedentary behavior. We present, for the first time, evidence in

12 GRADE format on behaviour type-outcome associations for infants, toddlers, and preschoolers.

13 Stakeholders supported all recommendations, but recommendations on sleep and screen time were not

14 accepted by the CMOs; UK guidelines will refer only to physical activity.

15 **Conclusions:** This is the first European use of GRADE-ADOLOPMENT to develop physical activity

16 guidelines. The process is robust, rapid and inexpensive, but the UK experience illustrates a number

17 of challenges which should help development of physical activity guidelines in future.

18

1 **INTRODUCTION**

2 The UK first published guidance on physical activity for the early years (birth-school-entry) in 2011[1].

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 day[1]. By 2018, there was a larger body of evidence on the benefits of physical

6 activity in the Under 5s than was available to inform 'Start Active, Stay Active'[2-7]. There has also been

7 a paradigm shift- physical activity is no longer seen in isolation from the other '24-hour movement

8 behaviors[2,8]' (sedentary behavior including screen time, and sleep, time spent standing). In a fixed 24-

9 hour day the time spent in one of these behaviors must inevitably influence the others, and by school

10 entry physical activity declines with age, and is displaced by time spent sedentary[9-11]. Sedentary time

11 continues to increase with age, producing further declines in physical activity. Although sleep

12 requirements naturally decrease with age, sleep duration is also affected by time spent in physical

13 activity and sedentary behavior[12,13]. These movement behaviors each influence health and development,

14 and the combination of behaviors also matters[2,7,8], so that evidence-based recommendations for the full

15 24-hour period can now be made.

16

17 The WHO Ending Childhood Obesity (ECHO) Reports[14,15] concluded that improving 24-hour

18 movement behaviors in the early years was central to prevention and treatment of obesity and related

19 non-communicable diseases (NCDs). The first evidence-based '24-Hour Movement Behaviour

20 Guidelines' for the early years were published in 2017 in Canada, Australia, and New Zealand[2,3] .

21 Evidence-based national guidelines on 24-hour movement behaviors were released in 2018 in South

22 Africa[16], and international guidance on physical activity, sedentary and sleep behaviors from the WHO

23 published in 2019[17]. This manuscript is aimed to describe the guideline development process for the

24 Under 5s in the UK 2017-2019, to illustrate the strengths and weaknesses of the process so that others

25 can learn from the UK experience, and to provide a more nuanced summary of the evidence base used

26 to develop the recommendations than has been presented to date. The UK guideline development

1 process was based on the principle that the most recent and relevant guidelines should be adapted so

2 that new UK guidelines could be developed relatively quickly and at low cost.

3 **METHODS**

4 The process was conducted in three phases. Phase 1 saw an initial web consultation to assess support

5 for the guideline update and take suggestions on format and content; the construction of Expert Working

6 Groups (for the Under 5s; for school-age children and adolescents; for adults; for older adults; for

7 sedentary behavior from age 5 to old age; for guideline communication and implementation); the

8 selection of international experts for each working group; formal evidence review and synthesis during

9 2018, and a website for national consultations on the new UK Chief Medical Officers (CMO, for

10 Scotland, Northern Ireland, Wales and England) guidelines

11 (http://www.bristol.ac.uk/sps/research/projects/current/physical-activity/). In Phase

12 2, draft recommendations were developed and circulated to participants attending two scientific

13 consensus meetings during June and July 2018. Draft recommendations were revised following

14 feedback from the scientific consensus meetings, and responses to end-user or stakeholder feedback

15 were provided. Phase 3 included further national online consultation on the draft recommendations,

16 and a final round of revision. The Expert Working Group then produced a technical report with

17 recommendations for the content and wording of new guidelines which were submitted to the CMOs

18 of Scotland, England, Wales, and Northern Ireland in November 2018 with recommendations as to what

19 the guidelines should contain. In the UK the guidelines are published by the Health Departments and

20 so they alone were responsible for accepting or rejecting these recommendations.

21

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

23 Phase 1 began with the formation of the Expert Working Group for the Under 5s at the end of 2017,

24 from a combination of open advertising/competition, and invitation. The aim was to have group

25 members, including early and mid-career academics, with the following characteristics: experience of

26 the UK Start Active Stay Active process 2009-2011; content expertise in the age groups for all three

27 behaviors (sleep, sedentary behavior, physical activity); expertise in guideline development

methodology; experience of other ongoing/recently completed Early Years physical activity guidelines. The Expert Working Group received feedback from a UK-wide online consultation (the first of three stages of consultation required in the UK process) in January 2018. This initial consultation supported a guideline update using the concept of 24-hour movement behaviors, emphasised the value of harmonisation with international guidelines, and recommended publication of a summary of the process in the peer-reviewed literature. The working group outlined a schedule of approximately monthly online meetings starting in January 2018, identified tasks and milestones required if the project was to be completed on time, and formed sub-groups for specific tasks. The group was represented on the wider Chairs Panel of UK Expert Working Groups (led by the University of Bristol) which also had monthly online meetings to guide and co-ordinate the work of the UK Expert Working Groups.

A number of practical and scientific considerations underpinned the guideline development work described in this manuscript. First, the work was based on the best (most recent, relevant, evidence-based) existing guidelines internationally. Thus, the starting point for the Under 5s was the 24-hour movement behavior approach[2,3], and this was approved in principle by the UK CMOs in early 2018. Second-and supported by national consultations- it was agreed that the UK draft recommendations should be as consistent as possible with the best available international guidance[2,3]. Implementing these decisions was possible with external support, in particular from a) the WHO guideline development group (up to February 2018), and b) international experts who led the South African and Australian processes. Implementing these early decisions was also possible because of Grading of Recommendations Assessment, Development and Evaluation (GRADE) Adaptation, Adoption, De Novo Development (ADOLOPMENT) approach[18]. This an evidence-based, and efficient (quick and low cost) process for developing guidelines. Recently, the Australian 24-Hour Movement Behaviour Guidelines were developed by the process of ADOLOPMENT of the Canadian Guidelines[3]. The UK Under 5s Expert Working Group therefore used the GRADE ADOLOPMENT approach.

1   **The GRADE ADOLOPMENT Process**

2   GRADE ADOLOPMENT involves a series of steps leading to adoption, adaptation, and/or de novo

3   development of an existing guideline. The first task of the Expert Working Group, guided by our

4   GRADE methodologist (AM) was to translate these steps into a series of tasks, summarised in brief

5   here, and in **Table 1.** The expert working group was responsible for making draft scientific

6   recommendations by the end of May 2018, for consultation (online and via two Scientific Consensus

7   Meetings attended mainly by academics and policymakers) in June and July 2018. The group then

8   responded to all points raised in this second consultation process and produced revised draft

9   recommendations taking account of scientific review and stakeholder feedback. This manuscript

10   focuses on the Expert Working Group responsibilities, up to the point where final recommendations

11   were made as to the content of the guidelines to the four UK CMOs in November 2018, and after all

12   feedback from stakeholders up to that point had been considered. The first major task was to agree on

13   the source guideline(s)[3,18] on which the new UK guideline should be based (Table 1, item 2). A search

14   for recent relevant guidelines had been carried out by the Bristol Co-ordinating Centre in 2017 and this

15   did not identify any recent relevant guidelines for the early years. We updated the Bristol search with

16   knowledge of the Canadian and Australian Early Years Guidelines[2,3] (published 20th November 2017)

17   and the ongoing South African and WHO Guidelines. In addition, the US Guideline Development

18   Process Evidence Synthesis became available in March 2018, though the US guideline was not

19   published until November 2018. The comparison of candidate guidelines against criteria for selecting a

20   source guideline is summarised in **Table 2,** and supported our judgement that our source guideline

21   would be the Canadian 24-Hour Movement Behaviour Guidelines for the Early Years

22   (https://csepguidelines.ca/early-years-0-4/)[2].

23

24   The second major task (**Table 1**, item 3) was to agree that the PICOs (Population,

25   Intervention/Exposure, Comparator, Outcomes) which had been used in the Canadian/Australian and

26   WHO systematic review/evidence synthesis (shared by WHO in February 2018) were appropriate to

27   our UK guideline update. The PICOs were agreed by the Expert Working Group and are summarised

1 in **Online Table 1.**The next major task (Table 1, items 4, 7-9) was to compile GRADE Summary of

2 Findings Tables for each of the target behaviors (time spent asleep, in sedentary behavior including

3 screen time, and in physical activity). **Table 3** gives an overview of the type and number of exposures

4 for the three 24-hour movement behaviors, which indicate that each 24-hour movement behavior is

5 assessed and reported in a number of ways in the literature. For example, 13 exposures for physical

6 activity were identified, three exposures for sedentary time, and seven exposures for sleep. The UK

7 guideline development process departed significantly from previous national and international

8 guidelines in that it was based on 'deconstructed' GRADE tables that summarised every distinct

9 combination of unique exposure type, outcome, and population group (age group). These UK

10 GRADE Tables (**Supplementary Table 2**) were derived from the source guideline GRADE Tables

11 but allowed greater clarity over exposure-outcome relationships to be obtained. For example, it was

12 possible to recommend that Toddlers and Pre-schoolers spend time in physically active play in the UK

13 because this was evident for both age groups using the GRADE table deconstructed by exposure type;

14 this was not evident from the original source GRADE tables.

15

16 A tenet of the GRADE ADOLOPMENT process is that a consensus on the balance of adoption,

17 adaptation, and *de novo* creation of recommendations is reached[3,18]. The *de novo* creation of a

18 recommendation based on sleep outcomes in the UK arose from the desire of the UK Expert Working

19 Group to go beyond the work done by guideline development groups in Canada, Australia, South Africa,

20 and the WHO. Previous 24-hour movement behavior guidelines only considered sleep duration as an

21 *exposure*. This was considered an important omission by UK stakeholders, as sleep is important to

22 health and development[6,19,20]. An additional systematic review was therefore undertaken, using sleep as

23 an *outcome* (e.g. sleep duration, latency of sleep onset, sleep disturbance) with physical activity and

24 sedentary behavior as the exposure variables (**Table 1**; items 6, 10). The details of this work are beyond

25 the scope of the current manuscript, but are reported elsewhere[21]. In the UK the consensus over the

26 balance of adoption and adaptation of the Canadian guideline was achieved at two online meetings of

27 the Expert Working Group in April 2018. Recommendations and an accompanying draft technical

1 report (explaining the basis of the recommendations) were shared with the stakeholders (**Table 1**, items

2 12-13) using an online consultation in June and July 2018, and face–to-face consultation in the form of

3 the two Scientific Consensus meetings noted above. Expert Working Group recommendations in the

4 UK were therefore ready by the summer of 2018.

5 **RESULTS**

6 There was consistent evidence that time spent in physical activity, sleep, and sedentary behavior was

7 associated with a range of health and developmental outcomes in the Under 5's (**Table 4),** allowing the

8 Expert Working Group to make 24-hour movement behavior recommendations to the CMOs. The *de*

9 *novo development* part of the process produced a recommendation on the avoidance of screens before

10 bedtime. This new recommendation was based on observational evidence that screen use before bedtime

11 was associated with shorter sleep duration, more night wakening, and longer sleep latency (delayed

12 onset of sleep) in Toddlers, and later bedtimes in Pre-schoolers[21] plus mechanistic studies on the impact

13 of light exposure on sleep. Three main adaptations to the Canadian and Australian guidelines were

14 recommended to the CMOs:

15   1. A recommendation for *active and outdoor play* for Toddlers and Pre-Schoolers, since that was

16   one of the specific physical activity exposures for which evidence was available when the

17   source GRADE Tables were deconstructed as part of the UK process. This type of physical

18   activity was not referred to specifically in the Canadian or Australian guidelines, but has many

19   benefits, few risks[22-24] and was valued highly by the Expert Working Group and by

20   stakeholders.

21   2. A specific recommendation for moderate-to-vigorous-intensity physical activity (MVPA) was

22   made, which was previously referred to as 'energetic play' in the Canadian and Australian

23   guidelines. Inclusion of MVPA was possible because specific evidence of benefit was identified

24   in the deconstructed GRADE tables from studies with MVPA as the exposure in Pre-schoolers.

25   Stakeholders in the second stage of the consultation also welcomed the continuity between the

26   MVPA recommendation for pre-schoolers and that for older children.

3. A relaxation of screen time guidance for Toddlers in the UK: 'screen time should be no more than one hour', compared to that in Canadian and Australian guidelines which suggested that 'For those younger than two years screen time is not recommended'. 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 (versus no exposure) may be seen as more helpful and realistic to modern families.

The UK recommendations derived from the GRADE ADOLOPMENT process are summarised in **Table 5.** In December 2018, the UK CMOs decided to not include the recommendations for sedentary behavior, sleep, and screen time in relation to sleep outcomes, and the final UK 2019 guidelines will therefore be based on physical activity only (see **Table 6).**

DISCUSSION

The 2019 UK guidelines are an advance on the UK 2011 version as they include more evidence based and more quantitative recommendations, indicating an evolution towards guidelines which are both more scientifically robust and more suitable for future surveillance (though the reliability and validity of existing surveillance methods are unclear[25]). Since 24-hour movement behavior guidelines were not adopted in the UK, it is worth a brief restatement of the rationale for these. First, the approach was rigorous, and the evidence base for sedentary behavior and sleep recommendations was not weaker than that for physical activity recommendations. Second, UK stakeholders supported the 24-hour approach. Evidence from the other countries with recently published 24-hour movement behavior guidelines shows that stakeholder (academic, policymaker, practitioner, family) acceptance of the 24-hour approach is high, and successful public health messaging of 24-hour movement behavior guidelines is realistic[26,27]. Third, the approach would have been consistent with a number of other countries and the

1   WHO guidelines published in 2019. Fourth, obesity prevention is high on the public policy agenda in

2   the UK and elsewhere and the need for a shift in how the Under 5s spend their 24 hours is central to

3   obesity prevention according to the WHO[14,15]: the movement behaviors in early life are major drivers

4   of the obesity epidemic[2,3,19,28,29]. Finally, emerging evidence suggests that many Infants, Toddlers, and

5   Pre-schoolers do not meet the new 24-hour movement behavior guidelines, and non-compliance with

6   at least some of the guidelines may vary markedly by socio-economic status.[30-34] As childhood obesity

7   is highly socially patterned in the UK and social patterning is increasing[33], there is a need for 24-hour

8   movement behavior guidelines in the UK to help reduce social inequalities in health.

9

10   As the evidence base improves, guidelines will evolve further. Guidelines are required now given the

11   importance of the 24-hour movement behaviors in the early years to child health and development[8,14,15].

12   Gaps in the evidence in the Under 5s should also be seen in the context of these behaviors later in

13   childhood and adolescence: there is a more substantial evidence base on the benefits of adequate

14   physical activity and sleep, and risks of some sedentary behaviors in school-age children [34-37]; levels of

15   these behaviors in the pre-school period are closely related to later levels in school-aged children, and

16   time spent sedentary increases steadily after school entry. Some issues were beyond our scope. In

17   particular, the *content* of screen time was not considered. There were also gaps and weaknesses in the

18   evidence base. First, recommending precise amounts of all of the 24-hour movement behaviors was

19   problematic. Second, time spent standing was not measured in most studies, it does not appear in the

20   literature and may be misclassified in accelerometry studies. This misclassification may obscure

21   associations with health outcomes, and produce biases in estimates of the levels of these behaviors. Our

22   unpublished data from postural monitoring of pre-school children suggests that they typically spend

23   around 3 hours per 24 hours standing. Third, while TV and DVD were the main sources of screen time

24   for the Under 5s, at least until recently[40], there is a need for more evidence on the impact of time spent

25   using newer devices which have become more widely available recently: some forms of modern screen-

26   based technology are potentially less harmful, and may bring greater benefits, than the kinds of

27   sedentary behavior used to inform the 2019 UK recommendations.

1   Finally, there are some limitations in the ADOLOPMENT process which are especially problematic for

2   movement behavior guidelines. GRADE was originally intended for clinical research evidence, in

3   particular RCTs. This methodology is less applicable to evidence from public health. GRADE

4   methodology currently assigns an initial rating to each study design (high for RCT, low for

5   observational studies – including longitudinal, cross-sectional, and even systematic reviews of

6   observational studies). This rating is then modified (up or down) according to the risk of bias,

7   inconsistency, indirectness, imprecision, publication bias, dose-response relationship, residual

8   confounding or the size of the magnitude of any associations[41,42] GRADE methodology therefore

9   downgrades evidence from study types which would widely be regarded as highly informative and

10   entirely appropriate to understanding relationships between movement behaviors and health, e.g. well-

11   conducted longitudinal studies. This meant that UK recommendations and guidelines were rated as

12   very/low quality in GRADE terms. In future this may be less of a problem for movement behavior

13   guideline development as GRADE methodology is being adapted to other kinds of evidence

14   (https://www.gla.ac.uk/researchinstitutes/healthwellbeing/resea

15   rch/mrccsosocialandpublichealthsciencesunit/programmes/policy/

16   evidencesynthesis/grade/#/collaborators).

17   In summary, the UK guideline development experience provides novel insights which should be

18   useful in the development of future movement behavior guidelines. First, an efficient and rigorous

19   process exists for developing guidelines (GRADE ADOLOPMENT), and this could be used more

20   widely, despite its limitations. Second, there are risks associated with developing guidelines when

21   they are not owned by the guideline developers, with the UK experience likely to be of relevance to

22   many others in future. The fact that ownership of the guidelines resided with government in the UK

23   both delayed the publication of the guidelines (by more than a year), and greatly altered the guideline

24   content. Third, the UK experience showed that the effort made in deconstructing the original source

25   GRADE Tables made a meaningful difference to adapting the source guidelines and so was

26   worthwhile: novel recommendations could be made in relation to physically active play and MVPA.

1 Finally, the UK process produced the first evidence-based recommendations for physical activity and

2 sedentary behavior with sleep *as an outcome*.

3

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21 **List of Tables**

1   Table 5 Draft recommendations made by the Expert Working Group

2   Table 6 The UK physical activity guidelines for the Under 5s, 2019.

3   **Table 1. Steps in the guideline development process using GRADE-ADOLOPMENT[18]**

4

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	1st 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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4 **Table 2 Choice of Source Guidelines from Candidate Guidelines, Adapted from Okely et al[3]**

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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3 **Table 3: 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	
Moderate physical activity intensity	Device measured sedentary time	Night time sleep duration
		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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1   **Table 4.** **Summary of Evidence Quality, Quantity, and Generalisability**

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

	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 behaviors (e.g. sleep environment and routine). Evidence for specific amounts inconclusive

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Table 5 The UK 24-Hour Movement Behaviour Recommendations for the Under 5s, 2018

Infants (less than 1 year) For infants, a healthy 24 hours includes:

- Being physically active several times in a variety of ways, including interactive floor-based activity *e.g. crawling. For infants not yet mobile, this includes at least 30 minutes of tummy time[Footnote1] spread throughout the day while awake (and other movements such as reaching and grasping, pushing and pulling)*; more is better.

- Minimising the amount of time restrained (e.g., in a pram or high chair). Screen time is not recommended. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.

- 14 to 17 hours (for those aged 0-3 months) or 12 to 15 hours (for those aged 4-11 months) of sleep, including naps.

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

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

- Not being restrained (e.g., in a pram/buggy or high chair) or sitting for extended periods (except when sleeping). Sedentary screen time should be no more than 1 hour; less is better[Footnote2]. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.

- 11 to 14 hours of good-quality sleep[Footnote3], including naps, with consistent bedtimes and wake-up times, avoiding use of screens for at least one hour before bed-time.

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[Footonote3], 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   **Footnote 1**. Tummy time may be unfamiliar to babies at first, but can be increased gradually-starting

11   from a minute or two at a time-as the baby becomes used to it Babies should not sleep on their

12   tummies.

13   **Footnote 2** The historical evidence on screen time was largely from studies of the duration of screen

14   time exposure to TV and DVD screens. These studies tend not to measure the type of content, nor the

15   nature of the child's engagement with it. While it is generally assumed that the child is sedentary

16   during screen time, some research suggests this is not always the case. There was a lack of evidence

17   on the health and developmental impact of more recent screen-based technology, especially that

18   which involves or requires interaction with other individuals (e.g. family members). The Expert

19   Working Group felt that accompanied/interactive screen-time had less potential for harm and greater

20   potential for benefit than solitary or sedentary screen time

21   **Footnote 3** Good quality sleep is not excessively restless or broken by long periods of wake. Note

22   children normally have brief wakings during the night but learn to settle themselves back to sleep

23   within a few minutes.

24

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1 **Table 6 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 **Toddlers.** At least 180 minutes spent in a variety of physical activities at any intensity,

7 including active and outdoor play, spread throughout the day—more is better.

8 **Pre-Schoolers**. At least 180 minutes spent in a variety of physical activities spread

9 throughout the day, including active and outdoor play,—more is better; the 180 minutes

10 should include at least 60 minutes of moderate-vigorous intensity physical activity (MVPA).

11 **Footnote.** 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.

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