Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods

We identified the potentially eligible studies for inclusion in the pooled analysis through the following methods: 1) an updated literature search of a 2017 review;[1] 2) two previously published systematic reviews of similar scope;[2,3] and 3) personal communication with researchers within our networks.

Methodology of the updated literature search

We performed an updated literature search in August 2022 as part of a broader review to update Kuzik and colleagues' work[1] for examining evidence on the relationships between meeting the WHO guidelines or the composition of 24-hour movement behaviours and health and development in children aged 2-5 years (PROSPERO registration no. CRD42020207953). Six electronic databases (MEDLINE, APA PsycINFO, SPORTDiscus, and the SCI-EXPANDED and SSCI indexes) were searched on the Ovid multi-database platform. The searches were limited to articles published in 2015 and later, and to English, French, German, Spanish, Portuguese, Arabic, Russian and Chinese languages. Below is an example of search strategy based on Ovid MEDLINE and APA PsycINFO search:

1. Physical Activity.mp. or exp Exercise/ or exp Exercise Movement Techniques/ or exp Exercise Therapy/ or Physical Exertion/ or exp "Physical Education and Training"/ or exp Sports/ or (sport$ or bicycl$ or swim$ or walk$ or run$ or jog$).tw,kf. or (physical$ adj2 activ$).tw,kf. or (aerobic adj2 (train$ or active$)).tw,kf. or ("Play and Playthings"/ and (activ* or outdoor*).tw,kf.) or ((activ* or outdoor*) adj3 play*).tw,kf. or playground*.tw,kf. or (active.ti. and (space* or behavio?r* or transport* or commut* or neighbo?rhood* or park* or game* or gaming or lifestyle).mp.) or (active adj3 (space* or behavio?r* or transport* or commut* or neighbo?rhood* or park* or game* or gaming or lifestyle)).tw,kf.
2. Sedentary Lifestyle/ or (sedentary or inactiv* or (lack adj2 activity)).tw,kw. or ((low adj3 energy expend*) or physical* inactiv*).tw,kw. or ((chair or stroller or car or automobile* or auto or motor vehicle* or bus or indoor* or in-door or computer) adj3 time).tw,kw. or sitting.tw,kw. or Television/ or Video Games/ or Software/ or Videodisc Recording/ or Cartoons as Topic/ or Motion Pictures as Topic/ or exp Internet/ or exp Computers, handheld/ or Communications Media/ or Mass Media/ or (television or screentime or ((screen or computer) adj3 time) or ((watch* or view*) adj2 (dvd* or video*)) or screen media or social media or video gam* or videogam* or computer gam* or electronic gam*).tw,kw. or (Smartphone* or ipad or apps or app or mobile applications).tw,kw. or screen based entertainment.tw,kw.
3. sleep.mp.
4. 1 and 2 and 3
5. (((24 hour or 24 h or 24 hr or 24hr or 24h or twenty four hour or integrated or combined or daily) adj2 (movement behaviour* or movement behavior* or movement guideline*)) or healthy day).ti,ab,kf.
6. (4 or 5) and (adher* or achiev* or complia* or meet* or met or exceed* or fulfil* or measur* or report card* or proportion or compositon*).ti,ab,kf.
7. limit 6 to ("preschool child (2 to 5 years)" or "child (6 to 12 years)")
8. 6 and (pre-school* or preschool* or early childhood or "ages 2").tw,kf.
9. 7 or 8
10. limit 9 to (english or french or spanish or arabic or russian or chinese or portuguese)
11. limit 10 to (journal article or published erratum or "retraction of publication")
12. limit 11 to yr="2015 -Current"
13. physical activity/ or exp exercise/ or activity level/ or movement therapy/ or dance therapy/ or mind body therapy/ or energy expenditure/ or physical education/ or exp sports/ or (sport* or bicycl* or swim* or walk* or run* or jog*).tw,id. or (physical* adj2 activ*).tw,id. or (aerobic adj2 (train* or active*)).tw,id. or ((childhood play behavior/ or childhood play development/ or games/ or recreation/) and (activ* or outdoor*).tw,id.) or ((activ* or outdoor*) adj3 play*).tw,id. or playgrounds/ or playground*.tw,id. or (active.ti. and (space* or behavio?r* or transport* or commut* or neighbo?rhood* or park* or game* or gaming or lifestyle).tw,id.) or (active adj3 (space* or behavio?r* or transport* or commut* or neighbo?rhood* or park* or game* or gaming or lifestyle)).tw,id.
14. (sedentar* or ((low adj3 energy expend*) or physical* inactiv*) or ((chair or stroller or car or automobile* or auto or motor vehicle* or bus or indoor* or in-door or computer) adj3 time) or sitting or ((television adj watch*) or tv watch* or cartoon*)).tw,id. or television viewing/ or (television or screentime or ((screen or computer) adj3 time) or ((watch* or view*) adj2 (dvd* or video*)) or screen media or social media or video gam* or videogam* or computer gam* or electronic gam* or gaming).tw,id. or screen based entertainment.tw,id. or exp Social Media/ or exp Mobile Devices/ or (smartphone* or smart phone* or cell phone* or mobile phone* or small screen*).tw,id. or (texting or text messag* or app or apps or mobile applications).tw,id. or (iphone* or ipad* or ipod* or tablet* or laptop*).tw,id. or bed rest.tw,id.
15. sleep.mp.
16. 13 and 14 and 15
17. (((24 hour or 24 h or 24 hr or 24hr or 24h or twenty four hour or integrated or combined or daily) adj2 (movement behaviour* or movement behavior* or movement guideline*)) or healthy day).mp.
18. (16 or 17) and (adher* or achiev* or complia* or meet* or met or exceed* or fulfil* or measur* or report card* or proportion or compositon*).mp.
19. limit 18 to (160 preschool age or 180 school age)
20. 18 and (pre-school* or preschool* or early childhood or "ages 2").mp.
21. 19 or 20
22. limit 21 to (english or french or spanish or arabic or russian or chinese or portuguese)
23. limit 22 to ("erratum/correction" or journal article)
24. 23 or (22 and retraction.ti.)
25. limit 24 to yr="2015 -Current"
26. 12 use medal
27. 25 use psyh
28. 26 or 27
29. remove duplicates from 28
30. 29 use medall
31. 29 use psyc

All records were downloaded and imported into a reference manager software, where duplicates were removed before being uploaded to Covidence systematic review software for further screening. All records were independently assessed for eligibility by two reviewers, with any discrepancies resolved through discussion or by involving a third reviewer to reach a decision. Studies were considered eligible for inclusion if: (1) participants were children aged 2–5 years; (2) there was one or more assessment of each 24-hour movement behaviours (physical activity, sedentary behaviour [including screen time] and sleep); and (3) they examined either meeting vs. not meeting 24-hour movement guidelines or conducted compositional analyses exploring the 24-hour time-use composition of

movement behaviours. After removing duplicates, a total of 785 unique records were screened, with 41 articles meeting the eligibility criteria for inclusion. Of these, seven articles that were not already identified in the previous reviews[2,3] met the initial data inclusion criteria (i.e., involving children aged 3.0 to 4.9 years and including accelerometry measures of physical activity and parent/caregiver reports of screen time and sleep duration) for this pooled analysis (see eTable 1).

eTable 1. List of articles/studies that met initial data inclusion criteria for pooled analyses.

Authors & Publication Year	Country	Study/Project name	Sources			Included in pooled analysis?		
			Previous. reviews[2,3]	Our updated review	Personal communication	Yes	No	Reasons for not including
Aadland et al. 2020[4]	Norway	Active Learning Norwegian Preschool(er)s (ACTNOW)			/	/		
Berglind et al. 2018[5]	Sweden	PRIMROSE	/				/	Unable to share the data due to ethical reasons.
Carson et al. 2017[6]	Canada	Physical Activity and Cognition in Early Childhood (PACE)			/	/		
Carson et al. 2019[7]	Canada	Canadian Healthy Infant Longitudinal Development Study (CHILD)	/				/	Unable to share the data due to ethical reasons.
Chaput et al. 2019[8]	Canada	Canadian Health Measures Survey (CHMS)	/			/		
Christian et al. 2022[9]	Australia	Play Spaces and Environments for Children's Physical Activity (PLAYCE)		/		/		
Cliff et al. 2017[10]	Australia	Preschool Activity, Technology, Health, Adiposity, Behavior and Cognition (PATH-ABC)	/			/		
De Craemer et al. 2018[11]	Belgium	ToyBox-Study	/			/		
De Craemer et al. 2020[12]	Belgium	ToyBox-Study		/		/		
de Lucena Martins et al. 2021[13]	Brazil	The Movement´s Cool Project		/		/		
Decraene et al. 2021[14]	Belgium, Bulgaria, Germany, Greece, Poland, and Spain	ToyBox-Study		/		/		*Note.* Only included data from Belgium due to lack of accelerometer

Authors & Publication Year	Country	Study/Project name	Sources			Included in pooled analysis?		
			Previous. reviews[2,3]	Our updated review	Personal communication	Yes	No	Reasons for not including
								data from the other countries.
Delisle Nyström et al. 2020[15]	Sweden	International Study of Movement Behaviours in the Early Years (SUNRISE)	/			/		
Draper et al. 2020[16]	South Africa	International Study of Movement Behaviours in the Early Years (SUNRISE)	/			/		
Guan et al. 2020[17]	China	N/A	/				/	Unable to share the data due to ethical reasons.
Hinkley et al. 2020[18]	Australia	Healthy Active Preschool and Primary Years (HAPPY)	/			/		
Hossain et al. 2021[19]	Bangladesh	International Study of Movement Behaviours in the Early Years (SUNRISE)		/		/		
Kim et al. 2022[20]	Vietnam	International Study of Movement Behaviours in the Early Years (SUNRISE)		/		/		
Kuzik et al. 2020[21]	Canada	Parent-Child Movement Behaviours and Pre-School Children's Development Study			/	/		
Leppänen et al. 2019[22]	Finland	Increased Health and Wellbeing in Preschools (DAGIS)	/			/		
McNeill et al. 2020[23]	Australia	Preschool Activity, Technology, Health, Adiposity, Behavior and Cognition (PATH-ABC)	/			/		
Meredith-Jones et al. 2019[24]	New Zealand	Prevention of Overweight in Infancy (POI)	/			/		

Authors & Publication Year	Country	Study/Project name	Sources			Included in pooled analysis?		
			Previous. reviews[2,3]	Our updated review	Personal communication	Yes	No	Reasons for not including
Tanaka et al. 2020[25]	Japan	International Study of Movement Behaviours in the Early Years (SUNRISE)	/			/		
Taylor et al. 2021[26]	New Zealand	Prevention of Overweight in Infancy (POI)		/		/		
Vale et al. 2020[27]	Portugal	Preschool Physical Activity, Body Composition and Lifestyle Study (PRESTYLE)	/			/		
Wilken et al. 2013[28]	United States Affiliated Pacific region	Children's Healthy Living (CHL) Program			/	/		

eTable 2. Methodological information of the included studies.

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
ACTNOW[4]	Norway; 2019-2020; 674	Accelerometer: Actigraph (GT3X+) Placement site: Right hip Registration period protocol: 24-hour protocol for seven consecutive days (excluding water-based activities)	Measured via parent-report using the following question: On a 24 hour period in the past week, how much time did the child spend using any electronic screen device such as a smart phone, tablet, video game, or watch television or movies, videos on the internet while they were sitting or lying down?	Measured via parent-report using the following question: How many hours of sleep does the child get in a typical 24-hours day (including naps)?
CHL[28]	• American Samoa; 2012; 102 • Commonwealth of Northern Mariana Island; 2012; 74 • Federated States of Micronesia; 2012; 52 • Guam; 2012; 69 • United States (Alaska, Hawaii); 280	Accelerometer: Actical (Z series) Placement site: Non-dominant wrist Registration period protocol: 24-hour protocol for seven consecutive days (including water-based activities)	Measured via parent-report using the following questions (separately for weekdays and weekend days; maximum 7 hours): • On usual day, how long on average a day does your child spend playing inactive video games? • On usual day, how long on average a day does your child spend watching Television and/or videos/DVD?	Measured via parent-report using the following question: How long on average (in hours) of sleep does your child get in a 24 hour period? (at night and in naps)
CHMS[8]	Canada; Cycles 2 (2009-2011), 3 (2012-2013) and 4 (2014-2015); 850	Accelerometer: Actical Placement site: Right hip Registration period protocol: Waking-hour protocol for	Measured via parent-report using the following questions: On average, how many hours a day the child spends:	Measured via parent-report using the following question: How many hours does your child usually spend sleeping in

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	**Sedentary screen time**	**Sleep duration**
		seven consecutive days (including water-based activities)	• Watching TV or videos or playing video games • On a computer Response categories: Cycle 2: 1. None 2. <1 hr 3. 1–2 hrs 4. 3–4 hrs 5. 5–6 hrs 6. ≥7 hrs Cycles 3 and 4: 1. None 2. <1 hr 3. 1– <3 hrs 4. 3– <5 hrs 5. 5– <7 hrs 6. ≥7 hrs *For cycle 2, the average daily screen time was derived using the mid-point of the response category. For cycles 3 and 4, the same midpoints applied in cycle 2 were assigned to each of the respective categories for consistency.	a 24-hour period, excluding time spent resting?
DAGIS[22]	Finland; 2015-2016; 456	Accelerometer: Actigraph (wGT3X-BT) Placement site: Right hip	Measured via parent-report in a 7-day diary using the following questions:	Measured via parent-report bed and wake-up times using a 7-day diary

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
		Registration period protocol: 24-hour protocol for seven consecutive days (excluding water-based activities)	Did your child do any of the following activities today in sitting or being still (Yes/No) and for how long? • Television viewing • DVDs or videos watching • Tablet computer or smart phone use • Computer use or playing computer games	
HAPPY[18]	Australia; 2008-2009; 481	Accelerometer: Actigraph (GT1M) Placement site: Right hip Registration period protocol: Waking-hour protocol for eight consecutive days (excluding water-based activities)	Measured via parent-report on the amount of time their child usually spend in each screen-based behaviours during a typical week (separately for weekdays and weekend days): • TV/videos/DVDs • Playstation/Nintendo/X-Box/Gameboy/computer games • Wii/Eye Toy • Computer/internet (excluding games)	Measured via parent-report using the following questions: • How many hours per night does your child usually sleep at the moment? • How many hours does your child usually sleep/nap for during the day at the moment?
PACE[7]	Canada; 2015-2016; 62	Accelerometer: Actigraph (wGT3X-BT) Placement site: Right hip Registration period protocol: Waking-hour for seven consecutive days (excluding water-based activities)	Measured via parent-report using the following questions (separately for weekdays and weekend days): • On average, how much time per day does your child watch television, videos, or DVDs on a television, computer, or portable device?	Measured via parent-report using the following questions: • On average, how long does your child usually sleep in total per night at the moment? • On average, how long does your child usually

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
			• On average, how much time per day does your child play video/computer games on devices such as a learning laptop, leapfrog leapster, computer, laptop, tablet, cell phone, the internet, Playstation, XBOX?	nap in total during the day at the moment?
PATH-ABC[10,23]	Australia; 2015; 213	Accelerometer: Actigraph (GT3X+) Placement site: Right hip Registration period protocol: 24-hour protocol for seven consecutive days (excluding water-based activities)	Measured via parent-report on the amount of time their child usually spend in each screen-based behaviours during a typical week (separately for weekdays and weekend days): • TV programs/ movies/ Internet clips on traditional devices (e.g., TV/DVD) • TV programs/ movies/ Internet clips on other devices (e.g., Tablet/ IPad, DVD in car, Computer, Laptop, Handheld-mobile phone etc.) • Games/Apps on portable/handheld devices (e.g., Tablet, IPad, mibile phone, handheld game system (Nintendo DS), Ipod) • Console Games (non-active) on Console game system (e.g., Playstation, Xbox)	Measured via parent-report using the following question: How many hours per night does your child usually sleep at the moment?

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
PLAYCE[9]	Australia; 2015-2017; 807	Accelerometer: Actigraph (GT3X+) Placement site: Right hip Registration period protocol: Waking-hour protocol for seven consecutive days (excluding water-based activities)	Measured via parent-report on the amount of time their child usually spend in sedentary screen activities during a typical week over the last month (separately for weekdays and weekend days): • TV/DVDs • Games consoles – standard • Computer • Tablet • Smartphone	Measured via parent-report using the following question: About how many hours and minutes does your child sleep in total: a) during the night?; b) during the day?
POI[24,26]	New Zealand; 2013-2016; 114	Accelerometer: Actical Placement site: Right hip Registration period protocol: 24-hour protocol for seven consecutive days	Measured via parent-report on the frequency (per week) and duration (each time) their child usually spend on each screen media: • TV (including free to air, cable and online streaming) • DVDs/videos • Computers/laptops for games • Passive games consoles (including handheld) • Mobile phone or tablets for playing games	Measured via parent-report using the following questions (separately for weekdays and weekend days): • What time does your child usually fall asleep at night? • What time does your usually wake up to start the day?
PRESTYLE[27]	Portugal; 2009-2015; 419	Accelerometer: Actigraph (GT1M) Placement site: Right hip Registration period protocol: Waking-hour protocol for seven consecutive days	Measured via parent-report using the following question (separately for weekdays and weekend days): How many hours does your child usually watch TV, use computer for activities or electronic games?	Measured via parent-report using the following question (separately for weekdays and weekend days): How many hours of sleep does your child usually have during the night?

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
		(excluding water-based activities)		
Parent-Child Movement Behaviours and Pre-School Children's Development Study[21]	Canada; 2018; 76	Accelerometer: Actigraph (wGT3X-BT) Placement site: Right hip Registration period protocol: 24-hour protocol for seven consecutive days (excluding water-based activities)	Measured via parent-report using the following questions (separately for weekdays and weekend days): • On average, how much time per day does your child watch television, videos, or DVDs on a television, computer, or portable device? • On average, how much time per day does your child play video/computer games on devices such as a learning laptop, leapfrog leapster, computer, laptop, tablet, cell phone, the internet, Playstation, XBOX?	Measured via parent -report using the following questions: • On average, how long does your child usually sleep in total per night at the moment? • On average, how long does your child usually nap in total during the day at the moment?
SUNRISE[15,16,19,20,25,29]	• Australia; 2018-2019; 41 • Bangladesh; 2019; 45 • Brazil; 2018; 43 • Canada; 2018-2019; 83 • China; 2018; 127 • Hong Kong; 2019; 85 • India; 2020; 43 • Indonesia; 2018-2020; 96 • Iran; 2022; 55 • Japan; 2018-2019; 61 • Malawi; 2022; 54 • Malaysia; 2019; 94 • Mongolia; 2021-2022; 51 • Morocco; 2019-2021; 87 • Nigeria; 2021; 75	All countries except Canada: Accelerometer: Actigraph (GT3X+, wGT3X+, wGT3X-BT) Placement site: Right hip Registration period protocol: 24-hour protocol for four/five consecutive days (excluding water-based activities) Canada: Accelerometer: Actical	All countries: Measured via parent/caregiver-report using the following question: On a 24 hour period in the past week, how much time did the child spend using any electronic screen device such as a smart phone, tablet, video game, or watch television or movies, videos on the internet while they were sitting or lying down?	Brazil, Canada, China, Papua New Guinea, South Africa: Measured via parent/caregiver-report using the following question: How many hours of sleep does the child get in a typical 24-hours day (including naps)? Other countries: Measured via parent/caregiver-report typical bed, wake and nap times

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
	• Pakistan; 2020; 77 • Papua New Guinea; 2018; 70 • Russia; 2020-2021; 52 • South Africa; 2018; 74 • Sri Lanka; 2019; 56 • Sweden; 2019; 81 • Tanzania; 2022; 83 • Vietnam; 2019-2020; 112	Placement site: Right hip Registration period protocol: 24-hour protocol for four consecutive days (excluding water-based activities)		
The Movement's Cool Project[13]	Brazil; 2019-2020; 93	Accelerometer: Actigraph (wGT3X) Placement site: Right hip Registration period protocol: Waking-hour protocol for seven consecutive days (excluding water-based activities	Measured via parent-report using the following question (separately for weekdays and weekend days): How many hours does your child usually watch TV, use computer, smartphones or electronics games?	Measured via parent -report using the following question (separately for weekdays and weekend days): How many hours of sleep does your child usually have during the night?
ToyBox-Study[11,12,14]	Belgium; 2012; 550	Accelerometer: ActiGraph (GT1M, GT3X and GT3X+) Placement site: Right hip Registration period protocol: Waking-hour protocol for six consecutive days (excluding water-based activities)	Measured via parent-report using the following questions (separately for weekdays and weekend days): • About how many hours a day does your child usually watch television (including DVDs and videos) in his/her free time (separately for weekdays and weekend days)? • About how many hours a day does your child use the computer for activities like playing games on a computer, game consoles (e.g., Playstation, Xbox,	Measured via parent-report using the following questions (separately for weekdays and weekend days): • How many hours of sleep does your child usually have during the night? Response categories: 1. Less than 6 hrs 2. 6–7 hrs 3. 8–9 hrs 4. 10–11 hrs 5. 12–13 hrs 6. 14 hrs

Survey/Study	Country/jurisdiction; data collection period; sample size for the analysis	Measurement methodology of movement behaviours		
		Physical activity	Sedentary screen time	Sleep duration
			GameCube) during leisure time? Response categories: 1. Never 2. Less than 30 minutes/day 3. 30 minutes to <1 hr/day 4. 1–2 hrs/day 5. 3–4 hrs/day 6. 5–6 hrs/day 7. 7–8 hrs/day 8. 8 hrs/day 9. More than 8 hrs/day 10. I don't know *Responses were recoded into minutes/day for each question using the mid-point method.	7. more than 14 hrs 8. I don't know • For how long does the child usually take a nap? Response categories: 1. My child does not take naps on weekdays/weekend days 2. Less than 1 hr 3. 1-2 hrs 4. 3-4 hrs 5. 5-6 hrs 6. 7-8 hrs 7. 9 or more hrs 8. I don't know *Responses were recoded into minutes/day for each question using the mid-point method.

eTable 3. Included countries by World Bank income classification and World Health Organization geographical regions.

World Bank Income Classification (number of countries included in analyses)	Countries
Low/Lower-middle income (13)	Bangladesh, Federated States of Micronesia, India, Indonesia, Iran, Malawi, Mongolia, Morocco, Nigeria, Pakistan, Papua New Guinea, Tanzania, Vietnam
Upper-middle income (7)	American Samoa, Brazil, China, Malaysia, Russia, South Africa, Sri Lanka
High-income (13)	Australia, Belgium, Canada, Commonwealth of Northern Mariana Islands, Finland, Guam, Hong Kong, Japan, New Zealand, Norway, Portugal, Sweden, USA
World Health Organization geographical regions (number of countries included in analyses)	**Countries**
Africa (4)	Malawi, Nigeria, South Africa, Tanzania
Americas (3)	Brazil, Canada, USA
Eastern Mediterranean (3)	Iran, Morocco, Pakistan
Europe (6)	Belgium, Finland, Norway, Portugal, Russia, Sweden
South-East Asia (4)	Bangladesh, India, Indonesia, Sri Lanka
Western Pacific (13)	American Samoa, Australia, China, Commonwealth of Northern Mariana Islands, Federated States of Micronesia, Guam, Hong Kong, Japan, Malaysia, Mongolia, New Zealand, Papua New Guinea, Vietnam

Note. Each country was classified according to the World Bank income classification at the time the data were collected, while regional grouping was performed according to World Health Organization definition.

eTable 4. Descriptive characteristics of participants by region and country.

Country	Sample size (N boys)	MVPA (min/day)[a]		TPA (min/day)[a]		Screen time (min/day)	Sleep duration (h/day)[b]	
		Unadjusted	Adjusted	Unadjusted	Adjusted		Unadjusted	Adjusted
Africa	286 (125)	90.7 (87.2,94.2)	85.8 (75.8,95.8)	192.0 (186.3,197.8)	182.5 (161.3,203.7)	80.5 (26.3,134.7)	10.6 (10.5,10.8)	10.6 (9.3,11.8)
Malawi	54 (29)	90.6 (81.3,99.8)	83.1 (74.4,91.9)	208.2 (193.9,222.6)	191.4 (178.4,204.4)	29.6 (12.0,48.0)	11.5 (11.2,11.8)	11.5 (11.3,11.8)
Nigeria	75 (28)	83.8 (77.4,90.2)	85.1 (78.9,91.3)	173.2 (162.7,183.7)	176.1 (166.6,185.6)	137.5 (114.0,162.0)	10.0 (9.7,10.3)	10.0 (9.7,10.3)
South Africa	74 (37)	101.6 (94.8,108.4)	98.8 (92.0,105.6)	202.1 (191.5,212.7)	195.8 (185.2,206.4)	121.9 (96.0,144.0)	9.9 (9.4,10.4)	9.9 (9.4,10.4)
Tanzania	83 (31)	87.2 (81.1,93.4)	80.4 (74.8,86.0)	189.6 (179.1,200.0)	174.0 (165.2,182.8)	39.5 (30.0,54.0)	11.3 (11.1,11.6)	11.3 (11.1,11.6)
Americas	1,487 (761)	80.1 (80.0,80.3)	87.2 (63.1,111.2)	328.3 (327.8,328.8)	302.2 (146.8,457.5)	158.1 (110.8,205.3)	10.4 (10.4,10.5)	10.2 (9.3,11.0)
Brazil	136 (64)	75.7 (71.7,79.6)	76.2 (72.1,80.3)	154.6 (148.2,160.9)	155.8 (149.6,162.0)	162.6 (144.0,180.0)	9.5 (9.3,9.8)	9.8 (9.6,10.1)
Canada	1,071 (554)	72.4 (72.1,72.6)	73.9 (69.1,78.7)	324.9 (324.1,325.6)	328.3 (311.6,345.1)	116.0 (96.0,138.0)	10.7 (10.7,10.8)	11.1 (10.7,11.4)
United States	280 (143)	112.0 (107.6,116.3)	112.1 (107.9,116.3)	425.6 (416.7,434.4)	425.8 (418.1,433.6)	197.7 (180.0,216.0)	9.8 (9.5,10.0)	9.8 (9.5,10.0)
Eastern Mediterranean	219 (129)	80.8 (76.4,85.2)	78.5 (63.7,93.3)	171.3 (164.1,178.6)	168.9 (146.4,191.3)	111.7 (58.4,165.1)	11.3 (11.1,11.5)	11.3 (9.8,12.8)
Iran	55 (33)	66.9 (59.9,74.0)	69.5 (63.3,75.7)	151.2 (139.4,163.0)	157.0 (147.2,166.9)	174.0 (144.0,204.0)	10.8 (10.4,11.2)	10.8 (10.4,11.2)
Morocco	87 (50)	101.9 (95.6,108.2)	95.1 (89.2,100.9)	206.3 (196.0,216.6)	190.8 (181.6,200.0)	85.7 (66.0,108.0)	11.4 (11.1,11.7)	11.4 (11.2,11.7)
Pakistan	77 (46)	66.8 (60.4,73.2)	73.0 (66.9,79.1)	146.2 (135.8,156.6)	160.2 (151.1,169.4)	86.7 (60.0,114.0)	11.5 (11.3,11.8)	11.5 (11.3,11.8)
Europe	2,232 (1,150)	94.8 (93.6,96)	93.9 (85.4,102.3)	188.6 (186.7,190.5)	185.9 (170.2,201.7)	86.2 (66.2,106.2)	10.9 (10.9,10.9)	11.1 (10.6,11.5)
Belgium	550 (287)	84.2 (82.2,86.3)	84.1 (82.2,86.1)	172.6 (169.5,175.8)	172.4 (169.5,175.2)	82.5 (78.0,90.0)	11.4 (11.3,11.5)	11.4 (11.3,11.5)
Finland	456 (236)	112.1 (109.3,115.0)	104.6 (101.9,107.4)	219.8 (215.2,224.4)	202.8 (198.4,207.3)	71.2 (66.0,72.0)	10.4 (10.3,10.4)	10.8 (10.8,10.9)

Country	Sample size (N boys)	MVPA (min/day)[a]		TPA (min/day)[a]		Screen time (min/day)	Sleep duration (h/day)[b]	
		Unadjusted	Adjusted	Unadjusted	Adjusted		Unadjusted	Adjusted
Norway	674 (359)	97.1 (95.1,99.1)	101.3 (99.3,103.4)	193.6 (190.7,196.5)	203.3 (200.3,206.2)	103.0 (96.0,108.0)	11.1 (11.0,11.1)	11.1 (11.0,11.1)
Portugal	419 (202)	86.8 (84.0,89.7)	84.9 (82.3,87.5)	170.2 (165.8,174.5)	165.8 (162.2,169.4)	109.2 (102.0,114.0)	10.5 (10.4,10.5)	10.9 (10.8,11.0)
Russia	52 (21)	85.7 (79.0,92.3)	90.0 (83.9,96.0)	166.2 (157.0,175.5)	176.0 (167.9,184.2)	45.6 (36.0,54.0)	11.8 (11.7,11.9)	11.8 (11.7,11.9)
Sweden	81 (45)	97.2 (91.0,103.4)	100.9 (95.0,106.8)	188.4 (179.5,197.4)	196.8 (188.5,205.0)	108.8 (96.0,126.0)	11.0 (10.8,11.1)	10.9 (10.9,11.1)
South-East Asia	240 (123)	75.3 (71.8,78.9)	74.3 (64.9,83.7)	163.6 (157.7,169.5)	160.0 (139.4,180.6)	110.1 (67.8,152.5)	10.7 (10.5,10.8)	10.7 (9.3,12)
Bangladesh	45 (27)	73.1 (64.8,81.5)	69.4 (61.3,77.6)	155.4 (142.2,168.7)	147.1 (134.2,159.9)	172.7 (144.0,198.0)	10.4 (10.0,10.7)	10.3 (10.0,10.7)
India	43 (21)	70.5 (63.1,77.9)	73.8 (67.0,80.6)	154.6 (142.3,167.0)	162.2 (151.4,173.0)	66.7 (54.0,84.0)	11.0 (10.6,11.4)	11.0 (10.6,11.4)
Indonesia	96 (46)	79.5 (73.1,86.0)	82.8 (76.7,88.8)	176.0 (165.6,186.4)	183.3 (173.8,192.8)	126.7 (102.0,150.0)	10.6 (10.4,10.9)	10.6 (10.4,10.9)
Sri Lanka	56 (29)	73.6 (67.4,79.9)	68.5 (63.2,73.8)	155.8 (145.6,166.0)	144.0 (136.3,151.8)	89.8 (72.0,108.0)	10.8 (10.5,11.1)	10.8 (10.5,11.1)
Western Pacific	2,553 (1,297)	87.7 (86.3,89.1)	87.3 (76.5,98.2)	209.5 (205.3,213.6)	257.5 (186.2,328.9)	125.7 (94.3,157.1)	10.7 (10.6,10.7)	10.2 (9.5,10.9)
American Samoa	102 (52)	130.5 (123.2,137.8)	128.2 (121.6,134.8)	458.9 (445.3,472.5)	453.7 (442.4,465.0)	166.1 (144.0,192.0)	7.8 (7.0,8.6)	7.8 (7.0,8.6)
Australia	1,542 (800)	86.4 (84.6,88.2)	89.0 (87.7,90.2)	169.6 (167.4,171.8)	176.3 (174.6,178.0)	205.2 (198.0,216.0)	11 (11.0,11.1)	11.1 (11.0,11.2)
China	127 (58)	81.2 (77.2,85.2)	73.0 (69.0,77.0)	174.8 (168,181.6)	156.3 (149.7,163.0)	74.5 (60.0,84.0)	10.2 (10.0,10.5)	10.2 (10.0,10.5)
Commonwealth of Northern Mariana Islands	74 (30)	114 (106.6,121.5)	114.7 (107.2,122.2)	428.4 (414,442.9)	430.1 (417.3,442.9)	203.5 (174.0,234.0)	9.5 (8.9,10.1)	9.5 (9.0,10.1)
Federated States of Micronesia	52 (25)	108.5 (97.8,119.3)	103.8 (93.7,113.8)	448.2 (427,469.4)	437.4 (418.1,456.6)	104.2 (66.0,138.0)	9.8 (9.0,10.5)	9.8 (9.1,10.5)
Guam	69 (32)	117.3 (108.0,126.6)	116.9 (108.1,125.8)	440.3 (424.2,456.4)	439.4 (425.6,453.3)	263.0 (222.0,300.0)	8.8 (8.1,9.4)	8.7 (8.2,9.4)
Hong Kong	85 (44)	70.0 (65.8,74.2)	67.6 (63.5,71.6)	147.8 (141.0,154.5)	142.2 (135.8,148.6)	77.6 (66.0,90.0)	11.2 (11.0,11.4)	11.2 (11.0,11.4)

Country	Sample size (N boys)	MVPA (min/day)[a]		TPA (min/day)[a]		Screen time (min/day)	Sleep duration (h/day)[b]	
		Unadjusted	Adjusted	Unadjusted	Adjusted		Unadjusted	Adjusted
Japan	61 (29)	93.8 (86.9,100.8)	82.2 (75.6,88.8)	198.7 (187.8,209.5)	172.3 (162.0,182.5)	101.0 (84.0,114.0)	10.7 (10.4,10.9)	10.7 (10.4,10.9)
Malaysia	94 (50)	61.6 (56.5,66.7)	65.0 (60.0,70.0)	135.7 (127.3,144.1)	143.4 (135.2,151.5)	97.5 (78.0,114.0)	10.5 (10.3,10.7)	10.5 (10.3,10.7)
Mongolia	51 (25)	71.1 (65.2,76.9)	70.4 (64.4,76.5)	152.5 (143.1,162.0)	151.1 (141.2,161.0)	130.9 (108.0,156.0)	11.1 (10.7,11.4)	11.1 (10.7,11.4)
New Zealand	114 (52)	80.3 (74.9,85.6)	81.3 (76.3,86.2)	372.5 (360.9,384.1)	374.8 (364.8,384.8)	83.8 (72.0,96.0)	10.5 (10.4,10.6)	10.9 (10.9,11.1)
Papua New Guinea	70 (36)	96.6 (89.2,103.9)	104.4 (97.6,111.2)	202.2 (191.2,213.2)	220.0 (210.0,230.0)	62.7 (48.0,78.0)	11.0 (10.6,11.4)	11.0 (10.6,11.4)
Vietnam	112 (64)	71.3 (67.4,75.3)	71.2 (67.3,75.1)	151.9 (145.7,158.2)	151.7 (145.6,157.8)	105.6 (90.0,120.0)	10.8 (10.6,11.0)	10.8 (10.6,11.0)

MVPA=moderate- to vigorous-intensity physical activity; TPA=total physical activity. All duration data presented as mean (95% confidence interval) for both unadjusted (raw data) and adjusted estimates (used in meta-analyses; except for screen time as no adjustments were made).

eTable 5. Proportion (95% confidence interval) of children meeting the World Health Organization guidelines by country.

Country	Sample size (N boys)	Physical activity		Sedentary behaviour (Screen time)	Sleep duration		All three recommendations	
		Unadjusted	Adjusted		Unadjusted	Adjusted	Unadjusted	Adjusted
Africa								
Malawi	54 (29)	68.5 (54.5,80.5)	53.7 (40.6,66.3)	85.2 (73.4,92.3)	94.4 (84.6,98.8)	94.4 (84.9,98.1)	55.6 (41.4,69.1)	44.4 (32.0,57.6)
Nigeria	75 (28)	40.0 (28.9,51.9)	40.0 (29.7,51.3)	25.3 (16.9,36.2)	57.3 (45.4,68.7)	57.3 (46.1,67.9)	6.7 (2.2,14.9)	8.0 (3.7,16.4)
South Africa	74 (37)	68.9 (57.1,79.2)	64.9 (53.5,74.8)	50.0 (38.9,61.1)	63.5 (51.5,74.4)	63.5 (52.1,73.6)	22.9 (13.9,34.2)	21.6 (13.8,32.3)
Tanzania	83 (31)	55.4 (44.1,66.3)	42.2 (32.1,52.9)	81.9 (72.3,88.7)	90.4 (81.9,95.7)	90.4 (82.1,95.0)	43.4 (32.5,54.7)	30.1 (21.3,40.7)
Americas								
Brazil	136 (64)	26.5 (19.3,34.7)	27.9 (21.1,36.0)	14.0 (9.1,20.8)	39.7 (31.4,48.5)	47.1 (38.9,55.4)	2.9 (0.8,7.4)	4.4 (2.0,9.3)
Canada	1,071 (554)	57.8 (54.7,60.8)	60.7 (57.7,63.6)	28.6 (25.9,31.3)	80.9 (78.4,83.1)	80.5 (78,82.7)	10.0 (8.3,11.9)	14.6 (12.6,16.8)
United States	280 (143)	91.8 (87.9,94.7)	93.9 (90.5,96.2)	11.1 (7.9,15.3)	58.2 (52.2,64.1)	58.2 (52.4,63.8)	5.4 (3.0,8.9)	5.7 (3.5,9.1)
Eastern Mediterranean								
Iran	55 (33)	21.8 (11.8,35.0)	25.5 (15.8,38.3)	21.8 (12.9,34.4)	65.5 (51.4,77.8)	65.5 (52.3,76.6)	3.6 (0.4,12.5)	5.5 (1.9,14.9)
Morocco	87 (50)	67.8 (56.9,77.4)	57.5 (47.0,67.3)	64.4 (53.9,73.6)	79.3 (69.3,87.2)	79.3 (69.6,86.5)	39.1 (28.8,50.1)	34.5 (25.3,44.9)
Pakistan	77 (46)	22.1 (13.4,32.9)	27.3 (18.6,38.1)	58.4 (47.3,68.8)	90.9 (82.2,96.3)	90.9 (82.4,95.5)	10.4 (4.6,19.4)	14.3 (8.2,23.8)
Europe								
Belgium	550 (287)	38.7 (34.6,42.9)	38.9 (34.9,43.0)	52.5 (48.4,56.7)	89.6 (86.8,92.1)	89.6 (86.8,91.9)	19.3 (16.1,22.8)	19.8 (16.7,23.4)
Finland	456 (236)	79.2 (75.2,82.8)	64.9 (60.4,69.2)	43.9 (39.4,48.4)	75.4 (71.2,79.3)	92.3 (89.5,94.4)	23.5 (19.7,27.6)	26.5 (22.7,30.8)
Norway	674 (359)	63.4 (59.6,67.0)	72.1 (68.6,75.4)	39.8 (36.1,43.5)	97.8 (96.4,98.7)	97.8 (96.4,98.6)	26.1 (22.8,29.6)	29.1 (25.8,32.6)

Country	Sample size (N boys)	Physical activity		Sedentary behaviour (Screen time)	Sleep duration		All three recommendations	
		Unadjusted	Adjusted		Unadjusted	Adjusted	Unadjusted	Adjusted
Portugal	419 (202)	40.1 (35.4,44.9)	35.6 (31.1,40.3)	25.8 (21.8,30.2)	80.4 (76.3,84.1)	89.3 (85.9,91.9)	7.2 (4.9,10.1)	8.1 (5.9,11.1)
Russia	52 (21)	30.8 (18.7,45.1)	44.2 (31.6,57.7)	94.2 (84.4,98)	100 (93.1,100)	100 (93.1,100)	30.8 (18.7,45.1)	44.2 (31.6,57.7)
Sweden	81 (45)	56.8 (45.3,67.7)	63.0 (52.1,72.7)	34.6 (25.1,45.4)	100 (95.5,100)	100 (95.5,100)	25.9 (16.8,36.8)	25.9 (17.6,36.4)
South-East Asia								
Bangladesh	45 (27)	24.4 (12.9,39.5)	20.0 (10.9,33.8)	15.6 (7.7,28.8)	71.1 (55.7,83.6)	71.1 (56.6,82.3)	6.7 (1.4,18.3)	4.4 (1.2,14.8)
India	43 (21)	25.6 (13.5,41.2)	27.9 (16.7,42.7)	62.8 (47.9,75.6)	83.7 (69.3,93.2)	83.7 (70.0,91.9)	11.6 (3.9,25.1)	9.3 (3.7,21.6)
Indonesia	96 (46)	48.9 (38.6,59.4)	52.1 (42.2,61.8)	38.5 (29.4,48.5)	80.2 (70.8,87.6)	80.2 (71.1,86.9)	10.4 (5.1,18.3)	15.6 (9.7,24.2)
Sri Lanka	56 (29)	30.4 (18.8,44.1)	10.7 (5.0,21.5)	50.0 (37.3,62.7)	83.9 (71.7,92.4)	83.9 (72.2,91.3)	12.5 (5.2,24.1)	5.4 (1.8,14.6)
Western Pacific								
American Samoa	102 (52)	99.0 (94.7,100)	100 (96.4,100)	24.5 (17.2,33.7)	38.2 (28.8,48.4)	38.2 (29.4,47.9)	6.9 (2.8,13.6)	6.9 (3.4,13.5)
Australia	1,542 (800)	37.0 (34.6,39.5)	43.3 (40.8,45.8)	19.3 (17.4,21.3)	91.3 (89.7,92.6)	91.2 (89.7,92.6)	6.4 (5.2,7.8)	7.6 (6.4,9.0)
China	127 (58)	41.7 (33.1,50.8)	27.6 (20.5,35.9)	65.4 (56.7,73.1)	76.4 (68.0,83.5)	76.4 (68.3,82.9)	22.1 (15.2,30.3)	14.2 (9.2,21.3)
Commonwealth of Northern Mariana Islands	74 (30)	97.3 (90.6,99.7)	95.9 (88.7,98.6)	16.2 (9.5,26.2)	50.0 (38.1,61.9)	50 (38.9,61.1)	9.5 (3.9,18.5)	9.5 (4.7,18.3)
Federated States of Micronesia	52 (25)	88.5 (76.6,95.7)	88.5 (77.0,94.6)	57.7 (44.2,70.1)	61.5 (47.0,74.7)	61.5 (48.0,73.5)	26.9 (15.6,41.0)	26.9 (16.8,40.3)
Guam	69 (32)	89.9 (80.2,95.8)	95.7 (88.0,98.5)	10.1 (5.0,19.5)	36.2 (24.9,48.7)	36.2 (25.9,48.0)	0 (0,5.2)	0 (0,5.3)
Hong Kong	85 (44)	20.0 (12.1, 30.1)	9.4 (4.8,17.5)	58.8 (48.2,68.7)	90.6 (82.3,95.9)	90.6 (82.5,95.2)	11.8 (5.8,20.6)	5.9 (2.5,13.0)
Japan	61 (29)	63.9 (50.6,75.8)	42.6 (31.0,55.1)	44.3 (32.5,56.7)	83.6 (71.9,91.8)	83.6 (72.4,90.8)	24.6 (14.5,37.3)	18.0 (10.4,29.5)
Malaysia	94 (50)	11.7 (5.9,19.9)	19.1 (12.5,28.3)	51.1 (41.1,60.9)	79.8 (70.3,87.4)	79.8 (70.6,86.7)	2.1 (0.3,7.5)	7.4 (3.7,14.6)

Country	Sample size (N boys)	Physical activity		Sedentary behaviour (Screen time)	Sleep duration		All three recommendations	
		Unadjusted	Adjusted		Unadjusted	Adjusted	Unadjusted	Adjusted
Mongolia	51 (25)	25.5 (14.3,39.6)	23.5 (14.0,36.8)	23.5 (14.0,36.8)	78.4 (64.7,88.7)	80.4 (67.5,89.0)	5.9 (1.2,16.2)	5.9 (2.0,15.9)
New Zealand	114 (52)	74.6 (65.5,82.2)	76.3 (67.7,83.2)	46.5 (37.6,55.6)	84.2 (76.2,90.4)	95.6 (90.1,98.1)	29.8 (21.6,39.1)	37.7 (29.4,46.9)
Papua New Guinea	70 (36)	70.0 (57.8,80.4)	85.7 (75.7,92.1)	70.0 (58.5,79.5)	65.7 (53.4,76.6)	65.7 (54.0,75.8)	32.9 (22.1,45.1)	41.4 (30.6,53.1)
Vietnam	112 (64)	16.9 (10.5,25.2)	19.6 (13.3,28.0)	42.9 (34.1,52.1)	77.7 (68.8,85)	77.7 (69.1,84.4)	7.1 (3.1,13.6)	8.0 (4.3,14.6)

Data presented as percentage (95% confidence interval) for both unadjusted (raw data) and adjusted estimates (except for screen time as no adjustments were made).

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