GUIDELINES ON PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND SLEEP FOR CHILDREN UNDER 5 YEARS OF AGE

WEB ANNEX
Evidence Profiles*

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This publication forms part of the *WHO guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age*. It is being made publicly available as supplied by those responsible for its development for transparency purposes and information, as required by WHO (see the *WHO handbook for guideline development*, 2nd edition (2014)).

Cover pages: Eddy Hill Design

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Introduction

The Guideline Development Group (GDG) decided on the scope of the guideline and PICO (Population, Intervention, Comparison, Outcome) questions at their first meeting. They requested that the available systematic reviews be updated to reflect recent data and explore sources of data in all six WHO official languages.

The systematic reviews conducted up to April 2016 for the Canadian 24-Hour Movement Guidelines for the Early Years were led by Valerie Carson (1), Veronica Poitras (2), Jean-Philippe Chaput (3) and Nicholas Kuzik (4) under the overall leadership of Dr Mark Tremblay. The search strategies were developed and peer-reviewed by experts in systematic reviews. The following databases were search in April 216: MEDLINE, SPORTDiscus, EMBASE, PsycINFO, CENTRAL to identify studies that were peer-reviewed, written in English or French and met the systematic review criteria (apparently healthy children aged under 5 years of age, objectively or subjectively measured physical activity/sedentary time/screen time/sleep duration reporting critical outcomes of adiposity, motor development, psychosocial health, cognitive development, growth, cardiometabolic health and fitness and additional outcomes of bone/skeletal health and risk of injuries). These systematic reviews were registered with the International Prospective Register of Ongoing Systematic Reviews and used the GRADE framework to determine the quality of evidence. Dr Anthony Okely oversaw the updating of these systematic reviews for randomised controlled trials and cohort studies for critical indicators only, for the Australian guidelines through to March 2017, using the same search criteria and methods. This resulted in the addition of one study on physical activity, three on sedentary behaviour, three on sleep and none on integrated behaviours (5). The GDG reviewed the existing systematic reviews and requested that these be updated to include high quality studies published since the Australian update and those identified in all official WHO languages to reflect the final PICO questions.

Additional literature searches, using the same search terms and methods as the original systematic reviews were conducted and summaries of the evidence and GRADE tables were updated in December 2017(6).

For physical activity, fifteen additional studies were identified, of which only six were of experimental or longitudinal design and were extracted. For sedentary behaviour, an additional 15 studies were identified, of which only four were longitudinal studies (no experimental studies) that were extracted. For sleep an additional 11 studies were identified, of which only five were of longitudinal study design and were extracted. For integrated physical activity, sedentary and sleep (movement) behaviours, an additional 4 studies were identified, of which three were of experimental or longitudinal design and were extracted.

The GDG employed the GRADE Evidence to Decisions (EtD) framework for generating question specific recommendations. The EtD framework is a systematic, structured and transparent approach to decision making. The framework employs explicit criteria for generating guideline recommendations in light of research evidence, certainty of evidence, and where required, expert opinion and topical knowledge from the perspective of the target audience.

1. Carson V, Lee EY, Hewitt L, Jennings C, Hunter S, Kuzik N, et al. Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). BMC Public Health. 2017;17(Suppl 5):854.
2. Poitras VJ, Gray CE, Janssen X, Aubert S, Carson V, Faulkner G, et al. Systematic review of the relationships between sedentary behaviour and health indicators in the early years (0-4 years). BMC Public Health. 2017;17(Suppl 5):868.
3. Chaput JP, Gray CE, Poitras VJ, Carson V, Gruber R, Birken CS, et al. Systematic review of the relationships between sleep duration and health indicators in the early years (0-4 years). BMC Public Health. 2017;17(Suppl 5):855.
4. Kuzik N, Poitras VJ, Tremblay MS, Lee EY, Hunter S, Carson V. Systematic review of the relationships between combinations of movement behaviours and health indicators in the early years (0-4 years). BMC Public Health. 2017;17(Suppl 5):849.
5. Okely AD, Ghersi D, Hesketh KD, Santos R, Loughran SP, Cliff DP, et al. A collaborative approach to adopting/adapting guidelines - The Australian 24-Hour Movement Guidelines for the early years (Birth to 5 years): an integration of physical activity, sedentary behavior, and sleep. BMC Public Health. 2017;17(Suppl 5):869.
6. Organization WH. Summary report of the update of systematic reviews of the evidence to inform the WHO guidelines on physical activity, sedentary behaviour and sleep in children under 5 years of age. Geneva: World Health Organization; 2018.

EVIDENCE PROFILES

1.1 Physical Activity

PICO: In children under 5 years of age what dose (i.e., durations, frequencies, patterns, types, and intensities) of physical activity, as measured by objective and subjective methods, is associated with favourable health indicators?

(black font is from original GRADE Tables of Carson et al., 2017 – red font is updates from Australian Guidelines - blue font are additions/edits based on recent WHO updates)

Table 1.1.1 The relationship between physical activity and adiposity.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	Indirectness	imprecision	other			
Mean baseline age ranged from 41 weeks to 59.6 months; where mean age was not reported, baseline age ranged from 2 weeks to <6 years. Data were collected by randomized control trial (n=1), clustered randomized control trial (n=3), non-randomized trial (n=2), longitudinal (n=9), case-control (n=3), cross-sectional (n=40) study designs with up to 4-year follow-up. Adiposity was assessed by BMI (objectively measured), weight-for-height z-score (objectively measured), BMI z-score (objectively measured; Center for Disease Control, World Health Organization, other country-specific reference data), weight/height^3 (objectively measured), weight percentiles (objectively measured), relative weights (objectively measured; country-specific reference data), non-overweight and overweight (objectively measured, proxy-reported; Center for Disease Control ≥ 85th percentile, International Obesity Task Force, other country-specific reference data), non-obese and obese (objectively measured; BMI>18, BMI percentile ≥95, World Health Organization, Center for Disease Control, Kaup index), normal weight, overweight, obese (objectively measured; ≥85th and ≥95thpercentiles, International Obesity Task Force), waist circumference (objectively measured), percentiles of waist circumference (objectively measured), hip circumference (objectively measured), waist to hip ratio (objectively measured), waist circumference z-score (Netherlands reference data), waist circumference-for- age z-score (objectively measured), sum of skinfolds (objectively measured), triceps skinfold thickness (objectively measured), body fat % (bioelectrical impedance, dual-energy X-ray absorptiometry), fat mass index (dual energy x ray absorptiometry, air- displacement plethysmography), fat free mass index (dual energy x ray absorptiometry, air-displacement plethysmography), fat free mass (dual energy X-ray absorptiometry), fat mass (dual energy X-ray absorptiometry, air-displacement plethysmography), % fat mass (dual energy X-ray absorptiometry), trunk fat mass index (dual-energy X-ray absorptiometry), and lean mass index (dual-energy X-ray absorptiometry).									
Intervention studies									
1	RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	161	The **physical activity intervention (physical activity recommendations from nurse)** was *favourably* associated with improved adiposity (*sum of four skinfolds but not % overweight, waist circumference, hip circumference, or body fat %*) in **1 study** *(1)*	Low[c]
3	Clustered RCT[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	None	1561	The **physical activity interventions (gross motor skill program)** were *favourably* associated with adiposity in **1 study** *(2)*. The **physical activity interventions (fundamental movement skill program and walk/ aerobic dance program)** were *not* associated with adiposity in **2 studies** *(3, 4)*.	Moderate[f]

2	Non-randomized intervention[g]	Serious risk of bias[h]	No serious inconsistency	No serious indirectness	No serious imprecision	None	640	The **physical activity interventions (physical education/physical activity classes)** were *not* associated with adiposity in **2 studies** *(5, 6)*.	Very Low[i]
Observational studies									
~~7~~ 9	Longitudinal[j]	Serious risk of bias[k]	No serious inconsistency	No serious indirectness	No serious imprecision	Dose-response gradient[l]	~~2441~~ 3462	**TPA** was *favourably* associated with adiposity (*change in weight- for-height z-score but not waist circumference-for-age z-score in 1 study*) in **2 studies** *(7, 8)*and *not* associated with adiposity in **2 studies** *(9, 10)* **MVPA** was *favourably* associated with adiposity (*fat free mass but not BMI, fat mass, or percent fat mass in 1 study*) and (*fat free mass index but not BMI, fat mass, or fat mass index*)] in ~~**1**~~ **2 studies** *(9, 11)* **VPA** was *not* associated with adiposity in **1 study** *(12)*, and was *favourably* (fat free mass index), *unfavourably* (BMI) and *not* (fat mass, or fat mass index) associated with adiposity in **1 study** *(11)* **MPA** was *not* associated with BMI, fat free mass index, fat mass or fat mass index in **1 study** *(11)*. **Activity energy expenditure** was *favourably* (*fat free mass*), *unfavourably* (*BMI, fat mass*), and *not* (*percent fat mass*) associated with adiposity in **1 study** *(9)*. **Physical activity level energy expenditure** was *favourably* (*free mass*) and *unfavourably* (*BMI*), and *not* (*fat free mass, percent fat mass*) associated with adiposity in **1 study** *(9)*.	Very Low[m]

								Aerobic PA was *favourably* associated with adiposity (*baseline PA only not change in PA*) in **1 study** *(13)* **Structured PA** was *not* associated with adiposity in **2 studies** *(13, 14)*. **Leisure PA** was *not* associated with adiposity in **1 study** *(13)*. **Home PA** was *not* associated with adiposity in **1 study** *(14)*. **Outdoor play time** was *favourably* associated with *body fat percentage* in girls, and *not* associated with BMI in girls, or adiposity body fat percentage or BMI) in boys *(15)*.	
3	Case-control[n]	Serious risk of bias[o]	No serious inconsistency	No serious indirectness	No serious imprecision	None	2271	**TPA** was *not* associated with adiposity in **1 study** *(16)* **MPA** was *not* associated with adiposity in **1 study** *(17)* **VPA** was *not* associated with adiposity in **1 study** *(17)* **Outdoor PA** was *favourably* associated with adiposity in **1 study** *(16)*and *not* associated with adiposity in **1 study** *(18)*	Very Low[p]

40	Cross- section al[q]	Serious risk of bias[r]	Serious inconsistency [s]	No serious indirectness	No serious imprecision	Exposure /outcome gradient[t]	37813	**TPA** was <u>*favourably*</u> associated with adiposity (*Age 6 months but not 1, 2, 3, and 4 years in 1 study; boys only in 1 stud; 95th percentile of vector magnitude and fat free mass index but not BMI, fat mass, or waist circumference and 90th percentile of vector magnitude and percent fat mass and fat free mass index but not BMI, fat mass index, or waist circumference in 1 study*) in **6 studies** *(19-24)*, <u>*unfavourably*</u> associated with adiposity (*BMI z-score but not waist circumference z-score in 1 study and hip circumference, but not relative weights, skinfold thicknesses, and waist circumference in 1 study*) in **3 studies** *(25-27)*, and <u>*not*</u> associated with adiposity in **11 studies** *(7, 9, 10, 28-35)* **LPA** was <u>*favourably*</u> associated with adiposity (*waist circumference z-score but not BMI z-score*) in **1 study** *(26)*, <u>*unfavourably*</u> associated with adiposity (*percentage of body fat and fat mass index but not but not with trunk fat mass index, lean mass index*) in **1 study** *(36)*, and not associated with adiposity in **6 studies** *(21, 31, 37-40)* **LPA 5-min bouts** were <u>*not*</u> associated with adiposity in **1 study** *(31)*. **MPA** was <u>*unfavourably*</u> associated with adiposity in **1 study** *(26)* and <u>*not*</u> associated with adiposity in **2 studies** *(21, 36)*. **MVPA** was <u>*favourably*</u> associated with adiposity (*percent fat mass but not BMI, fat free mass, fat mass in 1 study; boys only in 1 study; percentage of body fat and fat mass index but not trunk fat mass index or lean mass index in 1 study; percent fat mass and fat free mass index but not BMI, fat mass index, or waist circumference in 1 study; girls only and waist circumference at the 90th*	Very Low[u]

								percentile but not the 10^{th}, 25^{th}, 75^{th} percentiles or BMI z- score or waist circumference in 1 study) in **6 studies** *(9, 21, 24, 30, 36, 41)*, *unfavourably* associated with adiposity (*boys only and BMI z-score but not waist circumference in 1 study*) in **3 studies** *(27, 40, 41)*, and *not* associated with adiposity in **8 studies** *(28, 31, 32, 37-39, 42, 43)*. **MVPA 5-min bouts** were *not* associated with adiposity in **1 study** *(31)*. **VPA** was *favourably* associated with adiposity (*boys only in 1 study; percentage body fat, fat mass index, trunk fat mass index but not lean mass index in 1 study; fat free mass index but not BMI, fat mass, fat mass index, and waist circumference in 1 study*) in **4 studies** *(21, 24, 30, 36)*, *unfavourably* associated with adiposity in **1 study** *(26)*, and *not* associated with adiposity in **3 studies** *(28, 40, 44)*.	

								Outdoor PA was _favourably_ associated with adiposity in **1 study** *(45)* and _not_ associated with adiposity in **8 studies** *(20, 29, 33, 35, 46-49)*. **Indoor PA** was _not_ associated with adiposity in **1 study** *(33)*. **Organized Sport** was _unfavourably_ associated with adiposity (*girls only*) in **1 study** *(50)* **Activity energy expenditure** was *favourably* (*fat free mass*), *unfavourably* (*BMI*), and _not_ (*fat mass, percent fat mass*) associated with adiposity in **1 study** *(9)*. **PA level energy expenditure** was not associated with adiposity in **1 study** *(9)*. **Leisure PA** was _favourably_ associated with adiposity (*intermediate vs. none but not high vs. none*) in **1 study** *(51)*. **Physical Education** was _favourably_ associated with adiposity in **1 study** *(52)*. **Active Play** was _favourably_ associated with adiposity (*weekdays only in 1 study*) in **2 studies** *(32, 53)* and _not_ associated with adiposity in **1 study** *(54)*. **Active Transportation** was _not_ associated with adiposity in **1 study** *(55)*	

RCT = randomized control trial; BMI = body mass index; PA = physical activity; TPA = total physical activity; MPA = moderate-intensity physical activity; MVPA = moderate- to vigorous-intensity activity; LPA = light-intensity physical activity; VPA = vigorous-intensity physical activity.

[a] Includes 1 RCTs *(1)*
[b] The intervention did not result in a significant change in physical activity *(1)*.
[c] Quality of evidence was downgraded from high to low because of serious risk of bias.
[d] Includes 3 clustered RCTs *(2-4)*.
[e] Outcome assessors do not appear blinded to group allocation and it is unclear if the outcome was objectively measured in 1 study *(2)*.Physical activity was not measured so it is unknown if the intervention resulted in a significant change in physical activity in 1 study *(4)*.
[f] Quality of evidence was downgraded from high to moderate because of serious risk of bias.
[g] Includes 2 non-randomized interventions *(5, 6)*.
[h] No control group in 1 study *(6)*. No intention-to-treat analysis; boys were excluded if they did not assist with the final evaluation and girls were excluded if they provided a medical letter at the final evaluation in 1 study *(6)*. Physical activity was not measured so it is unknown if the intervention resulted in a significant change in physical activity in 2 studies *(5, 6)*.
[i] Quality of evidence was downgraded from low to very low because of serious risk of bias.
[j] Includes ~~7~~ 9 longitudinal studies *(7-15)*
[k] Convenience sample was used in 2 studies *(11, 13)*. Psychometric properties unknown for the subjective physical activity measures in 3 studies *(7, 13, 14)*. Cut points utilized for objective physical activity measure have not been validated for early years children *(11)*. Large loss to follow-up and incomplete data in 1 study *(7)*. No potential confounders were adjusted for in 2 studies *(7, 8)*. One study mutually adjusted for other movement behaviours in the fully adjusted models *(9)*.
[l] A dose-response gradient of higher aerobic PA and MVPA with better adiposity was observed in 2 studies *(9, 13)*. A dose- response gradient of higher activity energy expenditure and higher physical activity level energy expenditure was associated with both better and worse adiposity depending on the adiposity measure in 1 study *(9)*
[m] Quality of evidence was downgraded from low to very low because of serious risk of bias and because of this limitation was not upgraded for a dose-response gradient.
[n] Includes 3 case-control studies *(16-18)*.
[o] Psychometric properties unknown for the subjective physical activity measures in 3 studies *(16-18)*.
[p] Quality of evidence was downgraded from low to very low because of serious risk of bias.
[q] Includes 40 cross-sectional studies *(7, 9, 10, 19-55)*
[r] Convenience sample was used in 11 studies *(19, 22, 27, 30, 31, 37, 40-43, 53)*.Low participation rate in 3 studies *(30, 38, 50)*. Psychometric properties unknown for the subjective physical activity measure in 15 studies *(7, 19, 20, 23, 32, 35, 38, 48-55)* and the outcome measure in 2 studies *(51, 53)*. No potential confounders were adjusted for in 19 studies *(7, 20, 22, 23, 25-27, 31-34, 37, 39, 40, 42, 43, 46, 48, 54)*. Large amount of missing data in 12 studies *(23, 25, 26, 28, 32, 34, 36, 40, 48, 50, 52, 53)*. Physical activity was only measured during child care in 3 studies *(24, 28, 45)*. Other movement behaviours were mutually adjusted for in the fully adjusted models in 3 studies *(9, 21, 36)*.
[s] Favourable and unfavourable associations between physical activity and adiposity observed across studies.
[t]A gradient for higher TPA, MVPA, VPA activity energy expenditure, outdoor PA, physical education with better adiposity was observed in 6 studies *(9, 21, 36, 41, 45, 52)*. A gradient for higher activity energy expenditure and LPA, MVPA with worse adiposity was observed in 3 studies *(9, 36, 41)*.
[u] Quality of evidence was downgraded from low to very low because of serious risk of bias and because of this limitation was not upgraded for an exposure/outcome gradient.

Table 1.1.2. The relationship between physical activity and motor development.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline ranged from 18.3 weeks to 59.79 months; where mean age was not reported baseline age ranged from 0 months to 18 years. Data were collected by randomized control trial (n=4), clustered randomized control trial (n=1), non-randomized intervention (n=7), longitudinal (n=2), and cross-sectional (n=10) study designs with up to approximately 41 to 46 month follow-up. Motor development was assessed by fundamental movement skills/motor ability/motor performance/motor development/motor skills/gross-motor development/psychomotor skills (objectively measured; Test of Gross Motor Development- 2, movement assessment battery, Movement Assessment Battery for Children – 2, APM-Inventory, Dutch Second Edition of the Bayley Scales of Infant and Toddler - 3, Motoriktestfürvier-bissechsjährige Kinder 4-6; 12 meter run, standing long jump, Motor Test Battery 3-7, Alberta Infant Motor Scales, neurological examination technique for toddler-age, Children's Activity and Movement in Preschool Study Motor Skill Protocol, Comprehensive Developmental Inventory for Infants and Toddlers, Gessel Development Schedules- Development Quotient), achievement of developmental milestones (proxy-report questionnaire), coordination (proxy-report questionnaire), and fine motor coordination/fine motor development (proxy-report interview, Comprehensive Developmental Inventory for Infants and Toddlers).									
Intervention studies									
4	RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	705	The **physical activity intervention (physical activity recommendations from nurse)** was <u>*not*</u> associated with improved motor development in **1 study** *(1)*. The **physical activity interventions (planned passive cycling, physical education program, physical activity program)** were <u>*favourably*</u> associated with improved motor development in **3 studies** *(56-58)*.	Low[c]
1	Clustered RCT[d]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	97	The **physical activity intervention (fundamental movement skill program)** was <u>*favourably*</u> associated with improved motor development (*total score and jumping individual score but not for running, hopping, catching, and kicking*) in **1 study** *(3)*	High

~~6~~ 7	Non-randomized intervention[e]	Serious risk of bias[f]	No serious inconsistency	No serious indirectness	No serious imprecision	None	~~946~~ 1013	The **physical activity interventions (free play/structured activities, physical education/physical activity classes, dance program, swimming, tummy time)** were *favourably* associated with improved motor development (*boys only and running speed between time 2 and 3 only in 1 study; one-leg balance only in 1 study*) in **~~6~~ 7 studies** *(5, 6, 59-63)*.	Very Low[g]
Observational studies									
~~1~~ 2	Longitudinal[h]	Serious risk of bias[i]	No serious inconsistency	No serious indirectness	No serious imprecision	None	~~197~~ 382	**Prone position** was *favourably* associated with motor development (*higher prone duration and gross motor development only at age 6 mo but not at age 24 mo and prone- specific milestones only*) *(64)*. **MVPA** was *favourably* associated with motor development (*MVPA at 3.5 y, but not 19 mo, with locomotor skill at 5 y, but not with object skills or total skills)* in **1 study** *(65)*.	Very Low[j]
10	Cross-sectional[k]	Serious risk of bias[l]	No serious inconsistency	No serious indirectness	No serious imprecision	Exposure /outcome gradient[m]	1833	**TPA** was *favourably* associated with motor development (correlations but *not when comparing quartiles of fundamental movement skills in 1 study*) in **3 studies** *(22, 27, 66)*, *unfavourably* associated with motor development (*running speed only in 1 study*) in **2 studies** *(33, 67)*, and *not* associated with motor development in **1 study** *(31)*. **LPA** was *not* associated with motor development in **3 studies** *(31, 40, 66)*. **LPA 5-min bouts** were *not* assoc. with motor development in **1 study** *(31)* **MVPA** was *favourably* associated with motor development (*total and locomotor (high vs. low only)* but *not for object control skills in 1 study*) in **3 studies** *(27, 40, 66)*and *not* associated with motor development in **1 study** *(31)*	Very Low[n]

								MVPA 5-min bouts were _not_ associated with motor development in **1 study** *(31)* **VPA** was _favourably_ associated with motor development (total and locomotor (*high vs. low only*) but *not for object control skills)* in **1 study** *(40)*. **Prone position** was _favourably_ associated with motor development (*gross motor development but not fine motor development in 1 study*) in **3 studies** *(64, 68, 69)*. **Outdoor PA** was _not_ associated with motor development in **1 study** *(33)*. **Indoor PA** was _favourably_ associated with motor development (*throwing at target only*) in **1 study** *(33)*.	

RCT = randomized control trial; PA = physical activity; TPA = total physical activity; MVPA = moderate- to vigorous-intensity activity; LPA = light-intensity physical activity; VPA = vigorous-intensity physical activity.

[a] Includes 4 RCTs *(1, 56-58)*.
[b] No intention-to-treat analysis; parent-child dyads were excluded if they did not carry out the management plan or if they became sick during the study and the physical activity program was interrupted in 1 study *(58)*. Physical activity was not measured so it is unknown if the intervention resulted in a significant change in physical activity in 3 studies *(56-58)*The intervention did not result in a significant change in physical activity in 1 study *(1)*
[c] Quality of evidence was downgraded from high to low because of serious risk of bias.
[d] Includes 1 clustered RCT *(3)*.
[e] Includes ~~6~~ **7** non-randomized interventions *(5, 6, 59-63)*.
[f] The outcome was measured post-intervention only in 2 studies *(59, 61)*. No control group in 1 study *(6)*. No intention-to-treat analysis; boys were excluded if they did not assist with the final evaluation and girls were excluded if they provided a medical letter at the final evaluation in 1 study *(6)*; and only 19 out of 63 intervention children were included in the analysis because they received the requisite amount of swimming experience in 1 *(61)*. Physical activity was not measured so it is unknown if the intervention resulted in a significant change in physical activity in ~~6~~ 7studies *(5, 6, 59-63)*. Outcome assessors were not blinded to group allocation *(63)*.
[g] Quality of evidence was downgraded from low to very low because of serious risk of bias.
[h]Includes ~~1~~ 2 longitudinal studies *(64, 65)*.
[i]Psychometric properties unknown for the subjective physical activity measures and large loss to follow-up and incomplete data in 1 study *(64)*.
[j]Quality of evidence was downgraded from low to very low because of serious risk of bias.
[k] Includes 10 cross-sectional studies *(22, 27, 31, 33, 40, 64, 66-69)*.
[l] Convenience sample was used in 6 studies *(22, 27, 31, 40, 67, 69)*. Psychometric properties unknown for the subjective physical activity measure in 5 studies *(22, 64, 67-69)*and the outcome measure in 2 studies *(27, 67)*. Potential confounders were not adjusted for in 7 studies *(27, 31, 33, 40, 66-68)*. Large amount of missing data in 1 study *(40)*.
[m]A gradient for higher MVPA and VPA with better motor development was observed in 2 studies *(40, 66)*.
[n] Quality of evidence was downgraded from low to very low because of serious risk of bias and because of this limitation was not upgraded for an exposure/outcome gradient.

Table 1.1.3. The relationship between physical activity and psychosocial health.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline age ranged from 18.3 weeks to 57.61 months; where mean age was not reported baseline, age ranged from to 12 months to 5 years. Data were collected by randomized control trial (n=2), longitudinal (n=2), and cross-sectional (n=6) study designs with up to approximately 8 to 10-year follow-up. Psychosocial health was assessed by social competence (proxy-report Social Competence Behaviour Evaluation: Preschool Education Questionnaire), internalizing behaviour problems (proxy-report Social Competence Behaviour Evaluation: Preschool Education Questionnaire) externalizing behaviour problems (proxy-report Social Competence Behaviour Evaluation: Preschool Education Questionnaire), quality of life (self-reported Dartmouth Primary Care Cooperative Project charts), health-related quality of life (proxy-reported PedsQL 4.0), temper frequency (proxy-report interview), sociability (proxy-report Child Temperament Questionnaire), emotionality (proxy-report Child Temperament Questionnaire), soothability (proxy-report Child Temperament Questionnaire), conduct problems (proxy-report Strengths and Difficulties Questionnaire), anxiety symptoms (proxy-report Preschool Anxiety Scale-Revised), classroom peer acceptance (proxy-report sociometric interviews), and personal-social behaviour (objectively measured; Gessell Development Schedules – Development Quotient).									
Intervention studies									
2	RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	170	The **physical activity interventions (planned passive cycling, dance program)** were *favourably* associated with improved psychosocial health in **2 studies** *(58, 70)*	Low[c]
Observational studies									
2	Longitudinal[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	Dose-response gradient[f]	9989	**TPA** was *favourably* associated with psychosocial health (*active vs. less active but not active vs. average*) in **1 study** *(71)* and *not* associated with psychosocial health in **1 study** *(72)*. **Sport participation** was *favourably* associated with psychosocial health (*high risk and recovery trajectories* but *not the rebound trajectory*) in **1 study** *(72)*.	Very Low[g]
6	Cross-sectional[h]	Serious risk of bias[i]	Serious inconsistency[j]	No serious indirectness	No serious imprecision	None	5517	**TPA** was *unfavourably* associated with psychosocial health in **1 study** *(67)*and *not* associated with psychosocial health in 1 study *(73)*.	Very Low[k]

								MVPA was *unfavourably* associated with psychosocial health in **1 study** *(74)*and *not* associated with psychosocial health in **1 study** *(73)*. **Bike riding** was *unfavourably* associated with psychosocial health (*for boys only on the weekday only in 1 study*) in **2 studies** *(74, 75)*. **Walking** was *not* associated with psychosocial health in **2 studies** *(74, 75)*. **Exercise play** was *favourably* associated with psychosocial health (*mixed gender (not non-mediated) and same gender but not other gender*) in **1 study** *(76) unfavourably* associated with psychosocial health (*boys only, weekend only, and only for >2 and ≤24.0 hr group)* in **1 study** *(75)*, and *not* associated with psychosocial health in **1 study** *(74)*. **Rough and tumble play** was *not* associated with psychosocial health in **2 studies** *(76, 77)*.	

RCT = randomized control trial; PA = physical activity TPA = total physical activity; MVPA = moderate- to vigorous-intensity activity.

[a] Includes 2 RCTs *(58, 70)*

[b] No intention-to-treat analysis; parent-child dyads were excluded if they did not carry out the management plan or if they became sick during the study and the physical activity program was interrupted in 1 study *(58)* Physical activity was not measured so it is not known whether the intervention significantly changed physical activity in 2 studies *(58, 70)*

[c] Quality of evidence was downgraded from high to low because of serious risk of bias.

[d] Includes 2 longitudinal studies *(71, 72)*.

[e] No psychometric properties reported for the subjective physical activity measures in 2 studies *(71, 72)*.Large loss to follow-up in 1 study *(72)*.

[f] A significant trend was observed for poor quality of life when moving from the active to less active groups in 1 study *(71)*.

[g] Quality of evidence was downgraded from low to very low due to serious risk of bias and because of this limitation was not upgraded for a dose-response gradient.

[h] Includes 6 cross-sectional studies *(67, 73-77)*.

[i] Convenience sample was used in 5 studies *(76, 77)*; *(67, 74, 75)*. Physical activity was only measured during child care in 1 study *(73)*; Potential confounders were not adjusted for in 3 adjusted studies *(67, 73, 74)*. No psychometric properties reported for the subjective physical activity measures in 1 study *(67)*. No psychometric properties reported for the outcome measure in 2 studies *(67, 76)*. Large amount of missing data in 1 study *(75)*.

[j] Favourable and unfavourable associations between physical activity and psychosocial health observed across studies.

[k] Quality of evidence was downgraded from low to very low due to serious risk of bias and serious inconsistency.

Table 1.1.4. The relationship between physical activity and cognitive development.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline ranged from 18.3 weeks to 4.94 years; where mean age was not reported baseline age ranged from 12 months to 5 years. Data were collected by RCT (n=2), clustered RCT (n=3), non-randomized intervention (n=4), cross-over trial (n=3), longitudinal (n=1) and cross-sectional (n=3) study designs with up to 8 months follow- up. Cognitive development was assessed by psychomotor skills (objectively measured), time on task (direct observation), early literacy and language skills (objectively measured), creativity (direct observation Thinking Creatively in Action and Movement test), attention (direct observation), attention span (proxy- report interview, proxy-report Child Temperament Questionnaire), literacy skills (self-report Woodcock Johnson, Peabody Picture Vocabulary Test), math skills (self-report Woodcock Johnson Applied Problems subscale), language development (objectively measured; Gessell Developmental Schedules-Development Quotient), free and cued word recall (objectively measured), cognitive function (objectively measured; Herbst Test), and sustained attention and response inhibition (objectively measured; Picture Deletion Task for Preschoolers).									
Intervention studies									
2	RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	454	The **physical activity interventions (planned passive cycling or physical activity program)** were *favourably* associated with improved cognitive development in **2 studies** *(56, 58)*.	Low[c]
~~1~~ 3	Clustered RCT[d]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	125	**The physical activity intervention (physical exercises to enact meanings of words)** was *favourably* associated with improved cognitive development in *(78)*. The **physical activity intervention (physical exercises unrelated to ~~words~~lesson)** was *favourably* (*cued recall of words but not free recall of words; geography test performance*) and *not* (*math performance or response time*) associated with improved cognitive development *(78-80)*.	High
4	Non-rando-mized interve-ntion[e]	Serious risk of bias[f]	No serious inconsistency	No serious indirectness	No serious imprecision	None	460	The **PA interventions (physical education program, free play/structured activities and academic MVPA lessons)** were *favourably* associated with improved cognitive development (*only in intervention sites that actively participated in the intervention in 1 study; for alliteration and picture naming but not for rhyming in 1 study, for alliteration, and rhyming but not for picture naming in 1 study*) in **4 studies** *(59, 81-83)*.	Low[g]

3	Cross-over /trial[h]	Serious risk of bias[i]	No serious inconsistency	No serious indirectness	No serious imprecision	None	182	**The physical activity condition (gross motor skills program or MVPA breaks)** was *favourably* associated with improved cognitive development (*sustained attention but not response inhibition in 1 study*) in **2 studies** *(84, 85)*. **Outdoor PA (recess) conditions** were *favourably* associated with cognitive development, though optimal development was observed with the shorter conditions (*10 and 20 min vs. 30 min*) in **1 study** *(86)*.	Very Low[j]
Observational studies									
1	Longitudin-al[k]	Serious risk of bias[l]	No serious inconsistency	Serious indirectness[m]	No serious imprecision	None	1093	**Extracurricular PA** was *favourably* (*2-back performance in relation to 1-back*) and *not* (2-back coefficient) associated with working memory in **1 study** *(87)*.	Very Low[n]
3	Cross-sectional[o]	Serious risk of bias[p]	No serious inconsistency	No serious indirectness	No serious imprecision	None	3138	**TPA** was *unfavourably* associated with cognitive development in **1 study** *(67)* and *not* associated with cognitive development in **1 study** *(73)*. **MVPA** was *not* associated with cognitive development in **1 study** *(73)*. **Outdoor PA** (at child care) was *not* associated with cognitive development in 1 study *(45)*.	Very Low[q]

RCT = randomized control trial; PA = physical activity; TPA = total physical activity; MVPA = moderate- to vigorous-intensity activity

[a] Includes 2 RCTs *(56, 58)*

[b] No intention-to-treat analysis; parent-child dyads were excluded if they did not carry out the management plan or if they became sick during the study and the physical activity program was interrupted in 1 study *(58)*. Physical activity was not measured so it is not known whether the intervention significantly changed physical activity in 2 studies *(56, 58)*.

[c] Quality of evidence was downgraded from high to low because of serious risk of bias.

[d] Includes 1 clustered RCT *(78)*

[e] Includes 4 non-randomized interventions *(59, 81-83)*.

[f] Physical activity was not measured so it is not known whether the intervention significantly changed physical activity in in 2 studies *(59, 83)*.

[g] Quality of evidence was downgraded from low to very low because of serious risk of bias.

[h] Includes 3 cross-over trials *(84-86)*.

[i] Condition was not randomly assigned in 1 study *(86)*. Physical activity was not measured so it is unknown if there were significant differences in physical activity between conditions in 2 studies *(84, 86)*. Unclear what conditions had significant differences in the outcome measure in 1 study *(86)*.

[j] Quality of evidence was downgraded from low to very low because of serious risk of bias.

[k]Includes 1 longitudinal study *(87)*

[l]Convenience sample; PA measures were not validated and varied from site to site; large amount of unexplained missing data/attrition *(87)*.

[m]PA was assessed subjectively only as extracurricular (non-school) PA *(87)*.

[n]Quality of evidence was downgraded from low to very low because of serious risk of bias and serious indirectness.

[o]Includes 3 cross-sectional *(45, 67, 73)*

[p] Convenience sample was used in 1 study *(67)*. Physical activity was only measured during child care in 2 studies *(45, 73)*. No potential confounders were adjusted for in 2 adjusted studies *(67, 73)*. No psychometric properties reported for the subjective physical activity measure or the outcome measure in 1 study *(67)*].

[q] Quality of evidence was downgraded from low to very low because of serious risk of bias.

Table 1.1.5. The relationship between physical activity and fitness.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline age ranged 4.04 to 4.48 years. One study reported the sample was of preschool age but did not provide a mean or range. Data were collected by longitudinal (n=2) and cross-sectional (n=2) study designs with 1-year follow-up. Fitness was assessed as cardiorespiratory fitness (treadmill test, 20-meter shuttle run from the PREFIT fitness test battery), muscular fitness including handgrip strength and standing long jump (PREFIT fitness test battery), speed-agility (4x10 shuttle run from the PREFIT fitness test battery), and physical working capacity (Ruffier's test using Ruffier–Dickson index).									
Observational studies only									
~~1~~ 2	Longi-tudinal[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	~~123~~ 261	**TPA** was *favourably* associated with **cardiorespiratory fitness** *(8)*. **MPA** was *not* associated with **cardiorespiratory fitness**, **upper-** or **lower-body muscular fitness**, or **speed/agility** *(11)*. **VPA** was *favourably* associated with **cardiorespiratory fitness**, **lower-body muscular fitness**, and **speed/agility**, and *not* associated with **upper-body muscular fitness** *(11)*. **MVPA** was *favourably* associated with **cardiorespiratory fitness**, **lower-body muscular fitness**, and **speed/agility**, and *not* associated with **upper-body muscular fitness** *(11)*.	Very Low[c]
2	Cross-sectional[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	Exposure /outcome gradient[f]	594	***Cardiorespiratory Fitness*** **TPA** was *favourably* associated with fitness (*Only for 95th, 90th, 75th but not 50th and 25th percentiles of vector magnitude in 1 study*) in **2 studies** *(21, 88)*. **LPA** was *not* associated with fitness in **1**	Very Low[g]

								study *(21)* **MPA** was *not* associated with fitness in **1 study** *(21)* **MVPA** was *favourably* associated with fitness in **1 study** *(21)* **VPA** was *favourably* associated with fitness in **1 study** *(21)* ***Other Fitness Measures*** **TPA** was *favourably* associated with fitness (*Only for 95th, 90th, 75th (not standing long-jump) but not 50th and 25th percentiles of vector magnitude*) in **1 study** *(21)* **LPA** was *not* associated with muscular fitness and speed-agility in **1 study** *(21)* **MPA** was *not* associated with muscular fitness and speed-agility in **1 study** *(21)* **MVPA** was *favourably* associated with muscular fitness (*standing long jump but not hand grip strength)* and speed-agility in **1 study** *(21)* **VPA** was *favourably* associated with muscular fitness and speed- agility in **1 study** *(21)*	

TPA = total physical activity; LPA = light-intensity physical activity; MPA = moderate-intensity physical activity; MVPA = moderate- to vigorous-intensity physical activity; VPA = vigorous intensity physical activity.

[a] Includes ~~1~~ 2 longitudinal study *(8, 11)*.
[b] The findings that were reported did not adjust for any potential confounders *(8)*.Cut points for the objective physical activity measure have not been validated for early years children *(11)*.
[c] Quality of evidence was downgraded from low to very low because of serious risk of bias.
[d] Includes 2 cross-sectional studies *(21, 88)*.
[e] No potential confounders were adjusted for, a convenience sample was used and it is unclear if the fitness measure is suitable for this age group in 1 study *(88)*. Other movement behaviours were mutually adjusted for in the fully adjusted models in 1 study *(21)*.
[f] A gradient for higher TPA, MVPA, VPA with higher fitness was observed in one study *(21)*.
[g] Quality of evidence was downgraded from low to very low due to serious risk of bias and because of this limitation was not upgraded for an exposure/outcome gradient.

Table 1.1.6. The relationship between physical activity and bone and skeletal health.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline ages ranged from 9.27 to 57.12 months. One study reported the baseline age as 6 months but a mean was not given. Data were collected by RCT (n=1), and cross-sectional design (n=6) design with up to 1-year follow-up. Several bone and skeletal health measures were assessed by X-ray absorptiometry including total bone mineral content, bone mineral density of the lumbar spine (L2-L4), total body bone area, periosteal circumference of tibia, endosteal circumference of tibia, cortical bone area of tibia, hip bone area, hip bone mineral content, areal bone mineral density, and estimated volumetric bone mineral density. Bone and skeletal health was also assessed by vitamin D (25-(OH)- vitamin D3 measured in serum), vitamin D (25-(OH)- vitamin D3 parathyroid hormone in non-fasting venous blood samples), and bone stiffness (quantitative ultrasound).									
Intervention study									
1	RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	422	The **physical activity intervention (gross motor activity program)** was *not* associated with improved bone mineral content *(89)*.	Low[c]
Observational studies									
6	Cross-sectional[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	Exposure /outcome gradient[f]	14774	**TPA** was *favourably* associated with bone and skeletal health in **2 studies** *(90, 91)* and *not* associated with bone and skeletal health in **1 study** *(92)*. **LPA** was *not* associated with bone and skeletal health in **1 study** *(90)*. **MPA** was *favourably* associated with bone and skeletal health in **1 study** *(90)*and *not* associated with bone and skeletal health in **1 study** *(92)*. **MVPA** was *favourably* associated with bone and skeletal health in **2 studies**	Very Low[g]

								VPA was *not* associated with bone and skeletal health in **2 studies** *(90, 92)*. **Outdoor activity** was *favourably* associated with bone and skeletal health in **3 studies** *(91, 94, 95)*. **Leisure time physical activity** was *favourably* associated with bone and skeletal health in **1 study** *(90)*. **Weight bearing activity** was *favourably* associated with bone and skeletal health in **1 study** *(90)*.	

RCT = randomized control trial; TPA = total physical activity; LPA = light-intensity physical activity; MPA = moderate-intensity physical activity; MVPA = moderate- to vigorous-intensity activity; VPA = vigorous-intensity physical activity.

[a] Includes 1 RCT *(89)*.
[b] The intervention did not significantly change physical activity.
[c] Quality of evidence was downgraded from high to low because of serious risk of bias.
[d] Includes 6 cross-sectional studies *(90-95)*.
[e] Potential confounders were not adjusted for in 2 studies *(94, 95)*. Movement behaviours were mutually adjusted for in the fully adjusted models in 1 study *(90)*. No psychometric properties were reported for the subjective physical activity measure in 4 studies *(90, 91, 94, 95)*. A convenience sample was used in 2 studies *(92, 94)*. Data was not provided between exposure and outcome in 1 study *(92)*.
[f] A gradient for higher TPA, MPA, MVPA, leisure time physical activity, outdoor activity and weight bearing physical activity with better bone and skeletal health was observed in 2 studies *(90, 91)*.
[g] Quality of evidence was downgraded from low to very low due to serious risk of bias and because of this limitation was not upgraded for an exposure/outcome gradient.

Table 1.1.7. The relationship between physical activity and cardiometabolic health.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of	inconsistency	indirectness	imprecision	other			
Mean baseline ranged from 3 to 4.9 years. One study only reported that the children were preschool age. Data were collected by non-randomized intervention (n=1), longitudinal (n=2), and cross-sectional (n=6) study designs with up to 2 years follow up. Cardiometabolic health was assessed by mean arterial pressure, DBP, SBP, total cholesterol, total serum cholesterol, HDL, triglycerides, HDL_2, LDL, LDL/HDL, total serum cholesterol/HDL, HDL/total triglycerides, and clustered cardiovascular risk score (SBP, triglycerides, total cholesterol/HDL, HOMA-IR, sum of two skinfolds). All outcomes were objectively measured.									
Intervention study									
1	Non-Randomized Intervention[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	264	***BP*** The **physical activity intervention (gross-motor activity program)** was _favourably_ associated with DBP during rest and activity *(96)*	Very Low[c]
Observational studies									
2	Longitudinal[d]	Serious risk of bias[e]	Serious inconsistency[f]	No serious indirectness	No serious imprecision	None	291	**BP** **Structured PA** was _not_ associated with BP (*SBP or DBP*) in **1 study** *(97)*. **Leisure PA** was _unfavourably_ associated with BP (*DBP not SBP, boys only, 1-year follow-up but not 2-year follow-up*) in **1 study** *(97)*. **Aerobic PA** was _favourably_ associated with BP (*SBP but not DBP, boys only, 2-year follow-up but not 1-year follow-up*) in **1 study** *(97)*. ***Cholesterol*** **TPA** was _not_ associated with cholesterol (*total serum cholesterol, HDL, HDL_2, LDL, LDL.HDL, or total serum cholesterol/HDL*) in **1 study** *(8)*. ***Triglycerides*** **TPA** was _not_ associated with triglycerides in **1 study** *(8)*.	Very Low[g]

6	Cross-sectional[h]	Serious risk of bias[i]	Serious inconsistency[j]	No serious indirectness	No serious imprecision	Exposure /outcome gradient[k]	1882	***Clustered Risk Score*** **TPA** was *favourably* associated with clustered risk score (*boys only, Quartile 1 vs. Quartile 5 only*) in **1 study** *(98)*. **MPA** was *not* associated with clustered risk score in **1 study** *(98)*. **MVPA** was *not* associated with clustered risk score in **1 study** *(98)*. **VPA** was *favourably* associated with clustered risk score (*boys only, Quartile 2 vs. Quartile 5 only*) in **1 study** *(98)*. ***BP*** **TPA** was *unfavourably* associated with BP (*SBP and DBP*) in **1 study** *(88)* and *not* associated with BP (*SBP, DBP, or mean arterial pressure*) in **3 studies** *(25, 33, 34)*. **Outdoor PA** was *not* associated with BP (*SBP or DBP*) in **1 study** *(33)* **Indoor PA** was *not* associated with BP (*SBP or DBP*) in **1 study** *(33)*. **Structured PA** was *not* associated with BP (*SBP or DBP*) in **1 study** *(97)*. **Leisure PA** was *not* associated with BP (*SBP or DBP*) in **1 study** *(97)*. **Aerobic PA** was *not* associated with BP (*SBP or DBP*) in **1 study** *(97)*. ***Cholesterol*** **TPA** was *favourably* associated with cholesterol (*total cholesterol but not HDL*) in **1 study** *(33)* and *not* associated with cholesterol (*total cholesterol, HDL, or HDL/total cholesterol)* in **1 study** *(34)*. **Outdoor PA** was *unfavourably* associated with cholesterol (HDL but not *total cholesterol*) in **1 study** *(33)*. **Indoor PA** was *not* associated with cholesterol (*total cholesterol or HDL*) in **1 study** *(33)*. **Triglycerides** **TPA** was *not* associated with cholesterol (*total cholesterol, HDL, or HDL/total cholesterol*) in **1 study** *(34)*	Low[l]

BP = blood pressure; SBP = systolic blood pressure; DBP = diastolic blood pressure; HDL = high-density lipoprotein cholesterol; LDL = low-density lipoprotein cholesterol; HOMA-IR = homeostatic model assessment – insulin resistance; PA = physical activity; TPA = total physical activity; MPA = moderate-intensity physical activity; MVPA = moderate- to vigorous-intensity physical activity; VPA = vigorous intensity physical activity.

[a] Includes 1 non-randomized intervention *(96)*
[b] No intention to treat analysis; results are based on children that were measured at all three time points. Physical activity was not measured so it is not known whether the intervention significantly changed physical activity.
[c] Quality of evidence was downgraded from low to very low because of serious risk of bias.

[d] Includes 2 longitudinal studies *(8, 97)*.
[e] Potential confounders were not adjusted for in 1 study *(8)*. No psychometric properties were reported for the subjective physical activity measure in 1 study *(97)*.
[f] Favourable and unfavourable associations between physical activity and cardiometabolic health observed across studies.
[g] Quality of evidence was downgraded from low to very low because of serious risk of bias and serious inconsistency.
[h] Includes 6 cross-sectional studies *(25, 33, 34, 88, 97, 98)*.
[i] No potential confounders were adjusted for in 5 studies *(25, 33, 34, 88, 98)*. Convenience sample in 1 study *(88)*. Large percentage of the sample with missing data in 1 study *(98)*. No psychometric properties were reported for the subjective physical activity measure in 1 study *(97)*.
[j] Favourable and unfavourable associations between physical activity and cardiometabolic health observed across studies.
[k] A gradient for higher TPA with worse total cholesterol was observed in one study *(33)*.
[l] Quality of evidence was downgraded from low to very low due to serious risk of bias and serious inconsistency and because of this limitation was not upgraded for an exposure/outcome gradient.

Table 1.1.8. The relationship between physical activity and risks.

No. of studies	design	Quality Assessment					No. of participants	Absolute effect	Quality
		Risk of bias	inconsistency	indirectness	imprecision	other			
Mean baseline age ranged from 24 months to 4.5 years. Data were collected by case cross-over (n=1) and longitudinal (n=1) designs with 4.5-6.5 years follow up. Risk was assessed as injury risk (parent-reported Participant Event Monitoring method), injury severity (parent-reported minor injury severity scale), fracture incident (self-report).									
Observational studies									
1	Case cross-over[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	Serious imprecision[c]	None	170	**TPA** was *unfavourably* associated with injury risk but was *not* associated with injury severity *(99)*.	Very Low[d]
1	Longit udinal[e]	Serious risk of bias[f]	No serious inconsistency	Serious indirectness[g]	No serious imprecision	Dose-response evidence[h]	2692	**Outdoor time** was *favourably* associated with facture incidence in the winter but *unfavourably* associated with fracture incidence in the summer *(100)*	Very Low[i]

TPA – total physical activity

[a] Includes 1 case cross-over study *(99)*.
[b] Convenience sample.
[c] Wide confidence intervals for association between TPA and injury risk.
[d] Quality of evidence was downgraded from low to very low because of serious risk of bias and serious imprecision.
[e] Includes 1 longitudinal study *(100)*.
[f] No psychometric properties were reported for outdoor time and fracture incidence and there was a large loss to follow-up.
[g] Outdoor time was the measure of physical activity.
[h] Dose-response evidence was observed for higher outdoor time with lower fracture incidence.
[i] Quality of evidence was downgraded from low to very low due to serious risk of bias and serious indirectness and because of these limitations was not upgraded for dose-response evidence.

1.2 Sedentary Behaviour

PICO: In children under 5 years of age what dose [i.e., durations, patterns (frequency, interruptions), and type] of sedentary behaviour, as measured by objective and subjective methods, is associated with favourable health indicators?

(black font is from original GRADE Tables of Poitras et al., 2017 – red font are updates from Australian Guidelines - blue font are additions/edits based on recent WHO updates)

Table 1.2.1. The relationship between sedentary behaviour and adiposity.

No of partici-pants (No. of studies)	Design	Quality assessment					Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other		
The range of mean ages at time of exposure measurement was ~0.75 to 4.95 years; the oldest mean age at follow-up was ~~15.5~~ 20 years. Data were collected by randomized trial (n=1),longitudinal (n=18) case-control (n=2), cross-sectional (n=47) studies, and up to 12 years of follow-up. Adiposity measures were: BMI (absolute, z-score, SD score, percentile); fat mass, fat free mass, fat mass index, lean mass index, trunk fat mass index; % body fat (measured using BIA or DXA); skinfold ratio (triceps skinfold thickness to subscapular skinfold thickness); sum of skinfolds; waist-to-height ratio; waist-to-hip ratio; weight-for-height (z-score); weight-for-age (z-score); waist circumference (absolute, z-score for age); weight status (CDC, IOTF, or WHO cut-points; Flemish reference data; French reference standards; Rolland Cachera reference curves; United Kingdom reference standards in 1999); total fat mass (SD score); lean mass (SD score).								
Intervention study								
412 (1)	Randomized trial[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen time**[c] was significantly lower in the intervention vs control group at 2, 6, and 9 months post-intervention[d]. **BMI z-scores** were not different between the intervention and control groups at baseline or 9-month follow-up, but **BMI z-scores** increased in both groups *(101)*.	MODERATE[e]
Observational studies								
~~32,699 (13)~~ 36242 (18)	Longitudinal[f]	Serious risk of bias[g]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen-based sedentary behaviours:** *Computer (duration):* **1/1 studies** reported null associations *(102)* *Computer games (frequency):* **1/1 studies** reported null associations *(103)* *Screen time (duration):* **~~2/3~~ 2/4 studies** reported unfavourable associations *(104, 105)* **~~1/3~~ 1/4 studies** reported null associations *(14)* **1/4** studies reported mixed unfavourable and null associations *(15)*. *TV time (duration):* **~~6/10~~ 7/11 studies** reported unfavourable associations *(105-111)* **~~1/10~~ 1/11 studies** reported null associations *(112)*	VERY LOW[h]

							~~**3/10**~~ **3/11 studies** reported mixed unfavourable and null associations *(102, 103, 109)* *Watching DVDs (duration):* **1/1 studies** reported unfavourable associations *(108)* **Other sedentary behaviours:** *Time in baby seats (duration):* **1/1 studies** reported mixed unfavourable, null, and favourable associations *(7)* *Time in the car (duration):* **2/2 studies** reported null associations *(103, 107)* **Objectively measured sedentary time:** Total Sedentary time (duration): **2/2 studies** reported null associations *(9, 11)*	
1242 (2)	Case-control[i]	Serious risk of bias[j]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**TV time** *(17, 113)* and **total sedentary time** *(17)* were not different between children with **overweight/obese** (case group) or **normal weight** (control group) status, but watching **TV for ≥1 hr/day** was unfavourably associated with having **overweight status** (OR=1.71, 95% CI: 1.07, 2.75, p=0.02) *(113)*.	VERY LOW[k]
94191 (47)	Cross-sectional[l]	Serious risk of bias[m]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Objectively measured sedentary time:** *Sedentary time 30-min bouts (accelerometer derived):* **1/1 studies** reported null associations *(31)* *Total sedentary time (accelerometer-derived):* **10/11 studies** reported null associations *(28, 31, 36, 39, 40, 42, 114-117)* **1/11 studies** reported mixed unfavourable and null associations *(41)* **Screen-based sedentary behaviours:** *Computer (duration):* **3/4 studies** reported null associations *(29, 44, 47)* **1/4 studies** reported mixed unfavourable and null associations *(118)* *Screen time (duration):* **6/18 studies** reported unfavourable associations *(48, 53, 105, 119-121)* **10/18 studies** reported null associations *(29, 51, 118, 122-128)* **2/18 studies** reported mixed unfavourable and null associations *(19, 129)* *TV time (duration):* **5/23 studies** reported unfavourable associations *(44, 50, 105, 118, 130)*	VERY LOW[n]

							11/23 studies reported null associations *(8, 39, 42, 46, 47, 120, 131-135)* **5/23 studies** reported mixed unfavourable and null associations *(29, 106, 136-138)* **1/23 studies** reported mixed null and favourable associations *(139)* **1/23 studies** reported mixed unfavourable, null, and favourable associations *(140)* *Using the internet (duration):* **1/1 studies** reported null associations *(134)* *Video games (duration):* **1/1 studies** reported unfavourable associations *(134)* *Watching DVDs/videos (duration):* **1/1 studies** reported null associations *(134)* **Other sedentary behaviours:** *Sedentary quiet play (duration):* **1/1 studies** reported mixed unfavourable and null associations *(29)* *Time in baby seats (duration):* **1/1 studies** reported null associations *(7)* *Using books (duration):* **1/1 studies** reported null associations *(134)*	

BMI: Body Mass Index; CDC: Centers for Disease Control and Prevention; DXA: dual-energy X-ray absorptiometry; IOTF: International Obesity Task Force; SD: standard deviation; WHO: World Health Organization.

[a] Includes **1 randomized controlled trial** *(101)*.
[b] Serious risk of bias. Unclear if allocation was adequately concealed prior to group assignment; group allocation was adequately concealed from control, but not intervention group during the study; unclear if height and weight were directly measured or proxy-reported; baseline data were not reported, making it impossible to determine if baseline imbalances existed between groups *(101)*.
[c] Screen time was significantly lower in the intervention vs control group at 2 mo, 6 mo, and 9 mo follow-up post-intervention (mean ± SD: 2 mo: 39.48 ± 16.36 vs 86.64 ± 21.63 min/day; 6 mo: 24.72 ± 4.45 vs 84.95 ± 14.77 min/day; 9 mo: 21.15 ± 6.12 vs 93.96 ± 18.84 min/day; all *p* <0.001).
[d] Intervention: 3 printed materials and interactive CDs and one counselling call intended to decrease screen time; 8-week duration. Control: Usual care; unaware of counselling interventions.
[e] The quality of evidence from the randomized trial was downgraded from "high" to "moderate" because of a serious risk of bias that diminished the level of confidence in the observed effects.
[f] Includes **~~13~~ 18longitudinal studies** *(7, 14, 102-110, 112, 141)* from **9 unique samples**. Pagani et al. *(110)* and Fitzpatrick et al. *(109)* reported data from the Quebec Longitudinal Study of Child Development; Reilly et al. *(107)* and Leary et al. *(103)* reported data from the Avon Longitudinal Study of Parents and Children (ALSPAC); Gooze et al. *(104)* and Flores and Lin *(108)* reported data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B); and Fuller-Tyszkiewicz et al. *(106)* and Wheaton et al. *(102)* reported data from the Longitudinal Study of Australian Children (LSAC). Results are presented separately and participants are counted only once.

[g] Serious risk of bias. Questionable validity and reliability of the exposure measure *(7, 14, 102-110, 112, 141)* and *(11, 15)*Data were reported as missing, but amount and reasons were not provided *(109)* and *(15)*. Height and weight data were incomplete without explanation for 23% of the analyzed sample and 60.7% of the original cohort *(107)*. Possible selective reporting: differences between included and excluded participants were reported for confounding variables but not exposure variables without explanation *(103)*. BMI at age 3 yr was analyzed, but was not reported in the purpose or methods *(109)*. Did not account for potentially important confounding variables or mediating factors: sugar-sweetened beverage consumption and sleep were assessed but not accounted for *(105)*;diet was not measured or included in the analysis *(7)*; adjusted for physical activity *(109)*; of the potential child and family confounders that were assessed, potential confounders were included or omitted from analyses based on the authors' determination of what was "likely to be linked to our predictor or outcome variables," without providing a basis for that determination *(109)*. Data were pooled from the control and experimental groups of a messaging-based obesity prevention intervention study *(105)*. McVeigh et al 2016 *(111)*, did not properly controlled for confounding (only considered physical activity as a confounder)

[h] The quality of evidence from the longitudinal studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

[i] Includes **2 case-control studies** *(17, 113)*.

[j] Serious risk of bias. Questionable validity and reliability of the 1-day physical activity recall questionnaire *(17)*. Potentially inappropriate statistical analysis: investigators dichotomized participants by category of TV viewing of ≥1 hr/day or <1 hr/day based on exploratory bivariate analyses that showed 1 hr to be the duration most related to children's weight status *(113)*.

[k] The quality of evidence from the case-control studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

[l] Includes **47 cross-sectional studies** *(8, 26, 31, 40, 46, 48, 51, 105, 114-117, 119, 120, 122, 129, 131, 132, 136, 137)* *(19, 28, 29, 36, 39, 41, 42, 44, 47, 50, 53, 106, 118, 121, 123-128, 130, 133-135, 138-140)* from **40 unique samples**. *(40)*, Byun et al. *(115)*, and Byun et al. *(114)* reported data from the Children's Activity and Movement in Preschool Study (CHAMPS); Sijtsma et al.*(7)* and Sijtsma et al.*(26)* reported data from the Groningen Expert Center for Kids with Obesity (GECKO) Drenthe birth cohort; Manios et al. *(136)*, Kourlaba et al.*(132)*, and van Stralen et al. *(120)* reported data from the Growth, Exercise and Nutrition Epidemiological Study in preSchoolers (GENESIS); Mendoza et al. *(118)* reported data from the National Health and Nutrition Examination Survey (NHANES) 1999 to 2002, Fulton et al. *(128)* from NHANES 1999 to 2006, and Twarog et al. *(121)* from NHANES 2008 to 2012; Taverno Ross et al. *(135)* and Espana-Romero et al.*(41)* reported data from the Study of Health and Activity in Preschool Environments (SHAPES); Brown et al. *(130)* and Fuller-Tyszkiewicz et al.*(106)* reported data from the Longitudinal Study of Australian Children (LSAC); Dolinsky et al. *(117)* and Boling Turer et al. *(122)* reported data from Kids and Adults Now: Defeat Obesity! (KAN-DO). Results are presented separately and participants are counted only once.

[m] Serious risk of bias. Potentially inappropriate sampling technique: participants were a non-representative convenience sample *(50)*; sampling deviated from protocol and specific deviations were not documented *(123)*. Potentially inappropriate measurement tools were used: questionable validity and reliability of the exposure *(19, 26, 39, 42, 44, 46, 48, 50, 51, 53, 105, 106, 118-121, 123-135, 137-140)* and outcome measure *(127)*; questionable validity of exposure measure *(8, 29, 47, 122)*; poor reliability of exposure measure *(8)*; height and weight were obtained by parent-report *(51, 140)*; options for 2-3 hr and 4-5 hr were missing from the Likert-type scale used to assess screen time *(139)*; applied accelerometry cut-points were not validated for the age group of interest *(116)*. Potential attrition bias: amount of unexplained missing exposure or outcome data is unknown *(8, 120)* or ranged from 14% to 67% *(8, 31, 39, 46, 53, 115, 118, 121, 134, 135, 139)*, and reason may be related to the true outcome of interest *(31, 46, 50, 118)*. Potential selective reporting bias: statistics for non-significant relationships were not reported *(126, 136)*; authors decided post-hoc not to report analyses with continuous exposure variables *(53)*; only final model was reported *(51)*; results for correlations described in the methods section were not reported *(125)*; composite outcomes were presented without individual components; results for categorical screen time and total screen time described in the methods section were not reported *(119)*; outcomes from pooled hierarchical linear regression and variance information of included results were not reported *(140)*. Did not account for potentially important confounding variables or mediating factors: diet *(26, 28, 39, 41, 44, 46-48, 118, 120, 124, 126, 128)*; sugar-sweetened beverage consumption; and sleep *(104)*. Controlled for physical activity *(19, 36, 50, 53)*. Sleep during the day was considered sedentary time *(31)*.

[n] The quality of evidence from the cross-sectional studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

Table 1.2.2. The relationship between sedentary behaviour and motor development.

No of partici-pants (No. of studies)	Design	Quality assessment					Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other		
Participant ages at time of exposure measurement ranged from ~4 mo (0.3 yr) to 3-4 years; the oldest mean age at follow-up was 5.4 years. Data were collected by longitudinal (n=3) and cross-sectional (n=4) studies and up to 3 years of follow-up. Motor development indicators were assessed by parent-report unless otherwise indicated; specific indicators were: age at first sitting, age at first crawling, age at first walking, locomotion/locomotor skills (assessed by a "test of gross motor development" or CHAMPS Motor Skill Protocol), motor skill development (assessed by the PDMS-2 or CHAMPS Motor Skill Protocol), motor skills (assessed by a "neurological optimality score"), object control (assessed by a "test of gross motor development", or CHAMPS Motor Skill Protocol), and visual-motor abilities (assessed by the WRAVMA test).								
Observational studies								
3413 (3)	Longitudinal[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen-based sedentary behaviours:** *TV time (duration):* **2/3 studies** reported null associations*(141, 142)* **1/3 studies** reported mixed unfavourable and null associations *(143)* **Other sedentary behaviours:** *Time in a baby carrier/sling (duration):* **1/1 studies** reported null associations *(142)* *Time in a car seat (duration):* **1/1 studies** reported mixed null and favourable associations *(142)* *Time in a high chair or other chair (duration):* **1/1 studies** reported null associations *(142)* *Time in a playpen (duration):* **1/1 studies** reported null associations *(142)* *Time in a stroller (duration):* **1/1 studies** reported null associations *(142)*	VERY LOW[c]
681 (4)	Cross-sectional[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Objectively measured sedentary time:** *Sedentary time 30-min bouts (accelerometer-derived):* **1/1 studies** reported null associations *(31)* *Total sedentary time (accelerometer-derived):* **1/2 studies** reported null associations *(31)* **1/2 studies** reported mixed unfavourable and null associations*(40)* **Screen-based sedentary behaviours:** *TV time (duration):* **1/1 studies** reported unfavourable associations *(144)*	VERY LOW[f]

							Other sedentary behaviours: *Time in supine position (duration):* **1/1 studies** reported mixed unfavourable and null associations *(68)*	

CHAMPS: Children's Activity and Movement in Preschool Study; PDMS-2: Peabody Developmental Motor Scales–second edition; WRAVMA: Wide-Range Assessment of Visual Motor Ability.

[a] Includes **3 longitudinal studies** *(141-143)* from **3 unique samples**.
[b] Serious risk of bias. Questionable validity and reliability of exposure measure *(141-143)*.
[c] The quality of evidence from longitudinal studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.
[d] Includes **4 cross-sectional studies** *(31, 40, 68, 144)* from **4 unique samples**.
[e] Serious risk of bias. Questionable validity and reliability of exposure measure *(68, 144)*; large amount (30.9%) of unexplained missing data and pattern of nonresponse indicates reason for missing data may have been related to the outcome of interest *(31)*; sleep during the day was included in sedentary time exposure *(31)*.
[f] The quality of evidence from cross-sectional studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

Table 1.2.3. The relationship between sedentary behaviour and psychosocial health.

No of partici-pants (No. of studies)	Design	Quality assessment					Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other		
The range of mean ages at time of exposure measurement was ~1 to 4.3 years; the oldest mean age at follow-up was ~12 years. Data were collected by randomized trial (n=2), longitudinal (n=11) cross-sectional (n=7) studies, and up to 9.5 years of follow-up. Psychosocial health measures were: aggression toward a sibling (assessed by the Aggressive Sibling Social Behaviour Scale); aggressive behaviours/aggression, delinquent behaviours, total behaviour problems, externalizing problems, internalizing problems, emotional reactivity, anxious or depressed symptoms, and attention problems (assessed by the CBCL or Japanese CBCL); attentional problems (assessed by the hyperactivity subscale of the BPI); attention problems and hyperactivity (assessed by the BASC-2); bullying (assessed by unpublished questionnaire); co-operation, assertion, responsibility, self-control, and total social skills (assessed by the Social Skills Rating System); emotional symptoms/problems, conduct problems, hyperactivity-inattention, peer problems, and prosocial behaviour (assessed using the SDQ); self-esteem, emotional well-being, family functioning, and social networks (assessed using the KINDL^{R}); social-emotional competence (assessed by the MIT-SEA); soothability, sociability, and emotionality (assessed by the CTQ); victimization, anxiety, physical aggression, and prosocial behaviour (assessed by the SBQ); and risk of being a bully, victim, or bully-victim (assessed by unpublished questionnaire).								
Intervention studies								
~~412 (1)~~ 482 (2)	Randomized trial[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen time**[c] was significantly lower in the intervention vs control group at 2, 6, and 9 months post-intervention[d]. **Aggressive** and **delinquent behaviours** were not different between the intervention and control groups at baseline, but were significantly lower in the intervention vs control group at 9-months post-intervention *(101)*. Type of editing film: The dyads that watched the fast-paced film shifted between toys more compared to the dyads that watched the slow-paced film ($F(1,31) = 4.80$, $p = 0.036$, partial $\eta^2 = 0.134$). That is, the type of experimental film had a significant effect on the children's subsequent attention during play, as children in the fast-edit group stopped playing with a toy and switched to another one more frequently than children in the slow-edit group.	MODERATE[e]
Observational studies								
~~13301 (9)~~ ~~13412 (10)~~ 13520 (11)	Longitudinal[f]	Serious risk of bias[g]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen-based sedentary behaviours:** *Time e-gaming or on a computer (duration):* **1/1 studies** reported mixed unfavourable and null associations *(145)* **1/1 studies** reported mixed favourable and null associations *(146)* *Computer/Internet (non-gaming) use (duration):* 1/1 studies reported mixed favourable and null associations *(146)*	VERY LOW[h]

							TV/DVD/Video viewing (duration): **1/1 studies** reported null associations *(146)* *TV time (duration):* ~~**2/9**~~ **2/10 studies** reported unfavourable associations *(147, 148)* ~~**5/9**~~ **5/10 studies** reported mixed unfavourable and null associations *(110, 143, 145, 149, 150)*. ~~**1/9**~~ **2/10 studies** reported null associations *(151)* and *(9)* ~~**1/9**~~ **1/10 studies** reported mixed null and favourable associations *(152)*	
9429 (7)	Cross-sectional[i]	Serious risk of bias[j]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Objectively measured sedentary time:** *Total sedentary time (accelerometer-derived):* **1/1 studies** reported null associations *(73)* **Screen-based sedentary behaviours:** *TV time (duration):* **2/6 studies** reported unfavourable associations *(148, 153)* **2/6 studies** reported null associations *(151, 154)* **1/6 studies** reported mixed unfavourable and null associations *(155)* **1/6 studies** reported mixed null and favourable associations *(156)*	VERY LOW[k]

BASC-2: Behaviour Assessment System for Children; BPI: Behaviour Problems Index; CBCL: Child Behaviour Checklist; CTQ: Child Temperament Questionnaire; KINDL[R]: Questionnaire for Measuring Health-Related Quality of Life in Children and Adolescents-Revised Version; MIT-SEA: Modified Infant-Toddler Social and Emotional Assessment; SBQ: Social Behaviour Questionnaire; SDQ: Strengths and Difficulties Questionnaire.

[a] Includes ~~1~~ 2 **randomized controlled trials** *(101)* and *(157)*.

[b] Serious risk of bias. Unclear if allocation was adequately concealed prior to group assignment; group allocation was adequately concealed from control, but not intervention group during the study; knowledge of outcome of interest was not prevented and outcome measurement is likely to have been influenced by lack of blinding; baseline data were not reported, making it impossible to determine if baseline imbalances existed between groups *(101)*; group allocation was not blinded *(157)*.

[c] Screen time was significantly lower in the intervention vs control group at 2-, 6-, and 9-month follow-up post-intervention (mean ± SD: 2 month: 39.48 ± 16.36 vs 86.64 ± 21.63 min/day; 6 month: 24.72 ± 4.45 vs 84.95 ± 14.77 min/day; 9 month: 21.15 ± 6.12 vs 93.96 ± 18.84 min/day; all p<0.001).

[d] Intervention: 3 printed materials and interactive CDs and one counselling call, intending to decrease screen time; 8-week duration. Control: Usual care; unaware of counselling interventions.

[e] The quality of evidence from the randomized trial was downgraded from "high" to "moderate" because of a serious risk of bias in the single randomized controlled trial that diminished the level of confidence in the observed effects.

[f] Includes ~~9~~ 10 **longitudinal studies** *(110, 143, 145, 147-152)* and *(146)* from **7 unique samples.** Verlinden et al. *(149, 150)* reported data from the Generation R Study; and Pagani et al. *(110, 143)* and Watt et al. *(147)* reported data from the Quebec Longitudinal Study of Child Development (QLSCD). Results are presented separately and participants are counted only once.

[g] Serious risk of bias. Questionable validity and reliability of television duration exposure measure *(110, 143, 148-152)*; questionable validity and reliability of television duration exposure measure on weekdays only *(145)*; poor reliability of outcome measures for responsibility *(152)* and emotional symptoms, conduct problems, peer problems, and prosocial behaviour *(151)*; scale was validated for ages 7 to 18 yrs and 24% of sample was aged 6 at time of administration *(146)*; large amount of unexplained missing data and pattern of nonresponse indicates reason for missing data may have been related to the outcome of interest *(149)*; complete results were not reported for all relationships examined *(150)*.

[h] The quality of evidence from longitudinal studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.
[i] Includes **7 cross-sectional studies** *(73, 148, 151, 153-156)* from **7 unique samples.**
[j] Serious risk of bias. Questionable validity and reliability of television duration exposure measure *(148, 151, 153-156)*; poor reliability of outcome measures for emotional symptoms, conduct problems, peer problems, and prosocial behaviour *(151)*; small amount (218/4020) of unexplained missing outcome data at 3-year follow-up *(143)*.
[k] The quality of evidence from cross-sectional studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

Table 1.2.4. The relationship between sedentary behaviour and cognitive development.

No of partici-pants (No. of studies)	Design	Quality assessment					Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other		
The range of mean ages at time of exposure measurement was ~0.5 to 4.4 years; the oldest age range at follow-up was 9 to 10 years. Data were collected by longitudinal (n=12) , case-control (n=1) and cross-sectional (n=16) studies and up to 8 years of follow-up. Cognitive development indicators were: ADHD symptoms (assessed by checklists based on the DSM-IV); attentional problems (assessed by the BPI); attention span (assessed by the CTQ); classroom engagement (assessed by a Classroom Engagement Scale and an unpublished questionnaire); cognitive ability (assessed by the Imitation Sorting Task); cognitive development (assessed by BSID-II and BSID-III); cognitive inhibitory control (assessed by the Animal Stroop Task); executive function (assessed as a composite of cognitive inhibitory control and working memory capacity; the BASC-2; four tasks: grass/snow, whisper, backward digit span, tower); language development (total), auditory comprehension, expressive communication (assessed by ASQ, PLS-4, CELF-P2, CELF-4, CDI, K-ASQ, Thai CLAMS, medical diagnosis, and developmental assessment with Denver-II test); mathematical success (assessed as relative to the class distribution); mathematics, reading recognition, reading comprehension (assessed by the PIAT); number knowledge (assessed by NKT); receptive and total vocabulary (assessed by PPVT); short-term memory (assessed by the Memory for Digit Span of the WISC); speech disorders (assessed by the Chuturik test and Child Behaviour Checklist by Achenbach, conversation with parents, and clinical examination); and working memory capacity (assessed using the Animal Stroop Task and K-ABC number recall test).								
Observational studies								
~~8927 (11)~~ 10020 (12)	Longitudinal[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen-based sedentary behaviours:** *Electronic media exposure (duration):* **1/1 studies** reported unfavourable associations *(158)* *TV time (duration):* **~~5/10~~ 5/11 studies** reported unfavourable associations *(110, 143, 151, 159, 160)* **~~4/10~~ 5/11 studies** reported null associations *(141, 152, 161, 162)* and *(87)* **~~1/10~~ 1/11 studies** reported mixed unfavourable, null, and favourable associations *(163)* **Other sedentary behaviours:** *Parents reading (frequency):* 1/1 studies reported favourable associations *(160)* *Non-TV sedentary time (e.g.., homework, puzzles, computer games etc.) (high/low duration)*: **1/1 study** reported null associations *(87)*	VERY LOW[c]
166 (1)	Case-control[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Screen-based sedentary behaviours:** *TV time:* **1/1 studies** reported unfavourable associations *(164)*	VERY LOW[f]

9330 (16)	Cross-sectional[g]	Serious risk of bias[h]	No serious inconsistency	No serious indirectness	No serious imprecision	None	**Objectively measured sedentary time:** *Total sedentary time (accelerometer-derived):* **1/1 studies** reported null associations *(73)* **Screen-based sedentary behaviours:** *Computer use (yes, no):* **1/1 studies** reported null associations *(165)* *Mobile phone use (yes, no):* **1/1 studies** reported unfavourable associations *(165)* *TV time (duration):* **3/9 studies** reported unfavourable associations *(144, 166, 167)* **4/9 studies** reported null associations *(110, 151, 160, 168, 169)* **1/9 studies** reported mixed unfavourable and null associations *(170)* *Total media exposure (duration):* **1/1 studies** reported mixed null and unfavourable associations *(171)* *Video games (duration):* **1/1 studies** reported null associations *(172)* **Other sedentary behaviours:** *Reading with parents (duration, frequency):* **1/3 studies** reported null associations *(173)* **1/3 studies** reported favourable associations *(174)* **1/3 studies** reported mixed null and favourable associations *(171)* *Screen time (duration):* **1/1 studies** reported unfavourable associations *(175)* *Storytelling with parents (frequency):* **2/2 studies** reported mixed null and favourable associations *(171, 174)*	VERY LOW[i]

ADHD: Attention-Deficit/Hyperactivity Disorder; ASQ: Ages and Stages Questionnaire; BASC-2: Behaviour Assessment System for Children; BSID-II and BSID-III: Bayley Scales of Infant Development–second and third editions; BPI: Behavioural Problems Index; CDI: Communicative Development Inventory; CELF-P2: Clinical Evaluation of Language Fundamentals–Preschool; CELF-4: Clinical Evaluation of Language Fundamentals Fourth Edition; CLAMS: Clinical Linguistic Auditory Milestone Scale; CTQ: Child Temperament Questionnaire; DSM-IV: Diagnostic and Statistical Manual of Mental Disorders–4; K-ABC: Kaufman Assessment Battery for Children; K-ASQ: Korean–Ages and Stages Questionnaire, NKT: Number Knowledge Test; PIAT: Peabody Individual Achievement Test; PLS-4: Preschool Language Scale–4; PPVT: Peabody Picture Vocabulary Test; WISC: Wechsler Intelligence Scale for Children

[a] Includes ~~11~~ **12 longitudinal studies** *(110, 141, 143, 151, 152, 158-163)* *(87)*from ~~8~~ **9 unique samples**. Tomopoulos et al. *(158)* reported data from the Bellevue Project for Early Language, Literacy, and Education Success (BELLE); McKean et al. *(160)* reported data from the Early Language in Victoria Study (ELVS); Pagani et al. *(110, 143)* reported data from the Quebec Longitudinal Study of Child Development (QLSCD); Schmidt et al. *(141)* reported data from Project Viva; and Foster and Watkins *(161)*, Christakis et al. *(159)* and Zimmerman and Christakis *(163)* reported data from the National Longitudinal Survey of Youth, Children, and Young Adults (NLSY-Child). Results are presented separately and participants are counted only once.

[b] Serious risk of bias. Questionable validity and reliability of television duration exposure measure in all studies *(87, 110, 141, 143, 151, 152, 158-163)*; poor reliability of Attention Problems subscale of the Child Behaviour Checklist (α =0.59) *(152)*; possible reporting bias, because the relationship between TV exposure and BMI at age 3 yr was analyzed despite not being described in the methods section *(141)*; ~~two~~ three studies had unexplained missing data (30%, 34%, and 40% missing) and the pattern of nonresponse is unclear or indicates the reason for missing data may have been related to the outcome of interest *(87, 158, 160)*; data were reported incompletely for the relationship between TV exposure and reading achievement *(110)*; the methods section of one study indicated that bivariate analysis would be performed, but included variables and the results of the analysis were not reported *(160)*.

[c] The quality of evidence from longitudinal studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

[d] Includes **1 case-control study** *(164)*.

[e] Serious risk of bias. Exposure measure was described in poor detail; questionable validity and reliability of television duration exposure measure; the Denver II Scale is useful for detecting severe developmental problems but has been criticized as being unreliable for predicting less severe or specific problems; the regression model that predicted developmental delay from a composite of "age of onset of TV viewing" and "TV viewing >2 hr/day" was not pre-specified in the methods, and composite variables were not combined in analyses with other outcomes *(176)*.

[f] The quality of evidence from the case-control study was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

[g] Includes **16 cross-sectional studies** *(73, 110, 144, 151, 160, 167-172, 174, 175)*. Zimmerman et al. *(174)* and Ferguson and Donnellan *(171)* reported data from the same sample. Results are presented separately and participants are counted only once.

[h] Serious risk of bias. Potentially inappropriate sampling technique resulted in a sample with higher income and education than the overall population from which it was recruited *(171, 174)*; questionable validity and reliability of the exposure measure *(110, 154, 160, 162, 165-167, 169, 171, 172, 174, 175)*; questionable validity of exposure measure *(144)*; validation study showed overestimation of TV time exposure measure *(173)*; questionable validity and/or reliability of the outcome measure *(165, 173)*; unknown amount *(165, 174)* or between 28% and 60% *(160, 171)* of unexplained missing data and pattern of nonresponse indicates reason for missing data may have been related to the outcome of interest; incomplete reporting of exposure *(165)* and outcome *(110, 173)*; longitudinal relationships were reportedly collected but not reported in the results*(169)*; the methods section of one study indicated that bivariate analysis would be performed, but included variables and the results of the analysis were not reported *(160)*.

[i] The quality of evidence from longitudinal studies was downgraded from "low" to "very low" because of a serious risk of bias that diminished the level of confidence in the observed effects.

Table 1.2.5. The relationship between sedentary behaviour and bone and skeletal health.

No of participants (No. of studies)	Design	Quality assessment				Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision		
The mean age was 4.4 years. Data were collected by cross-sectional (n=1) study. Bone and skeletal health were assessed objectively using quantitative ultrasound.							
Observational study							
1512 (1)	Cross-sectional[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	Serious imprecision[c]	**Objectively measured sedentary time:** After adjusting for MVPA, accelerometer-derived **sedentary time** was no longer significantly associated with **bone stiffness index (SI)** in preschool children (β= -0.37; R^2=19%; *p*=0.28) *(90)*. **Screen-based sedentary behaviours:** There was no association between parent-reported **screen time** and **SI** (β=-0.04; R^2=18.4%; *p*=0.50) *(90)*.	VERY LOW[d]

MVPA: moderate-to-vigorous physical activity; SI: bone stiffness index.

[a] Includes **1 cross-sectional study** that reported data from the Identification and prevention of dietary- and lifestyle-induced health effects in children and infants (IDEFICS) sample *(90)*.
[b] Serious risk of bias. Study participants were selected by "judgment sample"; questionable validity and reliability of subjective and objective exposure measures, and of quantitative ultrasound for measurement of bone stiffness in children *(90)*.
[c] Serious imprecision. It was not possible to estimate the precision of the findings since the study did not provide a measure of variability in the results.
[d] The quality of evidence from the cross-sectional study was downgraded from "low" to "very low" because of: (1) a serious risk of bias that diminished the level of confidence in the observed effects, and (2) serious imprecision.

Table 1.2.6. The relationship between sedentary behaviour and cardiometabolic health.

No of partici-pants (No. of studies)	Design	Quality assessment				Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision		
The mean age was 3.1 years. Data were collected by cross-sectionall (n=1) study. Cardiometabolic health was assessed using an objective measure of blood pressure.							
Observational study							
276 (1)	Cross-sectional[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	**Screen-based sedentary behaviours:** Watching **TV for ≥2 hr/day** was not associated with **high blood pressure** (compared to <2 hr/day, Prevalence Ratio=0.9, 95% CI: 0.5, 1.4, *p*=0.568)*(176)*.	VERY LOW[c]

CI = confidence interval; hr = hours; TV = television

[a] Includes **1 cross-sectional study** *(176)*.
[b] Serious risk of bias. Unknown reliability and validity of the exposure measure *(176)*.
[c] The quality of evidence from the cross-sectional study was downgraded from “low” to “very low” because of a serious risk of bias that diminished the level of confidence in the observed effects.

Table 1.2.7. The relationship between sedentary behaviour and fitness.

No of partici-pants (No. of studies)	Design	Quality assessment				Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision		
The mean age at exposure measurement ranged from ~29 to 53 months (~2.4 to 4.4 yr). Data were collected by longitudinal (n=3) studies up to 8 years of follow-up. Fitness was assessed as: lower body explosive strength (standing long jump) and fitness level (parent-report level relative to other children).							
Observational studies							
~~1314 (2)~~ 1452 (3)	Longitudinal[a]	Serious risk of bias[b]	No serious inconsistency	Serious indirectness[c]	No serious imprecision	**Screen-based sedentary behaviours:** **Higher TV time** (hr/day) at age ~29 mo was unfavourably associated with **standing long-jump performance** (cm) at age 97.8 mo (B=-0.361; 95% CI: -0.576, -0.145; *p*<0.001) *(109)* and **physical fitness level** (scale from -2 to 2) in Grade 4 (β=-0.09, SE=0.0004; B=-0.01, 95% CI: -0.002, -0.02; *p*<0.01) *(110)*. A greater increase in **TV time** (hr/week) between age ~29 and ~53 months was unfavourably associated with **standing long-jump performance** (cm) at age 97.8 months (B=-0.285; 95% CI: -0.436,-0.134; *p*<0.01) *(109)* and **physical fitness level** (scale from -2 to 2, relative to other children) in Grade 4 (β=–0.10, SE=0.0003, *p*<0.01) *(110)*. **Sedentary time** at age 4.5 yr was not associated with **20-metre shuttle laps, handgrip strength, standing long jump distance, or 4 x 10 metre shuttle run time** at age 5.5 yr (p≥0.05).	VERY LOW[d]

TV = television; yr = year

[a] Includes ~~2~~ 3 **longitudinal studies** *(109, 110) (11)*from ~~1~~**2 unique samples** (QLSCD; MINISTOP).
[b] Serious risk of bias. Questionable reliability and validity of the exposure *(109, 110) (11)*and outcome *(110)* measures; large unexplained loss to follow-up and unclear if included participants differed from missing participants *(109)*; controlled for physical activity *(109, 110)*.
[c] Serious indirectness. Differences between outcomes of included studies and those of interest; only one study reported a measure of lower-body musculoskeletal fitness (lower-body strength assessed by standing long-jump performance) *(109)*, and one study reported an indirect measure of physical fitness *(110)*. No studies reported direct measures of total body musculoskeletal or cardiovascular fitness.
[d] The quality of evidence from the longitudinal studies was downgraded from "low" to "very low" because of: 1) a serious risk of bias that diminished the level of confidence in the observed effects, and 2) indirectness of the comparisons being assessed.
for a given indicator since some studies reported mixed associations. N/A: not applicable

1.3 Sleep

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

(black font is from original GRADE Tables of Chaput et al., 2017 – red font are updates from Australian Guidelines - blue font are additions/edits based on recent WHO updates)

Table 1.3.1. Association between sleep duration and adiposity in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 0 and 4.9 years. Data were collected cross-sectionally and up to 9.5 years of follow-up. Sleep duration was assessed by actigraphy or parent report. Adiposity was assessed objectively as body weight, body mass index (absolute, z-score or percentile), waist-for-length ratio, weight status (different definitions for underweight, normal weight, overweight, obese) or % body fat/fat mass/fat mass index (bioelectrical impedance, dual-energy X-ray absorptiometry, skinfolds).									
Observational studies									
~~13~~ 15	Longitudinal study[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	31,482	Out of ~~13~~ 15 longitudinal analyses, ~~10~~ 12 reported a significant association between short sleep duration and adiposity gain *(9, 10, 107, 177-183)*, 2 reported null findings *(184, 185)* , and 1 reported opposite findings, i.e. that longer sleep duration predicted adiposity gain*(186)*.	LOW
18	Cross-sectionals tudy[b]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	30,829	Out of 18 cross-sectional analyses, 10 reported a significant association between short sleep duration and adiposity *(48, 49, 181, 182, 187-192)*, 7 reported null findings *(9, 10, 29, 184, 185, 193, 194)*, and 1 reported opposite findings, i.e. that sleep duration was positively associated with BMI z-scores *(38)*.	LOW

BMI = Body mass index.

Note. Due to heterogeneity in the measurement of sleep and adiposity, a meta-analysis was not possible. Cross-hatched numbers and words indicate the GRADE table published by Chaput et al. 2017 has been updated with new data from the Australian update or the present World Health Organization (WHO) Update. Blue text represents studies identified by the WHO Update.

[a]Includes 15 longitudinal studies *(9, 10, 107, 177-186, 195)*.

[b]Includes 18 cross-sectional studies *(9, 10, 29, 38, 48, 49, 181, 182, 184, 185, 187-194)*.

Table 1.3.2. Association between sleep duration and emotional regulation in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 1 month and 4.7 years. Intervention studies were between 1 day and 25 days (in-home protocol), and longitudinal studies were up to 6 years. Sleep duration was assessed by actigraphy, polysomnography or parent report. Emotional regulation was assessed through various instruments (e.g. video- recording, cortisol response, or questionnaires).									
Intervention studies									
2	Randomized trial[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	22	Nap deprivation resulted in moderate-to-large effects on self-regulation strategies, with decreases in skepticism (d=0.77; 7% change), negative self-appraisal (d=0.92; 5% change) and increases in physical self-soothing (d=0.68; 10% change), focus on the puzzle piece that would not fit (perseveration; d=0.50; 9% change) and insistence on completing the unsolvable puzzle (d=0.91; 10% change). After losing daytime sleep, toddlers were less able to engage effectively in a difficult task and reverted to less mature self-regulation strategies than when they were well rested *(196)*. When sleep restricted, children displayed less confusion in response to neutral pictures, more negativity to neutral and negative pictures, and less positivity to positive pictures. Sleep restriction also resulted in a 34% reduction in positive emotion responses (solvable puzzle), as well as a 31% increase in negative emotion responses and a 39% decrease in confused responses (unsolvable puzzle) *(197)*.	HIGH
1	Non-randomized trial[b]	No serious risk of bias	No serious inconsistency	No serious indirectness	Serious imprecision[c]	None	7	The cortisol awakening response was robust after nighttime sleep, diminished after sleep restriction, and smaller but distinct after morning and afternoon (not evening) naps. Cortisol remained elevated 45 min after morning and afternoon naps *(198)*.	MODERATE[c]

Observational studies									
~~5~~ 7	Longitudinal study[d]	No serious risk of bias	No Serious inconsistency[e]	No serious indirectness	No serious imprecision	None	~~46,959~~ 47,199	Out of 7 longitudinal analyses, 1 reported that shorter sleep duration was associated with better emotional health *(199)*, 2 reported that shorter sleep duration was associated with worse emotional regulation at follow-up *(200, 201)* while ~~3~~ 4 reported null findings *(202-204)*;*(205)*	VERY LOW[e]
17	Cross-sectional study[f]	No serious risk of bias	Serious inconsistency[g]	No serious indirectness	No serious imprecision	None	16,536	Out of 17 cross-sectional analyses, 8 reported that shorter sleep duration was associated with poorer emotional regulation *(206-213)*, 7 reported null findings *(193, 204, 214-218)*, and 2 reported opposite associations *(219, 220)*.	VERY LOW[g]

Note. Due to heterogeneity in the measurement of sleep and emotional regulation, a meta-analysis was not possible. Cross-hatched numbers and words indicate the GRADE table published by Chaput et al. 2017 has been updated with new data from the Australian update or the present World Health Organization (WHO) Update. Blue text represents studies identified by the WHO Update.

[a] Includes 2 randomized cross-over studies *(196, 197)*.

[b] Includes 1 non-randomized intervention *(198)*.

[c] Only one study was published so the risk of imprecision is high (the quality of evidence was downgraded from high to moderate).

[d] Includes 8 longitudinal studies *(200-204)*; *(199, 205)*.

[e] Studies reported mixed findings (the quality of evidence was downgraded from low to very low).

[f] Includes 17 cross-sectional studies*(193, 204, 206-220)*. [g] Studies reported mixed findings (the quality of evidence was downgraded from low to very low).

Table 1.3.3. Association between sleep duration and cognitive development in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 6 months and 4.9 years. Data were collected by randomised trial (n=3), longitudinal (n=6) andcross-sectional (n=11) studies and up to ~~3~~ 4 years of follow-up. Sleep duration was assessed by actigraphy or parent report.Cognition was measured by various instruments including memory tasks, imitation tasks, neuropsychological tests, interviews, scales of intelligence or questionnaires.									
Intervention studies									
~~1~~ 3	Randomized trial[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	~~23~~ 131	The number of correct answers at the explicit recognition task was significantly higher in the nap (control) compared to the wake (sleep-restricted) condition, whereas implicit memory (priming task) did not differ between conditions *(221)*. Only infants who took a nap after learning produced a higher number of target actions than infants in the baseline control condition who had not seen any demonstrations of target actions, Mdiff = 0.90, p < 0.01, d = 0.93. Infants in the nap condition produced more target actions than infants in the no-nap condition, t(33.2) = −1.81, p = 0.040, d = 0.59. *(222)* Only infants in the nap-condition performed significantly more target actions than infants in the baseline control condition (Mdiff = .94, p = .048, d = .85). Furthermore, they were faster to carry out the first target action than infants in the no-nap condition. *(223)*	HIGH

Observational studies									
~~4~~ 6	Longitudinal study[b]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	~~438~~ 4292	Children getting higher proportions of their sleep at night as infants (i.e. 1 year) were found to perform better on executive functions, but did not show better general cognition *(224)*. Higher proportions of total sleep occurring at night time, at both 12 and 18 months, were associated with better performance on executive tasks, especially those involving a strong impulse control component. However, the total sleep duration at 12 and 18 months was not associated with executive functioning at 18 and 26 months. Sleep duration at 12 months was not correlated with 18 month working memory ($r=-0.11$, $p>0.05$), 26 month conflict executive functioning ($r=-0.10$, $p>0.05$) or 26 month impulse control ($r=-0.06$, $p>0.05$). Sleep duration at 18 months was not correlated with 18 month working memory ($r=-0.16$, $p>0.05$), 26 month conflict executive functioning ($r=0.09$, $p>0.05$) or 26 month impulse control ($r=-0.16$, $p>0.05$) *(225)*. The number of daytime naps was positively associated with both predicted expressive ($p=0.062$) and receptive vocabulary growth ($p=0.006$), whereas the length of nighttime sleep was negatively associated with rate of predicted expressive vocabulary growth ($p=0.045$) *(226)*. Children who had 8 h or more of sleep had significantly higher General Conceptual Ability (GCA) scores than those with 7 h or less of sleep by 35.53 points at age 3. Children with more than 10 h of sleep had higher GCA scores at age 3 compared to children with 8-9 h or less of sleep (233.91 vs. 203.92, respectively) *(227)*. Nocturnal sleep trajectories and poor PPVT-R performance at age 10 were reported to be significantly associated ($p = 0.003$). Specifically, compared to 11-h sleepers, the odds ratio of presenting poor receptive vocabulary at age 10 was 2.67 [95% CI: 1.24-5.74, $p = 0.012$] for short persistent sleepers and 1.66 (95% CI: 1.06-2.59, $p = 0.026$) for 10-h sleepers *(228)*. There was a U-shaped relationship between sleep duration at 2 years and IQ at 6 years (B per $h^2 = -0.32$; 95% CI: -0.60 to -0.04, $p = 0.03$; and between sleep duration at 2 years and language comprehension scores at 6 years (B per $h^2 = -0.002$; 95%CI: -0.004 to 0.00, $p = 0.04$).	LOW

								Long sleepers at age 2 years had 1.77 point lower IQ scores (95% CI: -3.52 to -0.01, $p < 0.05$) and 2% lower language comprehension scores (95% CI: -0.03 to -0.01, $p < 0.01$) than children who slept within the recommended TST range (11-14 hours TST). Short sleepers did not differ from children who slept within the recommended range (ps = 0.25 and 0.60, respectively). There were no linear associations between nighttime sleep duration and cognitive outcomes. There was a non-linear association between nighttime sleep duration at 2 yr and IQ at 6 yr (B per h2 = -0.46; 95%CI: -0.81 to -0.10, $p < 0.01$), and no relationship with language comprehension scores at 6 yr. Children napping more during the day at 2yr had lower subsequent language comprehension scores than children sleeping less (B = -0.01; 95% CI: -0.02 to -0.01; $p < 0.01$). Daytime napping at age 2 was not related to subsequent IQ *(229)*	
11	Cross-sectional study[c]	No serious risk of bias	No Serious inconsistency	No serious indirectness	No serious imprecision	None	10,838	Out of 11 cross-sectional analyses, 7 reported null findings *(193, 209, 213, 223, 230-232)*, 3 reported that shorter sleep duration was associated with worse cognitive function *(212, 233, 234)*, and 1 reported opposite associations *(235)*.	LOW

B = unstandardized beta; CI = confidence interval; GCA = General Conceptual Ability; IQ = Intelligence quotient; Mdiff = mean difference; TST = total sleep time

Note. Due to heterogeneity in the measurement of sleep and cognitive function, a meta-analysis was not possible. Cross-hatched numbers and words indicate the GRADE table published by Chaput et al. 2017 has been updated with new data from the Australian update or the present World Health Organization (WHO) Update. Red text represents new studies identified by the Australian update; blue text represents studies identified by the WHO Update.

[a]1 Randomized cross-over study *(221)*, 2 Randomized control trials *(222, 223)*
[b]Includes ~~4~~ 6 longitudinal studies*(224-227)*, *(228)*, *(229)*.
[c]Includes 11 cross-sectional studies *(193, 209, 212, 213, 223, 230-235)*.

Table 1.3.4. Association between sleep duration and motor development in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 7.4 months and 13 months. Data were collected cross-sectionally only. Sleep duration was assessed by actigraphy or parent report. Motor development was assessed using the Ages and Stages Questionnaire in both studies.									
Observational studies									
2	Cross-sectional study[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	1,403	Sleep duration was not associated with gross and fine motor skills *(209)*.	LOW

Note. Due to the fact that only two studies were published on sleep duration and motor development, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.
[a]Includes 2 cross-sectional studies *(209)*.

Table 1.3.5. Association between sleep duration and growth in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 4 months and 17 months. Data were collected by longitudinal (n=1) and cross-sectional (n=1) studies and up to 13 months. Sleep duration was assessed by actigraphy or parent report. Growth was assessed using the maximum stretch technique and using weight above the expected weight for length.									
Observational studies									
1	Longitudinal study[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No Serious imprecision	None	23	Saltatory length growth was associated with increased total daily sleep hours (p<0.001) and number of sleep bouts (p=0.001). Subject-specific probabilities of a growth saltation associated with sleep included a mean odds ratio of 1.20 for each additional hour of sleep (n=8, 95% CI 1.15-1.29) and 1.43 for each additional sleep bout (n=12, 95% CI 1.21-2.03) *(186)*.	VERY LOW[b]
1	Cross-sectional study[c]	No serious risk of bias	No serious inconsistency	No serious indirectness	Serious imprecision[d]	None	139,305	Using actigraphy, sleep duration was associated with weight-to-length ratio (r=-0.47, p<0.01) in girls only. Using the questionnaire, night sleep duration was associated with weight-to-length ratio (r=-0.26, p<0.05) and weight above the expected weight for length (r=-0.25, p<0.05) in the total sample *(236)*	VERY LOW[d]

Note. Due to the fact that only two studies were published on sleep duration and growth, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.

[a]Includes 1 longitudinal study *(186)*.

[b]Sleep duration was parent-reported with no psychometric properties reported. Therefore, the quality of evidence was downgraded from “low” to “very low”.

[c]Includes 1 cross-sectional study *(236)*

[d]Only one study was published so the risk of imprecision is high. Therefore, the quality of evidence was downgraded from low to very low.

Table 1.3.6. Association between sleep duration sedentary behaviours in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 6 months and 4.5 years. Data were collected by longitudinal (n=1) and cross-sectional (n=6) studies and up to 4 years. Sleep duration was assessed by parent report. Sedentary behaviours were assessed using accelerometers, time-use diaries or questionnaires.									
Observational studies									
1	Longitudinal study[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	2,984	Sleep duration at 4 years of age was inversely associated with television viewing (β=-0.07, p=0.003) and computer use (β=-0.04, p=0.001) at 6 years of age *(180)*.	VERY LOW[b]
6	Cross-sectional study[d]	No serious risk of bias	Serious inconsistency[e]	No serious indirectness	No serious imprecision	None	42751	Short sleep duration was associated with time spent watching TV (OR: 1.65, 95% CI 1.23–2.21 per additional hour/24 h) in boys. In girls, the association was not significant (p = 0.75) *(188)*. Infants who were exposed to screen media in the evening at 12 months of age had a 28-min lower nighttime sleep duration on weekdays. Moreover, infants who were exposed to screen media in the evening at age 6 months and 12 months had shorter 12-month nighttime sleep duration compared with those who were not exposed to screen media after 7 pm at both ages *(237)*. Watching more than an hour of TV in the evening was associated with short sleep duration (OR = 1.89, 95% CI 1.26–2.84). However, the association was not significant with watching more than an hour of TV in the morning (OR = 1.13, 95% CI 0.80–1.58) *(238)*. Short sleep duration was associated with longer hours spent	VERY LOW[d]

								watching television (OR = 1.91, 95% CI 1.26–2.90 for ≥4 h/day) and playing computer games (OR = 1.62, 95% CI 1.18–2.23 for ≥2 h/day) compared to not watching/playing *(239)*.	

Note. Due to the fact that only two studies were published on sleep duration and growth, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.

[a]Includes 1 longitudinal study *(180)*.

[b]Sleep duration was parent-reported with no psychometric properties reported. Therefore, the quality of evidence was downgraded from “low” to “very low”

[c]Includes 4 cross-sectional studies *(188, 237-239)*

[d]Sleep duration was parent-reported with no psychometric properties reported. Therefore, the quality of evidence was downgraded from “low” to “very low”

Table 1.3.7. Association between sleep duration and physical activity in children aged 0-4 years

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 6 months and 4.5 years. Data were collected by longitudinal (n=1) and cross-sectional (n=3) studies and up to 4 years. Sleep duration was assessed by parent report. Sedentary behaviours were assessed using accelerometers, time-use diaries or questionnaires.									
Observational studies									
1	Longitudinal study[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	2984	Sleep duration at 4 years of age was not associated with physical activity at 6 years of age (β = −0.02, 95% CI −0.09-0.03) *(180)*.	VERY LOW[b]
3	Cross-sectional study[d]	No serious risk of bias	Serious inconsistency[e]	No serious indirectness	No serious imprecision	None	2272	Longer nighttime sleep duration was associated with more physical activity (MVPA min/day: r = 0.19, p = 0.012; activity counts: r = 0.21, p = 0.006). In multivariable models, nighttime sleep duration was positively associated with physical activity (β = 0.332, p = 0.017) *(187)*. Sleep duration was not associated with physical activity in either boys (p = 0.89) or girls (p = 0.41) *(188)*. Total daily sleep duration was positively associated with physical activity in boys only (OR = 1.04, 95% CI 1.02–1.07) *(110)*.	LOW

Note. Due to the fact that only two studies were published on sleep duration and growth, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.

[a]Includes 1 longitudinal study *(180)*

[b]Sleep duration was parent-reported with no psychometric properties reported. Therefore, the quality of evidence was downgraded from "low" to "very low"

[c]Includes 3 cross-sectional studies *(110, 187, 188)*

Table 1.3.8. Association between sleep duration and quality of life/well-being in children aged 0-4 years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Children were 3 years of age and followed until first-year junior high school (approximately 13 years old). Data were collected longitudinally (approximately a 10-year follow-up period). Sleep duration was assessed by parent report. Quality of life was assessed using the Dartmouth Primary Care Cooperative Project (COOP) charts.									
Observational study									
1	Longitudinal study[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision	None	9,674	Short sleep duration at 3 years of age (< 10 h vs. > 11 h) was not associated with quality of life at age ~13 years (OR=1.15, 95% CI 0.99-1.33, p=0.06)*(103)*	VERY LOW

Note. Due to the fact that only two studies were published on sleep duration and growth, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.

[a]Includes 1 longitudinal study *(103)*.

[b]Sleep duration was parent-reported with no psychometric properties reported. Therefore, the quality of evidence was downgraded from low to very low.

Table 1.3.9. Association between sleep duration and risks/injuries in children of the early years.

No of studies	Design	Quality Assessment					No of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean age ranged between 18 months and 4.9 years. Data were collected by cross-sectional (n=3) studies only. Sleep duration was assessed by parent report. Risks/injuries were									
Observational studies									
3	Cross-sectional study[a]	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	2,382	Children with shorter sleep duration sustained a higher number of medically attended injuries (b = 0.1759, p < 0.05) *(240)*. Usual sleep duration shorter than 8 h was associated with an increased risk of accidental falls (OR = 2.7, 95% CI 1.2–6.1) *(241)* The Children's Sleep Habits Questionnaire (CSHQ) sleep duration score did not significantly differ between the high injury and low injury groups (5.93 ± 1.03 vs. 6.36 ± 0.96, respectively, p = 0.09). Also, the CSHQ sleep duration score did not significantly differ between the high-injury-behaviour and the low-injury-behaviour groups (5.73 ± 2.10 vs. 4.32 ± 1.92, respectively, p not provided) after Bonferroni correction. The Pearson correlation coefficient between sleep duration and the total Injury Behaviour Checklist score was r = 0.32, p = 0.005. To specifically examine the relationship between parent-reported sleep duration and injuries and injury behaviour, they divided the group by median split for sleep duration (low sleep < 690 min, high sleep ≥690 min). There were no significant differences in the number of injuries in the past 2 years or in the Injury Behaviour Checklist total score *(242)*	VERY LOW[b]

Note. Due to the fact that only two studies were published on sleep duration and growth, a meta-analysis was not possible. Black text represents data included in the original review from Chaput et al. 2017. No new studies were identified by the Australian update or the present World Health Organization (WHO) Update.
[a]Includes 3 cross-sectional studies *(240-242)*. [b]Studies reported mixed findings. Therefore, the quality of evidence was downgraded from low to very low.

1.4 Integrated

PICO: In children under 5 years of age what are the relationships between each of the following combinations of movement behaviours and health indicators? Sleep & Sedentary Behaviour; Sleep & Physical Activity; Sedentary Behaviour & Physical Activity; Sleep & Sedentary Behaviour & Physical Activity?

Multiple Movement Behaviours GRADE Tables (black font is from original GRADE Tables of Carson et al., 2017 – red font are updates from Australian Guidelines - blue font are additions/edits based on recent WHO updates)

Table 1.4.1. The relationship between movement behaviours and adiposity.

No. of studies	Design	Quality assessment					No. of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean baseline ages ranged from 3.29-4.97 years. One study had exposure measurements as early as 6 months (no average provided) but averaged several exposure measurements over 2 years. Data were collected by clustered RCT (n=~~2~~ 3), non-randomized intervention (n=1), longitudinal (n=~~2~~ 3), and cross-sectional (n=3) study designs. All height-for-weight indices of adiposity were objectively measured except in one study, which did not clearly indicate how measurement occurred. BMI was calculated from objectively measured height and weight. Other indicators of adiposity were assessed via bioelectrical impedance, and skinfold thickness (subscapular and tricep surae).									
Intervention studies									
~~2~~ 3	Cluster RCT[a]	Serious risk of bias[b]	No serious inconsistency	Serious indirectness[c]	No serious imprecision	None	~~1245~~ 1460	**SB+PA:** The movement behaviour interventions were *not* associated with changes in weight-for-height indices in **2 studies** *(243, 244)*. The movement behaviour intervention was *favourably* associated with body fat in **1 study** *(243)*. The movement behaviour interventions (childcare centre program or childcare centre program + home program) were *not* associated with changes in adiposity (percent body fat, fat mass, fat mass, or fat free mass) in **1 study** *(245)*	LOW[d]
1	Non-randomized intervention[e]	Serious risk of bias[f]	No serious inconsistency	No serious indirectness	No serious imprecision	None	86	**SB+PA:** The movement behaviour intervention was *favourably* associated with BMI reduction in **toddlers**, but *not* in the **preschool-aged sample** *(246)*.	VERY LOW[g]

Observational studies									
~~2~~ 3	Longitudinal[h]	Serious risk of bias[i]	No serious inconsistency	Serious indirectness[j]	No serious imprecision	Dose-response & large magnitude of an effect [k]	~~1827~~ 1965	**SB+PA:** Classification based on SB+PA variables was *not* associated with BMI percentile over 2 years in **1 study** *(247)*. Replacing 5 min/day of sedentary time with 5 min/day VP at age 4.5 yr was *favourably associated with* fat free mass index, but *unfavourably associated* with BMI at follow-up. This substitution was *not associated* with BMI at follow-up in **1 study** *(11)* **SLEEP+SB:** High levels of sleep and low levels of TV time were *favourably* associated with BMI-z scores, sum of skinfold thickness, and overweight status, and *not* associated with skinfold thickness ratio when compared to low levels of sleep and high levels of TV time in **1 study** *(248)*. High levels of sleep and low levels of TV time were *favourably* associated with BMI-z score, and *not* associated with sum of skinfold thickness, overweight status, and skinfold thickness ratio when compared to low levels of sleep, and low levels of TV time in **1 study** *(248)*. High levels of sleep and low levels of TV time were *not* associated with BMI-z score, sum of skinfold thickness, overweight status, and skinfold thickness ratio when compared to high levels of sleep and high levels of TV time in **1 study** *(248)*.	VERY LOW[l]
3	Cross-sectional[m]	Serious risk of bias[n]	No serious inconsistency	No serious indirectness	No serious imprecision	None	4874	**SB+PA:** Children with high amounts of SB and low amounts of PA were *favourably* associated with obesity classification in **1 study** *(249)* and *not* associated with obesity classification in **2 studies** *(54, 136)*.	VERY LOW[o]

BMI: body mass index; CI: confidence interval; LPA: light-intensity physical activity; MET: metabolic equivalent; MVPA: moderate- to vigorous-intensity activity; OR: odds ratio; PA: physical activity; RCT: randomized controlled trial; SB: sedentary behaviour; TPA: total physical activity; TV; television.

[a] Includes **~~2~~ 3 cluster RCTs** *(243-245)*

[b] Serious risk of bias. In 1 study, age was not adjusted for in the analysis *(243)*. Large amounts of missing data with unreported reason and imbalance in amount missing across intervention groups in one study *(245)*

[c] Serious indirectness. The sedentary behaviour component of the intervention was minimal in both studies, which could have caused a risk for indirectness. However, in 1 study the intervention significantly decreased sedentary behaviour *(243)*. Additionally, the intervention effects on movement behaviour changes may have caused a risk for indirectness. In 1 study the intervention significantly decreased sedentary behaviour and increased LPA, but had no effect on MVPA *(243)*. In another study *(244)*, the intervention had no effect on sedentary time and TPA, while the control group showed improvements in MVPA. In one study, movement behaviours did not significantly change and there was no between group difference after intervention *(245)*

[d] Quality of evidence was downgraded from "high" to "low" due to serious risk of bias and serious indirectness.

[e] Includes **1 non-randomized intervention** *(246)*.

[f] Serious risk of bias. No control group.

[g] Quality of evidence was downgraded from "low" to "very low" due to serious risk of bias.

[h] Includes **~~2~~ 3 longitudinal studies** *(11, 247, 248)*.

[i] Serious risk of bias. Both studies used convenience sampling for recruitment. One study measured movement behaviours via questionnaire and showed no evidence of psychometric testing; additionally, the analysed sample (n=915) and the full recruitment cohort (n=2128) differed on parental ethnicity, education, and household income *(248)*. Questionable validity and reliability of the exposure measure. *(11)*

[j] Serious indirectness. In 1 study, the method of classifying "less active" and "more active" groups resulted in groupings that did not significantly differ on sedentary time, but did differ on various components of LPA and MVPA (i.e., bouts per day, average minutes per bout, average MET score per bout, and total minutes per day) *(247)*.

[k] Dose-response & large magnitude of an effect. One study *(248)* showed evidence of dose-response where the group with high levels of sleep and low levels of TV time saw the most benefits for adiposity; as well, this study had a large magnitude of effect (i.e., compared to high sleep and low TV group, low sleep and high TV group had increased odds of overweight status (OR=5.93; 95% CI=2.03, 17.30))

[l] Quality of evidence was downgraded from "low" to "very low" due to serious risk of bias and serious risk of indirectness; because of this limitation, was not upgraded for dose-response and large magnitude of an effect.

[m] Includes **3 cross-sectional studies** *(54, 136, 249)*.

[n] Serious risk of bias. All studies used subjective measurements (questionnaires) with inadequate consideration of psychometric testing. One study used convenience sampling *(249)*.

[o] Quality of evidence was downgraded from "low" to "very low" due to serious risk of bias.

Table 1.4.2. The relationship between movement behaviours and motor development.

No. of studies	Design	Quality assessment					No. of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean baseline ages were 3.3 and 4.2 years. Data were collected by clustered RCT (n=3). Motor development was assessed via the Movement Assessment Battery for Children and the Test of Gross Motor Development–2.									
Intervention studies									
~~2~~ 3	Cluster RCT[a]	Serious risk of bias[b]	No serious inconsistency	Serious indirectness[c]	No serious imprecision	None	~~1245~~ 1460	**SB+PA:** The movement behaviour interventions were *favourably* associated with overall motor skills in **2 studies** *(244, 250)*. The movement behaviour interventions (childcare center program or childcare centre + home program) were *favourably* associated with motor development (locomotor skills) and *not* associated with object control skills, sum of raw scores, or gross motor quotient) in **1 study** *(251)*.	LOW[d]

LPA: light-intensity physical activity; MVPA: moderate- to vigorous-intensity physical activity; PA: physical activity; RCT = randomized controlled trial; SB: sedentary behaviour; TPA: total physical activity.

[a] Includes **~~2~~ 3 cluster RCTs** *(244, 250, 251)* .
[b] Serious risk of bias. In 1 study sex was not adjusted for in the analysis *(250)*. PA and SB were measured, but not reported at follow-up, so it is unknown if the intervention resulted in a significant change in movement behaviours; large amount of missing data with unreported reason and imbalance in amount missing across intervention groups; trends for baseline imbalance that did not reach statistical significance but that may have contributed to between-group differences at follow-up in 1 study *(251)*.
[c] Serious indirectness. The sedentary behaviour components of the interventions were minimal in both interventions, which could have caused a risk for indirectness. However, significant reductions in sedentary time were observed in 1 study *(250)*. Additionally, the intervention effects may have caused a risk for indirectness. In 1 study the intervention significantly decreased sedentary behaviour and increased LPA, but had no effect on MVPA *(250)*. In the other study *(244)*, the intervention had no effect on sedentary time and TPA, while the control group showed improvements in MVPA. PA and SB were measured but not reported, so it is unknown if the intervention resulted in a significant change in PA in 1 study *(251)*
[d] Quality of evidence was downgraded from "high" to "low" due to serious risk of bias and serious indirectness.

Table 1.4.3. The relationship between movement behaviours and fitness.

No. of studies	Design	Quality assessment					No. of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean baseline age of 4.48 years. Data were collected by longitudinal (n=1) and cross-sectional (n=1) study design. Fitness was assessed using the PREFIT fitness test battery, and included cardiorespiratory fitness (i.e., 20-metre shuttle run), muscular fitness (i.e., handgrip strength and standing long jump), and speed-agility (i.e., 4x10-m shuttle run).									
Observational studies									
1	Longitudinal[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness	No serious imprecision		138	**SB+PA** Replacing 5 min/day of SB with 5 min/day VPA at age 4.5 yr was *not* associated with 20-m shuttle performance or 4x10 m shuttle speed at age 5.5 yr. Replacing 5 min/day of SB with 5 min/day VPA at age 4.5 yr was *favourably* associated with handgrip strength and standing long jump at age 5.5 yr.	VERY LOW[c]
1	Cross-sectional[d]	Serious risk of bias[e]	No serious inconsistency	No serious indirectness	No serious imprecision	Exposure / indicator gradient[f]	307	**SB+PA:** Replacing SB with LPA was *unfavourably* associated with standing long jump, and *not* associated with 20-m shuttle performance, handgrip strength, or 4x10-m shuttle performance. Replacing SB with MPA was *not* associated with 20-m shuttle performance, handgrip strength, standing long jump, or 4x10-m shuttle performance.	VERY LOW[g]

								Replacing SB with VPA was *favourably* associated with 20-m shuttle performance, standing long jump, and 4x10-m shuttle performance, and *not* associated with handgrip strength.	

LPA: light-intensity physical activity; MPA: moderate-intensity physical activity; MVPA: moderate- to vigorous-intensity activity; PA: physical activity; SB: sedentary behaviour; TPA: total physical activity; VPA: vigorous-intensity physical activity.

[a] Includes **1 longitudinal study** *(11)*
[b] Serious risk of bias. Convenience sample; analyzed by predictive modelling (i.e., isotemporal substitution) instead of explanatory modelling; cut-points for wrist-worn accelerometer have not been validated for early years children
[c] Quality of evidence was downgrade from "low" to "very low" due to serious risk of bias.
[d]Includes **1 cross-sectional study** *(21)*.
[e] Serious risk of bias. This study used convenience sampling for recruitment. As well, the analysis relied on predictive modelling (i.e., isotemporal substitution) instead of explanatory modelling (e.g., linear regression).
[f] Exposure/indicator gradient. A gradient for higher TPA, MVPA, VPA with higher fitness was observed.
[g] Quality of evidence was downgraded from "low" to "very low" due to serious risk of bias; because of this limitation, was not upgraded for an exposure/indicator gradient.

Table 1.4.4. The relationship between movement behaviours and growth.

No. of studies	Design	Quality assessment					No. of participants	Absolute effect	Quality
		Risk of bias	Inconsistency	Indirectness	Imprecision	Other			
Mean baseline age of 3.3 years, and range of 2.5-3.5 years. Data were collected by cluster RCT (n=1) and longitudinal study design (n=1). Height and weight were objectively measured in both studies.									
Intervention study									
1	Cluster RCT[a]	Serious risk of bias[b]	No serious inconsistency	No serious indirectness[c]	No serious imprecision	None	83	**SB+PA:** The movement behaviour intervention was <u>*not*</u> associated with changes in height or weight *(243)*.	MODERATE[d]
Observational study									
1	Longitudinal[e]	No serious risk of bias[f]	No serious inconsistency	Serious indirectness[g]	No serious imprecision	None	248	**SB+PA:** Classification based on accelerometer variables did <u>*not*</u> predict weight percentile over 2 years *(247)*.	VERY LOW[h]

LPA: light-intensity physical activity; MET: metabolic equivalent; MVPA: moderate- to vigorous-intensity activity; RCT = randomized controlled trial; TPA: total physical activity.

[a] Includes **1 cluster RCT** *(243)*.
[b] Serious risk of bias. Age was not adjusted for in the analysis.
[c] No serious indirectness. The sedentary behaviour component of the intervention was minimal, which could have caused a risk for indirectness. However, the intervention did lead to significantly reduced sedentary time *(243)*. Additionally, while the intervention had no effect on MVPA, it did lead to increased TPA and LPA.
[d] Quality of evidence was downgraded from "high" to "moderate" due to serious risk of bias.
[e] Includes **1 longitudinal study** *(247)*.
[f] No serious risk of bias. This sample was recruited using convenience recruiting.
[g] Serious indirectness. The method of classifying "less active" and "more active" groups did not create groups that significantly differed on sedentary time, but did differ on various components of LPA and MVPA (i.e., bouts per day, average minutes per bout, average MET score per bout, and total minutes per day).
[h] Quality of evidence was downgraded from "low" to "very low" due to serious indirectness.

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