College of Paediatrics & Child Health of Academy of Medicine Singapore

SINGAPOREAN INTEGRATED 24-HOUR ACTIVITY GUIDELINES FOR EARLY CHILDHOOD (0 – 6 YEARS)

GRADE EVIDENCE TO DECISION FRAMEWORK

What are the recommendations to provide a holistic approach towards better metabolic and general health in Singapore infants, toddlers and preschoolers?

(Health system and public health recommendation)

QUESTION

Question details

Problem: To improve the metabolic and general health of Singapore infants, toddlers and preschoolers

Option: A set of guidelines that provide holistic recommendations towards good metabolic and general health outcomes

Comparison: Separate guidelines targeting different aspects of metabolic health

Main outcomes:

- Recommendations and health effects of Physical Activity
- Recommendations and health effects of Sedentary Behaviour
- Recommendations and health effects of Sleep
- Recommendations and health effects of Eating Activity
- Recommendations and relationships of Physical Activity, Sedentary Behaviour, Sleep and Eating Activity

Setting: Singapore community

Perspective: Healthcare providers

Background

Early childhood is a critical period of growth and development that forms the foundation for future and lifelong well-being. Adopting healthy lifestyle behaviours in early childhood can potentially influence and shape these behaviours throughout life. Frameworks have been developed and advocated for early childhood health promotion and disease prevention, and this can form a key strategy in reducing future non-communicable diseases (NCDs). In the World Health Organization's (WHO's) Global Action Plan for the Prevention and Control of Non-Communicable Diseases (2013-2020), they highlighted that exposure to risk factors of NCDs often starts in early life and primary prevention in early childhood often offer the best protection against these NCDs.

ASSESSMENT

Problem

Is the problem a priority?

Research evidence

Studies from the Growing Up in Singapore Towards healthy Outcomes (GUSTO) study, a longitudinal birth cohort study, showed that screen time in infants was negatively associated with later cognition (composite IQ and verbal IQ) and toddlers with higher screen time was associated with shorter duration of physical activity and longer duration of sedentary behaviour; sleep duration of children less than 2 years of age was significantly associated with body length and that shorter sleep duration was also associated with higher body mass index and shorter body length for those at 3 months of age; infants who were fed breast milk showed better gross motor skills at 2 years and better cognitive performance at both 2 and 4.5 years of age, when compared to formula-fed infants; intake of sugar-sweetened beverages in young childhood was also related to higher risks of adiposity and, hence, risks of overweight or obesity.

Desirable effects

How substantial are the desirable anticipated effects?

Research evidence

Type of Outcome	Author	Type of Study	No. of Studies/Participants	Summary of Findings	Certainty of Evidence
Physical Activity	Carson V et al. 2017	Systematic Review	96 studies (71,291 participants)	Physical activity interventions were consistently (>60% of studies) associated with improved motor and cognitive development, and psychosocial and cardiometabolic health. Across observational studies, physical activity was consistently associated with favourable motor development, fitness, and bone and skeletal health. For intensity, light- and moderate-intensity physical activity were not consistently associated with any health indicators, whereas moderate- to vigorous-intensity, vigorous-intensity, and total physical activity were consistently favourably associated with multiple health indicators. Across study designs, consistent favourable associations with health indicators were observed for a variety of types of physical activity, including active play, aerobic, dance, prone position (infants; ≤1 year), and structured/organized. Apart from ≥30 min/day of the prone position for infants, the most favourable frequency and duration of physical activity was unclear. However, more physical activity appeared better for health	⊕⊕⊕○
	Barnett LM et al. 2016	Cohort Study	272 participants	Based on standardized TGMD-2 scores most children were average or below in their skill level at age 5. MVPA at 19 months was not a predictor of actual or perceived skill at age 5. MVPA at 3.5 years was associated with actual locomotor skill (B = 0.073, p = 0.033) and perceived total skill at 5 years of age (B = 0.059, p = 0.044). MVPA was not a predictor of actual or perceived object control skill at any age.	⊕○○○

	Leppänen M et al. 2017	Randomised Controlled Trial	138 participants	Greater VPA and MVPA at the age of 4.5 were associated with higher fat-free mass index (FFMI) at 5.5 years of age (p<0.001 and p=0.044, respectively). Furthermore, greater VPA and MVPA at the age of 4.5 were associated with higher scores for cardiorespiratory fitness, lower body muscular strength and motor fitness at 12-month follow-up (p=0.001 to p=0.031). Substituting 5-minutes/day of SB, LPA or MPA for VPA at the age of 4.5 were associated with higher FFMI, and with greater upper and lower muscular strength at 12-month follow-up (p<0.001 to p=0.046)	⊕⊕○○
	López-Vicente M et al. 2017	Cohort Study	1400 participants	Low extracurricular physical activity levels at 4 years of age were associated with a nonsignificant 0.95% (95% CI −2.81 to 0.92) reduction of correct responses in the working memory task at age 7 years of age. Low extracurricular physical activity levels at 6 years of age were associated with a 4.22% (95% CI −8.05 to −0.39) reduction of correct responses at age 14 years.	⊕⊕○○
	Mavilidi MF et al. 2018	Randomised Controlled Trial	120 participants	Results showed that children who performed task-relevant integrated physical activity performed better than children in all other conditions. In addition, children who performed physical activity, either integrated or nonintegrated, reported higher scores for enjoyment of the instructional method than the two sedentary learning conditions.	⊕⊕○○
	Saldanha-Gomes C et al. 2017	Cohort Study	883 participants	In girls, outdoor play was inversely associated with %BF (β=−0.96 (95% confidence interval: −1.60, −0.32) for those in the highest tertile of outdoor play time vs those in the lowest tertile, *P*=0.001). Overall, at the age of 2 years, dietary patterns were associated with both TV/DVD watching time and outdoor play time, but no significant and independent association was observed between dietary patterns and later adiposity.	⊕⊕○○

	Hewitt L et al. 2020	Systematic Review	16 studies (4237 participants)	Tummy time was positively associated with gross motor and total development, a reduction in the BMI-*z* score, prevention of brachycephaly, and the ability to move while prone, supine, crawling, and rolling. An indeterminate association was found for social and cognitive domains, plagiocephaly, walking, standing, and sitting. No association was found for fine motor development and communication.	⊕⊕⊕○
	Senju A et al. 2018	Cohort Study	1804 participants	In the gross motor domain, significant difference in questionnaire scores was observed between the “could” and “could-not” groups at 6 months (Hedges’ g, 1.83) and persisted until 3 years (Hedges’ g, 0.33). Significant differences were also observed in the communication, fine motor, problem solving, and personal–social domains at 6 months (Hedges’ g, 0.20–0.58) and persisted until 1, 2, 2, and 1.5 years, respectively (Hedges’ g, 0.21–0.25).	⊕⊕○○
	Barnett LM et al. 2019	Cohort Study	178 to 259 participants	Maternal physical activity optimism (4 months; β = 2.43), home physical activity equipment (9 months; β = 0.82), time outdoors – middle (9 months; β = 2.50) and highest tertile (9 months; β = 2.86), time free to move about - highest tertile (19 months; β = 2.41), time with older children - middle (19 months; β = 3.15) and highest tertile (3.5 years; β = 3.00) were predictive of better locomotor scores. Mothers’ own physical activity (9 months; β = − 0.01) and time active with mum – highest tertile (3.5 years; β = − 3.73) were negatively associated with locomotor skill. Time with older children - highest (4 months; β = 2.27) and middle tertile (19 months; β = 2.97), time free to move about – middle (19 months; β = 2.55) and highest tertile (19 months; β = 2.47), and more home equipment (9 months; β = 0.83); (3.5 years; β = 0.17) were predictive of better object control skills. Maternal physical activity knowledge (3.5 years; β = − 3.05) was negatively associated with object control skill.	⊕○○○

	Lee RL et al. 2020	Systematic Review	8 studies	The study outcome measures of unstructured play were categorized into three aspects of children's physical health, social skills and emotional wellbeing. All studies reported positive impacts on children's physical activity level, social engagement and emotional wellbeing. We conclude that our review with identified impacts would assist future research directions and policy implementation in this promising field	⊕⊕○○
	Veldman SL et al. 2021	Systematic Review	39 studies	There was moderate evidence for a positive association between physical activity and motor ($n = 11$ studies) and cognitive development ($n = 10$ studies) based on consistent findings from studies having low-to-moderate methodological quality. There was insufficient evidence for an association between physical activity and body composition ($n = 15$ studies), cardiometabolic health indicators ($n = 7$ studies), social-emotional development ($n = 2$ studies) and bone health ($n = 2$ studies) based on inconsistent findings from studies having weak-to-high methodological quality.	⊕⊕⊕○
	Pate RR et al. 2019	Systematic Review	27 studies	For weight status/adiposity, 12 of 15 studies found negative associations between physical activity and one or more measures of the outcome. For bone health, 10 articles based on 4 studies were identified, and 9 studies showed stronger bone in more active children. For cardiometabolic health, 3 studies were identified and findings were limited and inconsistent. For cognition, 2 systematic reviews were identified and findings were limited. For all four health outcomes, evidence of dose-response relationships and effect modification by demographic factors was very limited.	⊕⊕⊕○

	Xiong S et al. 2017	Systematic Review	25 studies	A significant protective effect of outdoor time was found for incident myopia (clinical trials: risk ratio (RR) = 0.536, 95% confidence interval (CI) = 0.338 to 0.850; longitudinal cohort studies: RR = 0.574, 95% CI = 0.395 to 0.834) and prevalent myopia (cross-sectional studies: OR = 0.964, 95% CI = 0.945 to 0.982). With dose–response analysis, an inverse nonlinear relationship was found with increased time outdoors reducing the risk of incident myopia. Also, pooled results from clinical trials indicated that when outdoor time was used as an intervention, there was a reduced myopic shift of −0.30 D (in both myopes and nonmyopes) compared with the control group (WMD = −0.30, 95% CI = −0.18 to −0.41) after 3 years of follow-up. However, when only myopes were considered, dose–response analysis did not find a relationship between time outdoors and myopic progression ($R2$ = 0.00064).	⊕⊕⊕○
	Lingham G et al. 2021	Cohort Study	303 participants	Spending more time outdoors during childhood was associated with reduced risk of myopia in young adulthood (multivariable odds ratio [OR] 0.82, 95% confidence interval [CI] 0.69, 0.98). Spending more time outdoors in later adolescence and young adulthood was associated with reduced risk of late-onset myopia (≥ 15 years of age, multivariable OR 0.79, 95% CI 0.64, 0.98). Spending more time outdoors in both childhood and adolescence was associated with less myopia in young adulthood.	⊕○○○
Sedentary Behaviour	Poitras VJ et al. 2017	Systematic Review	96 studies (195,430 participants)	Associations between objectively measured total sedentary time and indicators of adiposity and motor development were predominantly null. Associations between screen time and indicators of adiposity, motor or cognitive development, and psychosocial health were primarily unfavourable or null. Associations between reading/storytelling and indicators of cognitive development were favourable or null. Associations between time spent seated (e.g., in car seats or strollers) or in the supine position, and indicators of adiposity and motor development, were primarily unfavourable or null.	⊕⊕⊕○

	López-Vicente M et al. 2017	Cohort Study	1400 participants	Television watching was not associated with working memory. Other sedentary behaviors at 6 year of age were associated with a 5.07% (95% CI −9.68 to −0.46) reduction of correct responses in boys at 14 years of age.	⨁⨁◯◯
	Saldanha-Gomes C et al. 2017	Cohort Study	883 participants	In boys, TV/DVD watching time at the age of 2 years was positively associated with %BF at the age of 5 years (β=0.50 (95% confidence interval: 0.001, 1.00) for those boys with ⩾60 min per day of TV/DVD watching time vs those with ⩽15 min per day, *P*-value for trend 0.05). Overall, at the age of 2 years, dietary patterns were associated with both TV/DVD watching time and outdoor play time, but no significant and independent association was observed between dietary patterns and later adiposity.	⨁⨁◯◯
	Butte NF et al. 2016	Cohort Study	111 participants	Cross-sectionally, positive associations between sedentary activity and weight and fat-free mass (FFM) (*P* = 0.009-0.047), and a negative association between moderate-vigorous physical activity (MVPA) and percent fat mass (FM) (*P* = 0.015) were observed. TEE and activity energy expenditure (AEE) were positively associated with weight, body mass index (BMI), FFM, and FM (*P* = 0.0001-0.046). Prospectively, TEE, AEE, physical activity level, and MVPA, but not sedentary activity, were positively associated with changes in BMI (*P* = 0.0001-0.051) and FFM (*P* = 0.0001-0.037), but not percent FM. Sleep duration inversely predicted changes in FM (*P* = 0.005) and percent FM (*P* = 0.006).	⨁◯◯◯

	McVeigh J et al. 2016	Cohort Study	2411 participants	Three distinct trajectories of TV watching were identified. Class 1 (47.4%) had consistently high (>14 hrs/wk) levels of TV watching, Class 2 (37.9%) was characterised by an increase in TV watching over adolescence and Class 3 (14.7%) had consistently lower (<14 hrs/wk) TV watching over 15 years. Sex was used as an active covariate in the latent class model and was significantly associated with class membership (p<0.001), with females comprising 45%, 47% and 59% of Class 1, 2 and 3 respectively. In females, membership in Class 2 or 3 was associated with lower body fat % at age 20, compared to Class 1 (p<0.001). For males, membership in Class 2 was associated with lower body fat % compared with males in Class 1 (p = 0.026). Membership of TV watching class and mental health were not related (p>0.05).	⊕⊕○○
	Hinkley T et al. 2017	Cohort Study	108 participants	Sedentary electronic games were positively associated with intrapersonal and stress management skills and total emotional quotient. Computer/internet use was inversely associated with interpersonal, and positively associated with stress management, skills.	⊕○○○
	Aishworiya R et al. 2019	Cohort Study	387 participants	The average amount of TV viewing at 12 months was 2.0 h/day (SD 1.9). TV viewing in hours per day was a significant exposure variable for composite IQ (ß = − 1.55; 95% CI: − 2.81 to − 0.28) and verbal IQ (ß = − 1.77; 95% CI: − 3.22 to − 0.32) at 4.5 years. Our path analysis demonstrated that lower maternal education and worse maternal mood (standardized ß = − 0.27 and 0.14, respectively, $p < 0.01$ for both variables) were both risk factors for more media exposure. This path analysis also showed that maternal mood and infant TV strongly mediated the relationship between maternal education and child cognition, with an exceptional model fit (CFI > 0.99, AIC 15249.82, RMSEA < 0.001).	⊕○○○

	Chen B et al. 2020	Cohort Study	552 participants	Total screen viewing time at age 2–3 years had a significant negative association with sleep (p=0·008), light physical activity (p<0·0001), and MVPA (p<0·0001) in relation to sedentary behaviour at age 5·5 years. Compared with children who spent 1 h or less per day screen viewing at age 2–3 years, children who screen viewed for 3 h or more per day at 2–3 years engaged in more sedentary behaviour (439·8 mins per day [≤1 h screen viewing time] *vs* 480·0 mins per day [≥3 h screen viewing time]), and less light physical activity (384·6 *vs* 356·2 mins per day), and MVPA (76·2 *vs* 63·4 mins per day) at age 5·5 years. No significant differences in time spent sleeping were observed between the groups (539·5 *vs* 540·4 mins per day). Similar trends were observed for television viewing and handheld device viewing.	⊕⊕○○
	Carson V et al. 2019	Longitudinal Study	251 participants	Across the study, screen time was negatively associated with express (b = − 0.068, 95%CI: -0.114, − 0.023) and comply (b = − 0.056; 95%CI: -0.094, − 0.018) scores and positively associated with disrupt scores (b = 0.004; 95% CI: 0.001, 0.006). Findings were similar for television/videos but less consistent for video/computer games. No associations were observed for physical activity. Screen time significantly tracked at moderate-high levels (β1 = 0.63; 95% CI: 0.45, 0.81), while all other behaviors tracked at moderate levels (β1 = 0.35–0.49; $p < 0.01$) over the three time-points.	⊕○○○

	Padmapriya N et al. 2021	Cohort Study	307 participants	Greater total screen-viewing time and handheld device times were associated with higher superficial and deep subcutaneous adipose tissue volumes, but not with visceral adipose tissue volumes. Interactions with child sex were found, with significant associations with superficial and deep subcutaneous and visceral adipose tissue volumes in boys, but not in girls. Among boys, the increases in mean (95% CI) superficial and deep subcutaneous and visceral adipose tissue volumes were 24.3 (9.9, 38.7), 17.6 (7.4, 27.8), and 7.8 (2.1, 13.6) mL per hour increase in daily total screen-viewing time, respectively. Ethnicity-specific analyses showed associations of total screen-viewing time with abdominal adiposity only in Malay children. Television viewing time was not associated with abdominal adiposity.	⊕○○○
	Padmapriya N et al. 2019	Cohort Study	956 participants	Among boys and girls combined, screen-viewing was positively associated with sum of skinfold thicknesses, but not with BMI or BP. Sex-specific analyses showed significant associations with both BMI and sum of skinfold thicknesses in boys, but not in girls. Screen-viewing was not associated with BP in boys or girls. The increases in mean (95% CI) BMI per hour increase in daily total, television and handheld-devices screen-viewing among boys were 0.12 (0.03, 0.21), 0.18 (0.06, 0.30) and 0.11 (−0.07, 0.29) kg/m2, respectively. The corresponding increases in mean sum of skinfold thicknesses were 0.68 (0.29, 1.07), 0.79 (0.26, 1.32) and 1.18 (0.38, 1.99) mm.	⊕⊕○○
Sleep	Chaput JP et al. 2017	Systematic Review	69 studies (148,524 participants)	Overall, shorter sleep duration was associated with higher adiposity (20/31 studies), poorer emotional regulation (13/25 studies), impaired growth (2/2 studies), more screen time (5/5 studies), and higher risk of injuries (2/3 studies). The evidence related to cognitive development, motor development, physical activity, and quality of life/well-being was less clear, with no indicator showing consistent associations.	⊕⊕⊕○

	Seegers V et al. 2016	Cohort Study	1192 participants	Four longitudinal nocturnal sleep trajectories were identified: short persistent sleepers (*n* = 72, 6.0%), short increasing sleepers (*n* = 47, 3.9%), 10-h sleepers (*n* = 628, 52.7%) and 11-h sleepers (*n* = 445, 37.3%). In all, 14.8% of the children showed poor PPVT-R performance at age 10 years. Nocturnal sleep trajectories and poor PPVT-R performance at age 10 were associated significantly (*P* = 0.003). After adjusting for baseline receptive vocabulary performance at age 4 and other potential confounding variables, logistic regression analyses suggest that, compared to 11-h sleepers, the odds ratio of presenting poor receptive vocabulary at age 10 was 2.67 [95% confidence interval (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. These results corroborate previous findings in early childhood, and indicate that short sleep duration is associated with poor receptive vocabulary during middle childhood.	⊕⊕○○
	Collings PJ et al. 2017	Cohort Study	1338 participants	With the exception of the sum of skinfolds, sleep duration was inversely and independently associated with indices of total and abdominal adiposity in South Asian children. For example, one standard deviation (SD) higher sleep duration was associated with reduced %BF by -0.029 (95% CI: −0.053, −0.0043) SDs. Higher adiposity was also independently associated with shorter sleep duration in South Asian children (for example, %BF: β = -0.10 (-0.16, -0.028) SDs). There were no significant associations in White children.	⊕⊕○○
	Derks IP et al. 2017	Cohort Study	5161 participants	Shorter sleep duration at 2 months predicted higher BMI and fat mass in 6-year-old children, accounting for confounders and BMI at 2 months (*e.g.*, for BMI, per hour sleep, *B* = −0.018, 95% CI = −0.026; −0.009). No temporal relationships among sleep duration at other ages, later body composition, and cardiometabolic outcomes were found. The cross-lagged model indicated a bidirectional association between sleep duration and BMI in early life (2 to 6 months of age)	⊕⊕○○

	Kocevska D et al. 2016	Cohort Study	2800 participants	Nonlinear association of total sleep time at 24 months with nonverbal intelligence ($p = 0.03$) and language comprehension ($p = 0.04$) at 6 years. Toddlers sleeping within the recommended 11–14 hr had more favorable cognitive development compared with both extremes. Frequent awakenings were negatively associated with nonverbal intelligence, but not with verbal comprehension.	⊕⊕○○
	Mindell JA et al. 2017	Cohort Study	117 participants	Later bedtimes and less total sleep across the 24-hr period predicted higher internalizing problem scores, which includes indices of depression/withdrawal, general anxiety, separation distress, and inhibition. In contrast, sleep fragmentation was minimally associated with decreased social competence but not with any negative social-emotional outcomes. These results indicate that sleep patterns, primarily later bedtimes and less total sleep, appear to be associated with and predictive of social-emotional problem areas, namely, internalizing issues, in infants and toddlers.	⊕○○○
	Janssen X et al. 2020	Systematic Review	31 studies-	Results indicate that screen time is associated with poorer sleep outcomes in infants, toddlers and preschoolers. Meta-analysis confirmed these unfavorable associations in infants and toddlers but not preschoolers. For movement behaviors results were mixed, though physical activity and outdoor play in particular were favorably associated with most sleep outcomes in toddlers and preschoolers. Overall, quality of evidence was very low, with strongest evidence for daily/evening screen time use in toddlers and preschoolers. Although high-quality experimental evidence is required, our findings should prompt parents, clinicians and educators to encourage sleep-promoting behaviors (e.g., less evening screen time) in the under 5s.	⊕⊕⊕○

	Cook F et al. 2020	Cohort Study	1460 participants	283 (19.4%) infants had persistent severe sleep problems, 817 (56.0%) had moderate/fluctuating sleep problems and 360 (24.7%) infants were settled. Infants with persistent severe sleep problems were more likely to report emotional symptoms at age 4 (adjusted odds ratio (AOR)=2.70, 95% CI 1.21 to 6.05, p=0.02), and meet diagnostic criteria for an emotional disorder at age 10 (AOR=2.37, 95% CI 1.05 to 5.36, p=0.04). Infants with persistent severe sleep problems also had elevated symptoms of separation anxiety (AOR=2.44, 95% CI 1.35 to 4.41, p<0.01), fear of physical injury (AOR=2.14, 95% CI 1.09 to 4.18, p=0.03) and overall elevated anxiety (AOR=2.20, 95% CI 1.13 to 4.29, p=0.02) at age 10.	⊕⊕○○
	Sivertsen B et al. 2021	Cohort Study	35075 participants	After accounting for previous internalizing problems, short sleep duration (≤10 hr) and frequent (≥3) nightly awakenings at 1.5 years predicted the development of depressive symptoms at 8 years of age (adjusted OR = 1.28; 95% confidence interval [CI] 1.08–1.51, and adjusted OR = 1.27, 95% CI 1.08–1.50, respectively). Also, internalizing problems at 1.5 years predicted onset of later short sleep duration (adjusted OR = 1.83, 95% CI 1.32–2.54) after accounting for early sleep problems.	⊕⊕○○
	Goetz AR et al. 2019	Cohort Study	270 participants	HBW-Normal had the longest and Overweight had the shortest mean 24 hr sleep duration across all time points with NBW-Normal falling in-between the two groups. Compared with Overweight, HBW-Normal exhibited longer 24 hr sleep duration at age 6 months with this group difference maintained over infancy and toddlerhood. No group difference was found for NBW-Normal.	⊕○○○

	Deng X et al. 2021	Meta-analysis	33 studies (57848 participants)	Overall analyses revealed statistically significant associations of short (adjusted RR = 1.57, 95% CI: 1.36 to 1.81, *P* < 0.001) and long sleep duration (0.83, 0.75 to 0.93, 0.001) with obesity. Short sleep duration was also associated with significant changes in body mass index z-score (mean difference = −0.06; 95% CI: −0.09 to −0.04; *P* < 0.001). By contrast, long sleep duration was identified as a protective factor for childhood obesity. In dose–response analyses, short sleep duration was significantly associated with obesity in toddlers (1–2 years) (adjusted RR = 1.20, 95% CI: 1.07 to 1.34, *P* = 0.001), preschool-aged (3–5 years) children (1.58, 1.36 to 1.83, <0.001), and school-aged (6–13 years) children (1.82, 1.51 to 2.21, <0.001). In subgroup analyses, geographic region, sleep duration assessment, age, and follow-up interval were possible sources of heterogeneity.	⊕⊕○○
	Sparano S et al. 2019	Cohort Study	7974 participants	Children reporting shorter sleep duration at T0 had significantly higher BP values (P for trend < 0.001) compared to those who slept more. Prospective analyses showed that shorter sleep duration at baseline predicted, over the 2-year follow-up, higher increases in systolic blood pressure and diastolic blood pressure, after adjustment for age, sex, country of origin, BMI z-score, parental education, physical activity, screen time, and T0 value of the examined outcome variables (P for trend < 0.001).	⊕⊕○○
	Reynaud E et al. 2021	Cohort Study	1021 participants	Five distinct sleep-duration trajectories were identified. At age 5–6 years, probability of hyperactivity-inattention problems was increased for boys belonging to the “short sleep” and “medium-low sleep” duration trajectory and girls belonging to the “changing sleep” duration trajectory as compared with children with the medium-high sleep duration trajectory (boys: OR 2.69 [95% CI 1.18–6.16], *p* = .03 and 1.95 [1.25–3.03], *p* = .003, and girls: OR 2.79 [1.09– 7.17], *p* = .03). No associations were observed with the other SDQ subscales.	⊕⊕○○

Eating Activity	Pang WW et al. 2020	Cohort Study	491 participants	Compared to infants fed formula only, those who were bottle-fed breast milk demonstrated signifcantly better cognitive performance on both the Bayley Scales of Infant and Toddler Development (Third Edition) at 2 years [adjusted mean diference (95% CI) 1.36 (0.32, 2.40)], and on the Kaufman Brief Intelligence Test (Second Edition) at 4.5 years [7.59 (1.20, 13.99)]. Children bottle-fed breast milk also demonstrated better gross motor skills at 2 years than those fed formula [1.60 (0.09, 3.10)]. Among infants fully fed breast milk, those fed directly at the breast scored higher on several memory tasks compared to children bottle-fed breast milk, including the deferred imitation task at 6 months [0.67 (0.02, 1.32)] and relational binding tasks at 6 [0.41 (0.07, 0.74)], 41 [0.67 (0.04, 1.29)] and 54 [0.12 (0.01, 0.22)] months.	⊕○○○
	Quah PL et al. 2019	Cohort Study	767 participants	Association between SSB intake (100 ml/d increments and tertile categories) and adiposity measures (BMI standard deviation scores (sd units), sum of skinfolds (SSF)) and overweight/obesity status were examined using multivariable linear and Poisson regression models, respectively. After adjusting for confounders and additionally for energy intake, SSB intake at age 18 months were not significantly associated with later adiposity measures and overweight/obesity outcomes. In contrast, at age 5 years, SSB intake when modelled as 100 ml/d increments were associated with higher BMI by 0·09 (95 % CI 0·02, 0·16) sd units, higher SSF thickness by 0·68 (95 % CI 0·06, 1·44) mm and increased risk of overweight/obesity by 1·2 (95 % CI 1·07, 1·23) times at age 6 years. Trends were consistent with SSB intake modelled as categorical tertiles.	⊕⊕○○

	Spill MK et al. 2019	Systematic Review	27 studies	Moderate evidence from randomized controlled trials suggests that providing responsive feeding guidance to teach mothers to recognize and respond appropriately to children's hunger and satiety cues can lead to “normal” weight gain and/or “normal” weight status in children aged ≤2 y compared with children whose mothers did not receive responsive feeding guidance. Moderate evidence from longitudinal cohort studies indicates an association between maternal feeding practices and the child's weight status and/or weight gain, but the direction of effect has not been adequately studied. Restrictive feeding practices are associated with increased weight gain and higher weight status, and pressuring feeding practices are associated with decreased weight gain and lower weight status. Evidence suggests that a mother's feeding practices are related to concerns about her child's body weight.	⊕⊕⊕○
	Cristina Lindsay A et al. 2017	Systematic Review	14 studies	Non-responsive parental feeding practices and unhealthy child eating behaviors were associated with a risk of child overweight and obesity in several Southeast Asian countries. Nonetheless, due to the small number of identified studies (n = 14) and because only about half of the Southeast Asian countries (Thailand, Vietnam, Singapore, the Philippines, and Malaysia) were represented (5/11) in the examined studies, additional research is needed to further understand the factors associated with childhood obesity among children in Southeast Asia to develop interventions that are tailored to the specific needs of Southeast Asian countries and designed to address practices and behaviors that may promote childhood obesity	⊕⊕○○

	Scaglioni S et al. 2018	Narrative Review	88 studies	The family system that surrounds a child's domestic life will have an active role in establishing and promoting behaviours that will persist throughout his or her life. Early-life experiences with various tastes and flavours have a role in promoting healthy eating in future life. The nature of a narrative review makes it difficult to integrate complex interactions when large sets of studies are involved. In the current analysis, parental food habits and feeding strategies are the most dominant determinants of a child's eating behaviour and food choices. Parents should expose their offspring to a range of good food choices while acting as positive role models. Prevention programmes should be addressed to them, taking into account socioeconomic aspects and education.	⊕⊕○○
Relationships of Activity	Kuzik N et al. 2017	Systematic Review	10 studies (7436 participants)	The most ideal combinations of sedentary behaviour and physical activity were: favourably associated with motor development and fitness among preschool-aged children (3.00 to 4.99 years); both favourably and not associated with adiposity among toddlers (1.10 to 2.99 years) and preschool-aged children; and not associated with growth among toddlers and preschool-aged children. The most ideal combinations of sleep and sedentary behaviour were favourably associated with adiposity among infants (1.00 month to 1.00 years) and toddlers.	⊕⊕⊕○
	Santos R et al. 2017	Cross-Sectional Study	202 participants	Average BMI Z-scores did not significantly differ between children who complied with none or any individual guideline, any combination of meeting two guidelines, and those who met all three guidelines ($p > 0.05$). Although the lack of significant differences, participants who accomplished any combination of two guidelines or all three guidelines appear to have had a lower BMI Z-score than those complying with one of the guidelines or none.	⊕○○○

	Carson V et al. 2017	Cross-Sectional Study	552 participants	The composition of movement behaviours was significantly associated with BMI z-scores (p = 0.006) but not with WC (p = 0.718). Further, the time spent in sleep (BMI z-score: $\gamma sleep$ = −0.72; p = 0.138; WC: $\gamma sleep$ = −1.95; p = 0.285), sedentary behaviour (BMI z-score: γSB = 0.19; p = 0.624; WC: γSB = 0.87; p = 0.614), LPA (BMI z-score: γLPA = 0.62; p = 0.213, WC: γLPA = 0.23; p = 0.902), or MVPA (BMI z-score: $\gamma MVPA$ = −0.09; p = 0.733, WC: $\gamma MVPA$ = 0.08; p = 0.288) relative to the other behaviours was not significantly associated with the adiposity indicators.	⨁○○○
	Chia MY et al. 2020	Cross-Sectional Study	2384 participants	Parent-reported data showed that 12.6% *met none* while 9.6% of preschool children *met all* the WHO guidelines. 70.7%, 56.9% and 26.5%, of preschool children respectively, achieved the sleep, physical activity and screen media use guidelines within a 24-h period. 40.5% *met two* guidelines while 37.4% *met one* guideline. Significant differences were detected in the health-related quality of life among preschool children who *met all*, *none*, or *met 1–2* of the WHO guidelines (i.e. total health score: 82.9 ± 12.4 vs. 76.4 ± 15.1 vs. 78.6 ± 14.5%, $p < 0.05$; $\eta 2 = 0.008–0.11$). Our results show that the health-related quality of life of preschool children increased with the number of WHO guidelines accomplished.	⨁○○○

	Santos R et al. 2017	Cross-Sectional Study	202 Participants	Only 8.9% of the sample met the overall 24 h movement guidelines. Most of the sample met the physical activity (96.5%) and sleep (79.7%) guidelines but only 11.4% met the sedentary behavior guideline. Average BMI Z-scores did not significantly differ between children who complied with none or any individual guideline, any combination of meeting two guidelines, and those who met all three guidelines ($p > 0.05$). Although the lack of significant differences, participants who accomplished any combination of two guidelines or all three guidelines appear to have had a lower BMI Z-score than those complying with one of the guidelines or none.	⊕○○○
	Carson V et al. 2016	Cross-Sectional Study	4169 participants	The composition of movement behaviours was entered into linear regression models via an isometric log ratio transformation and was found to be associated with all health indicators ($p < 0.01$). Relative to other movement behaviours, time spent in SB or LPA was positively associated ($p < 0.04$) and time spent in MVPA or sleep was negatively associated ($p < 0.02$) with obesity risk markers. Similarly, LPA was positively associated ($p < 0.005$) and sleep was negatively associated ($p < 0.03$) with unfavourable behavioural strengths and difficulties scores and systolic blood pressure. Relative to other movement behaviours, time spent in SB was negatively associated ($p < 0.001$) and time spent in MVPA ($p < 0.001$) was positively associated with aerobic fitness. Likewise, MVPA was also negatively associated with several cardiometabolic risk markers ($p < 0.008$).	⊕○○○

	Kuzik N et al. 2020	Cross-Sectional Study	95 participants	Children accumulated 11.1 hours of sleep, 6.1 hours of stationary time, 5.1 hours of light-intensity physical activity (LPA), and 1.8 hours of moderate- to vigorous-intensity physical activity (MVPA) per day. Movement behaviour compositions were significantly associated with physical (i.e., locomotor skills, object motor skills, and total motor skills) and cognitive (i.e., working memory and vocabulary) development (R2 range: 0.11–0.18). In relation to other movement behaviours in the composition, MVPA was positively associated with most physical development outcomes; while stationary time had mixed findings for cognitive development outcomes (i.e., mainly positive associations in linear regressions but non-significant in substitution models). Most associations for LPA and sleep were non-significant.	⨁○○○

Undesirable effects

How substantial are the undesirable anticipated effects?

Research evidence

Referring to the studies listed under ‘Desirable Effects’, there is no evidence that physical activity is associated with serious risks of injury in any age group.

Certainty of the evidence

What is the overall certainty of the evidence of effects?

Research evidence

Type of Outcome	Author	Type of Study	No. of Studies/Participants	Certainty of Evidence
Physical Activity	Carson V et al. 2017	Systematic Review	96 studies (71,291 participants)	⨁⨁⨁◯
	Barnett LM et al. 2016	Cohort Study	272 participants	⨁◯◯◯
	Leppänen M et al. 2017	Randomised Controlled Trial	138 participants	⨁⨁◯◯
	López-Vicente M et al. 2017	Cohort Study	1400 participants	⨁⨁◯◯
	Mavilidi MF et al. 2018	Randomised Controlled Trial	120 participants	⨁⨁◯◯
	Saldanha-Gomes C et al. 2017	Cohort Study	883 participants	⨁⨁◯◯
	Hewitt L et al. 2020	Systematic Review	16 studies (4237 participants)	⨁⨁⨁◯
	Senju A et al. 2018	Cohort Study	1804 participants	⨁⨁◯◯
	Barnett LM et al. 2019	Cohort Study	178 to 259 participants	⨁◯◯◯
	Lee RL et al. 2020	Systematic Review	8 studies	⨁⨁◯◯
	Veldman SL et al. 2021	Systematic Review	39 studies	⨁⨁⨁◯
	Pate RR et al. 2019	Systematic Review	27 studies	⨁⨁⨁◯
	Xiong S et al. 2017	Systematic Review	25 studies	⨁⨁⨁◯
	Lingham G et al. 2021	Cohort Study	303 participants	⨁◯◯◯
Sedentary Behaviour	Poitras VJ et al. 2017	Systematic Review	96 studies (195,430 participants)	⨁⨁⨁◯
	López-Vicente M et al. 2017	Cohort Study	1400 participants	⨁⨁◯◯
	Saldanha-Gomes C et al. 2017	Cohort Study	883 participants	⨁⨁◯◯
	Butte NF et al. 2016	Cohort Study	111 participants	⨁◯◯◯
	McVeigh J et al. 2016	Cohort Study	2411 participants	⨁⨁◯◯
	Hinkley T et al. 2017	Cohort Study	108 participants	⨁◯◯◯
	Aishworiya R et al. 2019	Cohort Study	387 participants	⨁◯◯◯
	Chen B et al. 2020	Cohort Study	552 participants	⨁⨁◯◯
	Carson V et al. 2019	Longitudinal Study	251 participants	⨁◯◯◯
	Padmapriya N et al. 2021	Cohort Study	307 participants	⨁◯◯◯
	Padmapriya N et al. 2019	Cohort Study	956 participants	⨁⨁◯◯
Sleep	Chaput JP et al. 2017	Systematic Review	69 studies (148,524 participants)	⨁⨁⨁◯
	Seegers V et al. 2016	Cohort Study	1192 participants	⨁⨁◯◯
	Collings PJ et al. 2017	Cohort Study	1338 participants	⨁⨁◯◯
	Derks IP et al. 2017	Cohort Study	5161 participants	⨁⨁◯◯
	Kocevska D et al. 2016	Cohort Study	2800 participants	⨁⨁◯◯

	Mindell JA et al. 2017	Cohort Study	117 participants	⨁○○○
	Janssen X et al. 2020	Systematic Review	31 studies-	⨁⨁⨁○
	Cook F et al. 2020	Cohort Study	1460 participants	⨁⨁○○
	Sivertsen B et al. 2021	Cohort Study	35075 participants	⨁⨁○○
	Goetz AR et al. 2019	Cohort Study	270 participants	⨁○○○
	Deng X et al. 2021	Meta-analysis	33 studies (57,848 participants)	⨁⨁○○
	Sparano S et al. 2019	Cohort Study	7974 participants	⨁⨁○○
	Reynaud E et al. 2021	Cohort Study	1021 participants	⨁⨁○○
Eating Activity	Pang WW et al. 2020	Cohort Study	491 participants	⨁○○○
	Quah PL et al. 2019	Cohort Study	767 participants	⨁⨁○○
	Spill MK et al. 2019	Systematic Review	27 studies	⨁⨁⨁○
	Cristina Lindsay A et al. 2017	Systematic Review	14 studies	⨁⨁○○
	Scaglioni S et al. 2018	Narrative Review	88 studies	⨁⨁○○
Relationships of Activity	Kuzik N et al. 2017	Systematic Review	10 studies (7436 participants)	⨁⨁⨁○
	Santos R et al. 2017	Cross-Sectional Study	202 participants	⨁○○○
	Carson V et al. 2017	Cross-Sectional Study	552 participants	⨁○○○
	Chia MY et al. 2020	Cross-Sectional Study	2384 participants	⨁○○○
	Santos R et al. 2017	Cross-Sectional Study	202 Participants	⨁○○○
	Carson V et al. 2016	Cross-Sectional Study	4169 participants	⨁○○○
	Kuzik N et al. 2020	Cross-Sectional Study	95 participants	⨁○○○

Values

Is there important uncertainty about, or variability in, how much people value the main outcomes?

Research evidence

In a cross-sectional study on physical activity and sedentary behaviour in preschoolers, the findings suggested that parents and teachers value the benefit of improving their awareness and education in healthy lifestyle recommendations for young children.
Ref: Chen B, Waters CN, Compier T, Uijtdewilligen L, Petrunoff NA, Lim YW, Van Dam R, Müller-Riemenschneider F. Understanding physical activity and sedentary behaviour among preschool-aged children in Singapore: A mixed-methods approach. BMJ open. 2020 Apr 1;10(4):e030606.

Balance of effects

Does the balance between desirable and undesirable effects favour the option or the comparison?

Research evidence

In a cross-sectional study on physical activity and sedentary behaviour in preschoolers, the findings suggested that parents and teachers value the benefit of improving their awareness and education in healthy lifestyle recommendations for young children.

Reference: Chen B, Waters CN, Compier T, Uijtdewilligen L, Petrunoff NA, Lim YW, Van Dam R, Müller-Riemenschneider F. Understanding physical activity and sedentary behaviour among preschool-aged children in Singapore: A mixed-methods approach. BMJ open. 2020 Apr 1;10(4):e030606.

Resources required

How large are the resource requirements (costs)?

Research evidence

Public information materials such as infographic aids will be useful for easy understanding and reference.

Healthcare providers will need education through scientific reports and lectures or workshops to improve their understanding and delivery of these recommendations.

Long-term improvement in metabolic and general health will reduce healthcare expenditure considerably.

Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

Research evidence

Long-term improvement in metabolic and general health will reduce healthcare expenditure considerably.

This is similar to current lifestyle-related campaigns against non-communicable diseases.

Cost-effectiveness

Does the cost-effectiveness of the option favour the option or the comparison?

Research evidence

The investment in the public education of these recommendations likely will reduce future healthcare costs considerably.

This is similar to current lifestyle-related campaigns against non-communicable diseases.

Equity

What would be the impact on health equity?

Research evidence

These recommendations are available to all caregivers of infants, toddlers and preschoolers in the community.

These recommendations can be delivered from healthcare institutions, educational networks and related organisations.

Acceptability

Is the option acceptable to key stakeholders?

Research evidence

The option is likely acceptable to key stakeholders as there are current lifestyle-related guidelines and campaigns against non-communicable diseases.

Feasibility

Is the option feasible to implement?

Research evidence

The option is likely feasible to implement as this approach is similar to current lifestyle-related programmes and campaigns against non-communicable diseases.

CONCLUSIONS

Summary of judgements

Problem	- Don't know	- Varies		- No	- Probably No	- Probably Yes	**Yes**
Desirable effects	- Don't know	- Varies		- Trivial	- Small	**Moderate**	- Large
Undesirable effects	- Don't know	- Varies		- Large	- Moderate	**Small**	- Trivial
Certainty of the evidence	- No included studies			- Very low	- Low	**Moderate**	- High

Values				– Important uncertainty or variability	– Possibly important uncertainty or variability	**Probably no important uncertainty or variability**	– No important uncertainty or variability
Balance of effects	– Don't know	– Varies	– Favours the comparison	– Probably favours the comparison	– Does not favour either the option or the comparison	**Probably favours the option**	– Favours the option
Resources required	– Don't know	– Varies	– Large costs	– Moderate costs	– Negligible costs or savings	**Moderate savings**	– Large savings
Certainty of evidence of required resources	– No included studies			– Very low	– Low	**Moderate**	– High
Cost-effectiveness	– Don't know	– Varies	– Favours the comparison	– Probably favours the comparison	– Does not favour either the option or the comparison	**Probably favours the option**	– Favours the option
Equity	– Don't know	– Varies	– Reduced	– Probably reduced	– Probably no impact	**Probably increased**	– Increased
Acceptability	– Don't know	– Varies		– No	– Probably No	**Probably Yes**	– Yes
Feasibility	– Don't know	– Varies		– No	– Probably No	**Probably Yes**	– Yes

Type of recommendation

Recommendation

Consensus Statements for Infants (0 – 11 months)

1. Physical Activity: Be physically active several times a day in a variety of forms and within a safe and supervised environment, where more is better. Non screen-based interactive floor-based play is encouraged. For those not yet mobile, this includes at least 30 minutes of tummy time spread throughout the day. Planning a daily routine of physical activities may be helpful.
2. Sedentary Behaviour: Avoid restraining infants unattended for more than 1 hour at a time. Any form of screen time, including background screen time, is not recommended in infants. When sitting or lying down, it would be most beneficial for caregivers to engage the child in singing, reading, storytelling and imaginative play. Having a daily routine for activities, sleep and meals may be useful in reducing the amount of sedentary behaviour.
3. Sleep: Have a total amount of 14-17 hours (for 0-3 months of age) and 12-16 hours (for 4-11 months of age) of daily sleep, including regular naps, to promote optimal health. It is recommended for infants to sleep on their back in their own cot, in the same room as their caregivers to maintain sleep safety. Develop a regular sleep time routine to help infants fall asleep easier.
4. Eating Habit and Diet: Breastfeeding is recommended for infants when possible. From 4 to 6 months of age, introduce a variety of developmentally- and culturally-appropriate solid foods of various textures and flavours, prepared with no added salt and sugar. Provide a daily routine of meals, spaced 2-3 hourly during the day, and avoid overfeeding.

Consensus Statements for Toddlers (1 – 2years)

1. Physical Activity: Accumulate at least 180 minutes in a variety of physical activities at any intensity spread throughout the day within a safe environment, where more is better. Daily outdoor active play is highly encouraged. Caregivers should participate actively with child during all forms of active play.
2. Sedentary Behaviour: Avoid restraining toddlers on a seat for more than 1 hour at a time. Sedentary screen time, regardless of the type of device, is not recommended for children younger than 2 years of age. When sitting or lying down, it would be most beneficial to engage the child in singing, reading, storytelling or imaginative play.
3. Sleep: Have a total amount of 11-14 hours of daily sleep with regular sleep and wake-up times. Develop a bedtime routine and keep to a consistent bedtime. Provide a conducive sleep environment and avoid screen time before bed.

4. Eating Habit and Diet: Continue to increase the variety of foods offered to your child and wean off milk as the main source of nutrition. Introduce healthy family meals and offer whole milk and water, while establishing a structured routine for meal and snack times. Using food to soothe your child or as a reward is discouraged.

Consensus Statements for Preschoolers (3 – 6years)

1. Physical Activity: Accumulate at least 180 minutes of physical activity, at any intensity spread throughout the day and within a safe environment. At least 60 minutes should be moderate– to vigorous-intensity, where more is better, and can be in various forms. Older children should be exposed to a variety of age-appropriate vigorous-intensity play and engage in muscle- and bone-strengthening activities several times a week. Daily outdoor active play is highly encouraged. Caregivers should participate actively with children during all forms of active play.
2. Sedentary Behaviour: Limit the total daily amount of sedentary behaviour, such as sitting or lying down, and interrupt extended periods of time spent being sedentary. Recreational screen time, regardless of the type of screen device, should be limited to less than 1 hour.
3. Sleep: Have a total of 10-13 hours (for 3-5 years of age) or 10-11 hours (for 6 years of age) daily sleep. Older pre-schoolers may not need to nap if sufficient sleep has been obtained at night. Develop a bedtime routine and keep to a consistent bed and wake-up time. Provide a conducive sleep environment and avoid screen time before bed.
4. Eating Habit and Diet: Encourage healthy eating habits as a family, with caregivers as role models. Limit the amount and frequency of sugar-sweetened beverage consumption. Provide a structured routine for meal and snack times in appropriate portions that support growth and development. Teach your child to recognise hunger and satiety cues.

Consensus Statements for All Groups (0 – 6 years)

Integration: Aim to achieve most or all recommendations on physical activity, sedentary behaviour, sleep and diet for the best results.

Justification

We recommend these guidelines to encourage Singapore infants, toddlers and preschoolers to adopt a holistic approach towards integrating all types of activity within a daily 24-hour period. These activities (physical activity, sedentary behaviour, sleep and eating activity) are closely interrelated in terms of health benefits and time expenditure. It is equally important to understand the significance of each type of activity and aim to achieve all the recommendations consistently within 24 hours for the best health outcomes.

Detailed justification

- ☒ Problem
- ☒ Desirable effects
- ☒ Undesirable effects
- ☒ Certainty of the evidence
- ☐ Values
- ☐ Balance of effects
- ☐ Resources required
- ☐ Certainty of evidence of required resources
- ☒ Cost-effectiveness
- ☐ Equity
- ☐ Acceptability
- ☐ Feasibility

Problem

Providing holistic care of infants, toddlers and preschooler including education and promotion of healthy lifestyle activities that will build the foundation for future and life-long well-being. Lifestyle intervention, especially in early childhood, has proved to be an important process to reduce future non-communicable diseases.

Desirable effects

There is at least moderately certain evidence to support the integration of regular physical activity, limited sedentary behaviour, adequate sleep and good eating activity in promoting better general and metabolic health in infants, toddlers and preschoolers.

Undesirable effects

Safety precautions should be taken when the children are engaging in physical activities and during sleep.

Certainty of the evidence

There is at least moderately certain evidence to support the recommendations and the evidence consisted of many systematic reviews with a significant number of studies or participants.

Cost-effectiveness

Promoting healthy lifestyle behaviours in early childhood will likely reduce overall healthcare expendiure in the future.