

## Online Supplementary Material

# SINGAPORE INTEGRATED 24-HOUR ACTIVITY GUIDE FOR CHILDREN AND ADOLESCENTS GRADE EVIDENCE TO DECISION FRAMEWORK

**What are the recommendations to provide a holistic approach towards better metabolic and general health in Singapore children and adolescents?**

QUESTION

### *Question details*

**Problem:** To improve the metabolic and general health of Singapore children and adolescents (aged 7–17 years)

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

**Comparison:** Separate recommendations 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***

Metabolic morbidities in children are one of the more important non-communicable diseases (NCDs) of today. Indeed, metabolic health in paediatrics does not just include overweight and obesity but also hyperglycaemia and diabetes. At the other extreme, eating disorders with morbid weight loss and biochemical impairment result from the psychosocial effects of society with all its attendant mental health morbidities and impairment. The advent of widespread, pervasive and promiscuous social media, internet and technological influences only seek to further exacerbate and compound the overall metabolic and mental health of our children, especially in developed and well-connected societies like Singapore.

## ASSESSMENT

### ***Problem***

Is the problem a priority?

### **Research evidence**

Statistics from the Ministry of Education revealed that the proportion of overweight children has increased from 11% in 2013 to 13% in 2017.

### **Additional considerations**

Studies on children and adolescents in Singapore have previously shown that they could only meet up to 40% of the recommended physical activity level and above 70% of adolescents exceeded more than 2 hours of electronic screen time daily.

*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	Poitras VJ et al. 2016	Systematic Review	162 studies (204171 participants)	Overall, total PA was favourably associated with physical, psychological/social, and cognitive health indicators. Relationships were more consistent and robust for higher (e.g., MVPA) versus lower (e.g., LPA) intensity PA. All patterns of activity (sporadic, bouts, continuous) provided benefit. LPA was favourably associated with cardiometabolic biomarkers; data were scarce for other outcomes. These findings continue to support the importance of at least 60 min/day of MVPA for disease prevention and health promotion in children and youth, but also highlight the potential benefits of LPA and total PA. All intensities of PA should be considered in future work aimed at better elucidating the health benefits of PA in children and youth.	⊕⊕⊕○
	Janssen I et al. 2010	Systematic Review	86 studies	Physical activity was associated with numerous health benefits. The dose-response relations observed in observational studies indicate that the more physical activity, the greater the health benefit. Results from experimental studies indicate that even modest amounts of physical activity can have health benefits in high-risk youngsters (e.g., obese). To achieve substantive health benefits, the physical activity should be of at least a moderate intensity. Vigorous intensity activities may provide even greater benefit. Aerobic-based activities had the greatest health benefit, other than for bone health, in which case high-impact weight bearing activities were required.	⊕⊕○○

	Strong WB et al. 2005	Systematic Review	850 studies	Most intervention studies used supervised programs of moderate to vigorous physical activity of 30 to 45 minutes duration 3 to 5 days per week. The panel believed that a greater amount of physical activity would be necessary to achieve similar beneficial effects on health and behavioral outcomes in ordinary daily circumstances (typically intermittent and unsupervised activity).	⊕⊕⊕○
	Jakicic JM et al. 2019	Systematic Review	29 studies	The literature review identified 29 articles that were pertinent to the research question that used either cross-sectional, prospective cohort, or randomized designs. One prospective cohort study (N=4,840) reported similar associations between moderate-to-vigorous physical activity (MVPA) and all-cause mortality when examined as total MVPA, MVPA in bouts ≥5 minutes in duration, or MVPA in bouts ≥10 minutes in duration. Additional evidence was identified from cross-sectional and prospective studies to support that bouts of physical activity <10 minutes in duration are associated with a variety of health outcomes. Randomized studies only examined bouts of physical activity ≥10 minutes in duration.	⊕⊕○○
	da Silva MP et al. 2015	Systematic Review	9 studies	With the exception of a single study, studies demonstrated a high risk of methodological bias in at least 1 of the QUADAS-2 domains. Guidelines ranged from 10,000 to 16,000 steps/day for the Health studies (5–16 years old), and from 9,000 to 14,000 steps/day for PA studies (6–19 years old). Due to the high risk of methodological bias, none of the Health Cohort guidelines were endorsed. The PA Cohort study with the lowest risk of methodological bias suggested 12,000 steps/day for children and adolescents irrespective of gender.	⊕⊕○○

	Tudor-Locke C et al. 2011	Systematic Review	35 studies	Controlled studies of cadence show that continuous MVPA walking produces 3,300-3,500 steps in 30 minutes or 6,600-7,000 steps in 60 minutes in 10-15 year olds. Limited evidence suggests that a total daily physical activity volume of 10,000-14,000 steps/day is associated with 60-100 minutes of MVPA in preschool children (approximately 4-6 years of age). Across studies, 60 minutes of MVPA in primary/elementary school children appears to be achieved, on average, within a total volume of 13,000 to 15,000 steps/day in boys and 11,000 to 12,000 steps/day in girls. For adolescents (both boys and girls), 10,000 to 11,700 may be associated with 60 minutes of MVPA. Translations of time- and intensity-based guidelines may be higher than existing normative data (e.g., in adolescents) and therefore will be more difficult to achieve (but not impossible nor contraindicated).	⊕⊕○○
	Carson V et al. 2013	Cross-Sectional	1731 participants	Adjusted for confounders, each additional hour/day of low light-intensity activity was associated with 0.59 (95% CI: 1.18–0.01) mmHG lower diastolic blood pressure. Each additional hour/day of high light-intensity activity was associated with 1.67 (2.94–0.39) mmHG lower diastolic blood pressure and 0.04 (0.001–0.07) mmol/L higher HDL-cholesterol. Each additional hour/day of moderate- to vigorous-intensity activity was associated with 3.54 (5.73–1.35) mmHG lower systolic blood pressure, 5.49 (1.11–9.77)% lower waist circumference, 25.87 (6.08–49.34)% lower insulin, and 16.18 (4.92–28.53)% higher HOMA-%S.	⊕⊕○○
	Fuezeki E et al. 2017	Systematic Review	40 studies	Overall, 37 cross-sectional studies and three longitudinal studies were included in the analysis, with considerable variation observed between the studies with regard to their operationalization of light-intensity PA. Light-intensity PA was found to be beneficially associated with obesity, markers of lipid and glucose metabolism, and mortality. Few data were available on musculoskeletal outcomes and results were mixed.	⊕⊕○○

	Colley RC et al. 2012	Cross-Sectional	1613 participants	Daily step counts were correlated with daily minutes of MVPA ( $r = 0.81$ , $P < 0.0001$ ). The step count equivalents to 60 min of MVPA ranged between 11,290 and 12,512 steps per day ( $R^2$ range = 0.59–0.74). A step count target of 12,000 steps per day resulted in closer population estimates of meeting the physical activity guideline (as measured as minutes of MVPA by accelerometer) as well as improved balance between sensitivity and specificity when compared with any cut point between 8000 and 15,000 steps per day, including the currently used daily step count target of 13,500 steps per day.	⊕⊕○○
Sedentary Behaviour	Carson V et al. 2011	Cross-Sectional	2527 participants	Volume and patterns of sedentary behavior were not predictors of high CRS after adjusting for MVPA and other confounders ( $P > 0.1$ ). For types of sedentary behavior, high TV use, but not high computer use, was a predictor of high CRS after adjustment for MVPA and other confounders. Children and adolescents who watched $\geq 4$ hours per day of TV were 2.53 (95% confidence interval: 1.45-4.42) times more likely to have high CRS than those who watched $< 1$ hour per day. MVPA predicted high CRS after adjusting for all sedentary behavior measures and other confounders. After adjustment for waist circumference, MVPA also predicted high non-obesity CRS; however, the same relationship was not seen with TV use	⊕⊕○○
	Veitch J et al. 2012	Cross-Sectional	544 participants	Cross-sectional and prospective regression analyses showed that a more positive social network and higher social trust/cohesion was related to lower BMI among children. There was no evidence that time spent in physical activity or sedentary behaviors mediated this relation, despite significant associations between social networks and screen-time and between screen-time and BMI.	⊕⊕○○

	Tremblay MS et al. 2011	Systematic Review	232 studies (983840 participants)	<p>Television (TV) watching was the most common measure of sedentary behaviour and body composition was the most common outcome measure. Qualitative analysis of all studies revealed a dose-response relation between increased sedentary behaviour and unfavourable health outcomes. Watching TV for more than 2 hours per day was associated with unfavourable body composition, decreased fitness, lowered scores for self-esteem and pro-social behaviour and decreased academic achievement. Meta-analysis was completed for randomized controlled studies that aimed to reduce sedentary time and reported change in body mass index (BMI) as their primary outcome. In this regard, a metaanalysis revealed an overall significant effect of -0.81 (95% CI of -1.44 to -0.17, p = 0.01) indicating an overall decrease in mean BMI associated with the interventions. There is a large body of evidence from all study designs which suggests that decreasing any type of sedentary time is associated with lower health risk in youth aged 5-17 years. In particular, the evidence suggests that daily TV viewing in excess of 2 hours is associated with reduced physical and psychosocial health, and that lowering sedentary time leads to reductions in BMI.</p>	⊕⊕⊕○
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	Twenge JM et al. 2018	Cross-Sectional	40337 participants	After 1 h/day of use, more hours of daily screen time were associated with lower psychological well-being, including less curiosity, lower self-control, more distractibility, more difficulty making friends, less emotional stability, being more difficult to care for, and inability to finish tasks. Among 14- to 17-year-olds, high users of screens (7+ h/day vs. low users of 1 h/day) were more than twice as likely to ever have been diagnosed with depression (RR 2.39, 95% CI 1.54, 3.70), ever diagnosed with anxiety (RR 2.26, CI 1.59, 3.22), treated by a mental health professional (RR 2.22, CI 1.62, 3.03) or have taken medication for a psychological or behavioral issue (RR 2.99, CI 1.94, 4.62) in the last 12 months. Moderate use of screens (4 h/day) was also associated with lower psychological well-being. Non-users and low users of screens generally did not differ in well-being. Associations between screen time and lower psychological well-being were larger among adolescents than younger children.	⊕⊕○○
	Schimdt ME et al. 2012	Systematic Review	47 studies	Twenty-nine achieved significant reductions in TV viewing or screen-media use. Studies utilizing electronic TV monitoring devices, contingent feedback systems, and clinic-based counseling were most effective. While studies have reduced screen-media use in children, there are several research gaps, including a relative paucity of studies targeting young children ( $n = 13$ ) or minorities ( $n = 14$ ), limited long-term (>6 month) follow-up data ( $n = 5$ ), and few ( $n = 4$ ) targeting removing TVs from children's bedrooms. Attention to these issues may help increase the effectiveness of existing strategies for screen time reduction and extend them to different populations.	⊕⊕○○
	Drummy C et al. 2016	Randomised Control Trial	120 participants	Compared with the control group, the intervention group significantly increased weekday MVPA (+9.5 min) from baseline to post-intervention. There were no significant changes in BMI; however, an increase in sum-of-skinfolds of the intervention group was observed.	⊕⊕○○

	Ma JK et al. 2014	Single Cross-Over	50 participants	When comparing no-activity breaks with FUNtervals the grade 4 class demonstrated reductions in both passive (no activity = 29% ± 13% vs. FUNterval = 25% ± 13%, $p < 0.05$ , effect size (ES) = 0.31) and motor (no activity = 31% ± 16% vs. FUNterval = 24% ± 13%, $p < 0.01$ , ES = 0.48) off-task behaviour following FUNtervals. Similarly, in the grade 2 class, passive (no activity = 23% ± 14% vs. FUNterval = 14% ± 10%, $p < 0.01$ , ES = 0.74), verbal (no activity = 8% ± 8% vs. FUNterval = 5% ± 5%, $p < 0.05$ , ES = 0.45), and motor (no activity = 29% ± 17% vs. FUNterval = 14% ± 10%, $p < 0.01$ , ES = 1.076) off-task behaviours were reduced following FUNtervals. In both classrooms the effects of physical activity were greatest in those students demonstrating the highest rates of off-task behaviour on no-activity days. These data demonstrate that very brief high-intensity bouts of exercise can improve off-task behaviour in grade 2 and 4 students, particularly in students with high rates of such behaviour.	⊕○○○
Sleep	Chaput et al. 2016	Systematic Review	141 studies (592215 participants)	Overall, longer sleep duration was associated with lower adiposity indicators, better emotional regulation, better academic achievement, and better quality of life/well-being. The evidence was mixed and/or limited for the association between sleep duration and cognition, harms/injuries, and cardiometabolic biomarkers. The quality of evidence ranged from very low to high across study designs and health indicators. In conclusion, we confirmed previous investigations showing that shorter sleep duration is associated with adverse physical and mental health outcomes.	⊕⊕⊕○
	Fatima Y et al. 2015	Systematic Review	22 studies (24821 participants)	A review of 22 longitudinal studies, with subjects from diverse backgrounds, suggested an inverse association between sleep duration and BMI. Meta-analysis of 11 longitudinal studies, comprising 24,821 participants, revealed that subjects sleeping for short duration had twice the risk of being overweight/obese, compared with subjects sleeping for long duration (odds ratio 2.15; 95% confidence interval: 1.64–2.81). This study provides evidence that short sleep duration in young subjects is significantly associated with future overweight/obesity.	⊕⊕○○

	Dutil C et al. 2017	Narrative Review	23 studies	Notwithstanding the conflicting results found in these studies and despite being attenuated by adiposity level, maturity, sex and age, there is still some compelling evidence for an association between sleep duration (for both objective or subjective measurements of duration) and architecture with one or more T2D biomarkers in children and adolescents. The majority of the studies reviewed did focus on sleep duration and one or more T2D biomarkers in children and adolescents, but sleep architecture, more precisely the suppression of slow wave sleep and rapid eye movement sleep, has also been shown to be associated with insulin resistance. Only two studies looked at sleep quality, and the association between sleep quality and insulin resistance was not independent of level of adiposity	⊕○○○
	Sparano S et al. 2019	Cross-Sectional / Longitudinal	7974 participants / 5656 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, parenteral education, physical activity, screen time, and T0 value of the examined outcome variables ( $P$ for trend $< 0.001$ ). Our findings reveal that shorter sleep duration is associated with higher BP in childhood, suggesting that sleep may be a potential risk factor for hypertension later in life.	⊕⊕○○
Eating Activity	Quah PL et al. 2019	Longitudinal	871 participants	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.	⊕○○○

	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.	⊕⊕○○
	Wang DD et al. 2016	Cohort Study	83349 participants	During 3 439 954 person-years of follow-up, 33 304 deaths were documented. After adjustment for known and suspected risk factors, dietary total fat compared with total carbohydrates was inversely associated with total mortality (hazard ratio [HR] comparing extreme quintiles, 0.84; 95% CI, 0.81-0.88; $P < .001$ for trend). The HRs of total mortality comparing extreme quintiles of specific dietary fats were 1.08 (95% CI, 1.03-1.14) for saturated fat, 0.81 (95% CI, 0.78-0.84) for polyunsaturated fatty acid (PUFA), 0.89 (95% CI, 0.84-0.94) for monounsaturated fatty acid (MUFA), and 1.13 (95% CI, 1.07-1.18) for <i>trans</i> -fat ( $P < .001$ for trend for all). Replacing 5% of energy from saturated fats with equivalent energy from PUFA and MUFA was associated with estimated reductions in total mortality of 27% (HR, 0.73; 95% CI, 0.70-0.77) and 13% (HR, 0.87; 95% CI, 0.82-0.93), respectively. The HR for total mortality comparing extreme quintiles of $\omega$ -6 PUFA intake was 0.85 (95% CI, 0.81-0.89; $P < .001$ for trend). Intake of $\omega$ -6 PUFA, especially linoleic acid, was inversely associated with mortality owing to most major causes, whereas marine $\omega$ -3 PUFA intake was associated with a modestly lower total mortality (HR comparing extreme quintiles, 0.96; 95% CI, 0.93-1.00; $P = .002$ for trend).	⊕⊕○○

Relationships of Activity	Janssen I et al. 2017	Cross-Sectional	17000 participants	The findings indicating that participants achieving any given recommendation had preferable scores for the health outcomes compared with participants who did not meet the recommendations. There was a doseresponse pattern between the number of recommendations achieved and the health outcomes, indicating the health outcomes improved as more recommendations were achieved. When the number of recommendations achieved was the same, there were no differences in the health outcomes. For instance, health indicators scores were not different in the group who achieved the sleep and screen time recommendations, the group who achieved sleep and moderate-to-vigorous physical activity recommendations, and the group who achieved screen time and moderate-to-vigorous physical activity recommendations.	⊕⊕○○
	Sampasa-Kanyinga H et l. 2017	Cross-Sectional	6106 participants	In the full sample, children meeting the screen time recommendation, the screen time þ sleep recommendation, and all three recommendations had significantly better HRQoL than children not meeting any of these guidelines. Differences in HRQoL scores between sites were also found within combinations of movement/non-movement behaviors. For example, while children in Australia, Canada, and USA self-reported better HRQoL when meeting all three recommendations, children in Kenya and Portugal reported significantly lower HRQoL when meeting all three recommendations (relative to not meeting any).	⊕⊕○○
	Saunders TJ et al. 2016	Systematic Review	14 studies (36560 participants)	Children and youth with a combination of high PA/high sleep/low SB had more desirable measures of adiposity and cardiometabolic health compared with those with a combination of low PA/low sleep/high SB. Health benefits were also observed for those with a combination of high PA/high sleep (cardiometabolic health and adiposity) or high PA/low SB (cardiometabolic health, adiposity and fitness), compared with low PA/low sleep or low PA/high SB. Of the 3 movement behaviours, PA (especially moderate- to vigorous-intensity PA) was most consistently associated with desirable health indicators.	⊕⊕○○

	Hjorth MF et al. 2014	Cross-Sectional / Longitudinal	723 participants	<p>In the cross-sectional analysis, physical activity was negatively associated with the MetS-score (P,0.03). In the longitudinal analysis, low physical activity and high sedentary time were associated with an increased MetS-score (all P,0.005); however, after mutual adjustments for movement behaviors, physical activity and sleep duration, but not sedentary time, were associated with the MetS-score (all P,0.03). Further adjusting for fat mass index while removing waist circumference from the MetS-score rendered the associations no longer statistically significant (all P. 0.17). Children in the most favorable tertiles of changes in moderate-to-vigorous physical activity, sleep duration and sedentary time during the 200-day follow-up period had an improved MetS-score relative to children in the opposite tertiles (P = 0.005).</p>	⊕⊕○○
	Carson V et al. 2017	Cross-Sectional	4157 participants	<p>Compared to meeting all three recommendations, meeting none, one, and two recommendations were associated with a higher BMI z-score, waist circumference, and behavioral strengths and difficulties score and lower aerobic fitness in a gradient pattern (Ptrend&lt;0.05). Additionally, compared to meeting all three recommendations, meeting none and one recommendation were associated with higher systolic blood pressure and insulin (Ptrend&lt;0.05). Finally, compared to meeting all three recommendations, meeting no recommendations was associated with higher triglycerides and lower HDL-cholesterol (Ptrend&lt;0.05). Collectively, meeting more recommendations within the 24-hour movement guidelines was associated with better overall health. Since a small proportion (17%) of this representative sample was meeting the overall guidelines, efforts to promote adoption are needed.</p>	⊕⊕○○

	Dalene KE et al. 2017	Cross-Sectional	4937 participants	Substituting 10 min per day of sedentary time with light PA was associated with higher WC (0.17 to 0.29 cm, $p \leq 0.003$ ) in all age groups. Substituting 10 min per day of sedentary time with moderate PA was associated with lower WC in 6- and 9-year-olds (-0.32 to -0.47 cm, $p \leq 0.013$ ). Substituting 10 min per day of sedentary time with vigorous PA was associated with lower WC in 9- and 15-year-olds (-1.08 to -1.79 cm, $p \leq 0.015$ ). Associations were similar with BMI as the outcome. In prospective analyses, substituting sedentary time with light, moderate or vigorous PA at age 9 was not associated with BMI or WC at age 15.	⊕⊕○○
	Huang YW et al. 2016	Cohort	672 participants	Controlling for covariates and total behavior time, isotemporal substitution models indicated that the displacement of 30 min of other sedentary behaviors with equal amounts of screen time ( $B = 0.12$ ; 95% confidence interval, 0.04–0.20) or academic-related activities ( $B = 0.13$ ; 95% confidence interval, 0.04–0.21) was associated with higher BMI. Reallocating 30 min of MVPA with each of the sedentary behavior variables resulted in increased BMI.	⊕○○○

*Undesirable effects*

How substantial are the undesirable anticipated effects?

**Research evidence**

Type of Outcome	Author	Type of Study	No. of Studies/Participants	Summary of Findings	Certainty of Evidence
Safety in Exercise	Rossler R et al. 2014	Systematic Review	21 studies (27561 participants)	The overall RR was 0.54 (95 % CI 0.45–0.67) [ $p < 0.001$ ]. Girls profited more from injury prevention than boys ( $p = 0.05$ ). Both prevention programs with a focus on specific injuries (RR 0.48 [95 % CI 0.37–0.63]) and those aiming at all injuries (RR 0.62 [95 % CI 0.48–0.81]) showed significant reduction effects. Pre-season and in-season interventions were similarly beneficial ( $p = 0.93$ ). Studies on programs that include jumping/plyometric exercises showed a significant better ( $p = 0.002$ ) injury preventive effect (RR 0.45 [95 % CI 0.35–0.57], $Z = 6.35$ , $p < 0.001$ ) than studies without such exercises (RR 0.74 [95 % CI 0.61–0.90], $Z = 3.03$ , $p = 0.002$ ).	⊕⊕⊕○

*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	Overall Certainty of Evidence
Physical Activity	Poitras VJ et al. 2016	Systematic Review	162 studies (204171 participants)	⊕⊕⊕○
	Janssen I et al. 2010	Systematic Review	86 studies	
	Strong WB et al. 2005	Systematic Review	850 studies	
	Jakicic JM et al. 2019	Systematic Review	29 studies	
	da Silva MP et al. 2015	Systematic Review	9 studies	
	Tudor-Locke C et al. 2011	Systematic Review	35 studies	
	Carson V et al. 2013	Cross-Sectional	1731 participants	
	Fuezeki E et al. 2017	Systematic Review	40 studies	
	Colley RC et al. 2012	Cross-Sectional	1613 participants	
Sedentary Behaviour	Carson V et al. 2011	Cross-Sectional	2527 participants	⊕⊕○○
	Veitch J et al. 2012	Cross-Sectional	544 participants	
	Tremblay MS et al. 2011	Systematic Review	232 studies (983840 participants)	
	Twenge JM et al. 2018	Cross-Sectional	40337 participants	
	Schmidt ME et al. 2012	Systematic Review	47 studies	
	Drummy C et al. 2016	Randomised Control Trial	120 participants	
	Ma JK et al. 2014	Single Cross-Over	50 participants	
Sleep	Chaput et al. 2016	Systematic Review	141 studies (592215 participants)	⊕⊕○○
	Fatima Y et al. 2015	Systematic Review	22 studies (24821 participants)	
	Dutil C et al. 2017	Narrative Review	23 studies	
	Sparano S et al. 2019	Cross-Sectional / Longitudinal	7974 participants / 5656 participants	

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Eating Activity	Scaglioni S et al. 2018	Narrative Review	88 studies	⊕⊕○○
	Wang DD et al. 2016	Cohort Study	83349 participants	
Relationships of Activity	Janssen I et al. 2017	Cross-Sectional	17000 participants	⊕⊕○○
	Sampasa-Kanyinga H et al. 2017	Cross-Sectional	6106 participants	
	Saunders TJ et al. 2016	Systematic Review	14 studies (36560 participants)	
	Hjorth MF et al. 2014	Cross-Sectional / Longitudinal	723 participants	
	Carson V et al. 2017	Cross-Sectional	4157 participants	
	Dalene KE et al. 2017	Cross-Sectional	4937 participants	
	Huang YW et al. 2016	Cohort	672 participants	
Safety in Exercise	Rosler R et al. 2014	Systematic Review	21 studies (27561 participants)	⊕⊕⊕○

*Values*

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

**Research evidence**

Based on the findings of I-24H survey study (Singapore Children Lifestyle Survey), most participants value the outcomes

*Balance of effects*

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

**Research evidence**

Based on the findings of I-24H survey study (Singapore Children Lifestyle Survey), most participants value the outcomes

*Resources required*

How large are the resource requirements (costs)?

**Research evidence**

Public will require educational or infographic aids for easy understanding and reference.

Healthcare providers will require scientific report and educational lectures or workshops to improve skills in delivering the recommendations.

Long-term improvement in metabolic and general health will result in considerable savings in healthcare expenditure.

*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 result in considerable savings in healthcare expenditure.  
This is assumed to be similar to existing lifestyle-related campaigns (e.g. War on Diabetes)

*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 the overall healthcare costs considerably.  
This is similar to existing lifestyle-related campaigns.

*Equity*

What would be the impact on health equity?

**Research evidence**

These recommendations are available to all children and adolescents in the community.  
These recommendations can be delivered from primary care, tertiary care and related organisations.

*Acceptability*

Is the option acceptable to key stakeholders?

**Research evidence**

The option is likely acceptable to key stakeholders as there are existing lifestyle-related recommendations and campaigns.

*Feasibility*

Is the option feasible to implement?

**Research evidence**

The option is likely feasible to implement as this approach is similar to existing lifestyle-related programmes and campaigns.

## CONCLUSIONS

### *Summary of judgements*

Problem	- Don't know	- Varies		- No	- Probably No	- Probably Yes	<b>Yes</b>
Desirable effects	- Don't know	- Varies		- Trivial	- Small	<b>Moderate</b>	- Large
Undesirable effects	- Don't know	- Varies		- Large	- Moderate	<b>Small</b>	- Trivial
Certainty of the evidence	- No included studies			- Very low	- Low	<b>Moderate</b>	- High
Values				- Important uncertainty or variability	- Possibly important uncertainty or variability	<b>Probably no important uncertainty or variability</b>	- 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	<b>Probably favours the option</b>	- Favours the option

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Resources required	- Don't know	- Varies	- Large costs	- Moderate costs	- Negligible costs or savings	<b>Moderate savings</b>	- Large savings
Certainty of evidence of required resources	- No included studies			- Very low	- Low	<b>Moderate</b>	- High
Cost-effectiveness	- Don't know	- Varies	- Favours the comparison	- Probably favours the comparison	- Does not favour either the option or the comparison	<b>Probably favours the option</b>	- Favours the option
Equity	- Don't know	- Varies	- Reduced	- Probably reduced	- Probably no impact	<b>Probably increased</b>	- Increased
Acceptability	- Don't know	- Varies		- No	- Probably No	<b>Probably Yes</b>	- Yes
Feasibility	- Don't know	- Varies		- No	- Probably No	<b>Probably Yes</b>	- Yes

***Type of recommendation***

***Recommendation***

1. For physical, mental and social health, children and adolescents should acquire a lifestyle that integrates regular physical activity, limited sedentary behaviour, adequate sleep and good eating habits within each 24-hour period.
2. Accumulate at least an average of 60 minutes per day of moderate-to-vigorous intensity physical activity in a week, where more is better.
3. Engage in muscle and bone strengthening exercises at least three times a week. This could be part of the daily minimum accumulation of 60 minutes of moderate-to-vigorous intensity physical activity.
4. Engage regularly in a variety of light physical activities throughout the day.
5. Limit recreational screen time as much as possible.
6. Build in regular breaks to move around during times of prolonged sitting or inactivity.
7. Have regular sleep of at least 9 hours (for 7-13-years-olds) and at least 8 hours (for 14-17-year-olds).
8. Take the necessary precautions before, during and after exercise and see a doctor if you feel unwell during the exercise.
9. Have regular meals consisting of nutritionally-balanced foods and drinks to support daily activities, in order to optimise growth, maturation and development.
10. Aim to achieve most or all recommendations on physical activity, sedentary behaviour, sleep and diet for the best results.

### **Justification**

We recommend these recommendations to encourage Singapore children and adolescents (aged 7–17 years) 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 inter-related in terms of health benefits and time consumption. It is equally vital to understand the importance of each type of activity and to organise these activities throughout a day (and night) schedule 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**

Improving the metabolic and general health of children and adolescents (aged 7–17 years) will reduce the incidence of overweight and/or obesity and related metabolic complications. Lifestyle intervention has proved to be a vital process to combat these non-communicable diseases and lifestyle changes should start early to cultivate good habits in adulthood.

#### **Desirable effects**

There is at least moderately certain evidence to support the incorporation of regular physical activity, limited sedentary behaviour, adequate sleep and good eating activity promotes good metabolic and general health in children and adolescents.

#### **Undesirable effects**

Children and adolescents should take necessary precautions when engaging in exercise and that they should seek medical attention if they feel unwell during the exercise.

#### **Certainty of the evidence**

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

#### **Cost-effectiveness**

Early lifestyle programmes or campaigns will likely reduce overall healthcare costs in the future.