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Author(s)	Natalie Joan Aw, Terence Buan Kiong Chua, Kok Hian Tan, Benny Kai Guo Loo, Phaik Ling Quah and Michael Yong Hwa Chia

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# Adherence to Singapore 24-hour Integrated Activity Guidelines and Quality of Life among Singaporean Children and Adolescents in the COVID-19 Pandemic

Natalie Joan Aw<sup>1</sup>, Terence Buan Kiong Chua<sup>1</sup>, Kok Hian Tan<sup>2</sup>, Benny Kai Guo Loo<sup>3</sup>,  
Phaik Ling Quah<sup>2</sup>, Michael Yong Hwa Chia<sup>1\*</sup>

<sup>1</sup>Physical Education and Sports Science, National Institute of Education, Nanyang Technological University, 637616, Singapore

<sup>2</sup>Division of Obstetrics and Gynaecology, KK Women's and Children's Hospital, 229899, Singapore

<sup>3</sup>General Paediatric Service, KK Women's and Children's Hospital, 229899, Singapore

\*Corresponding Author: [michael.chia@nie.edu.sg](mailto:michael.chia@nie.edu.sg)

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**Abstract.** This study aimed to examine the prevalence of children and adolescents in meeting *The Singapore Integrated 24-Hour Activity Guidelines for Children and Adolescents* and whether the number of guidelines met was associated to Quality of Life (QoL). Parents of youths aged 7 to 18 years completed an online questionnaire consisting of the Singaporean Children Lifestyle Questionnaire and the Pediatric Quality of Life (PedsQL™) 4.0 Inventory. Parents reported on the physical activity (PA), sedentary behaviour (SB), recreational screen time (ST), sleep, dietary habits, as well as the QoL of their children. Their responses were benchmarked against the Singapore Integrated 24-Hour Activity Guidelines. Survey results of 181 youths showed that more than 38% of children and adolescents did not meet any of four guidelines relating to PA, recreational ST, sleep, and diet. Daily moderate-to-vigorous PA (31.1 vs. 17.1 min) and ST (3.5 vs. 2.5 h) of adolescents were significantly higher than that of children ( $p < .05$ ) while adolescent sleep was significantly lower than that of children (7.3 vs 8.5 h,  $p < .05$ ). QoL scores were higher when more guidelines were met but the association was not statistically significant ( $p = .11$ ). Ameliorative programs to help more youths cultivate positive lifestyle habits are recommended.

**Key words:** lifestyle behaviour, quality of life, time-use, young people

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## INTRODUCTION

### The Singapore Integrated 24-hour Activity Guidelines for Children and Adolescents

In January 2021, *the Singapore Integrated 24-hour Activity Guidelines for Children and Adolescents* were launched to define healthy lifestyle behaviours for children and adolescents in the formative years (College of Paediatrics & Child Health, 2021). The guidelines stipulated that children and adolescents aged 7 to 18 years should: develop a lifestyle that incorporates regular physical activity (PA), minimal sedentary behaviour (SB), sample sleep, and healthy eating habits throughout each 24-hour period for good physical, mental, and social health, perform an average of at least 60 minutes of moderate-to-vigorous physical activity (MVPA) each day in a week; perform strength training exercises at least three times a week; participate in light PA throughout the day; keep recreational screen time (ST) to a minimum; take multiple breaks during periods of prolonged sitting or inactivity to move around; sleep on a regular basis for minimally nine hours for 7- to 13-year-olds, eight hours for 14- to 17-year-olds, and seven hours for 18-year-olds, take protective measures before, during, and after exercise, and seek medical attention when ill; have regular meals consisting of nutritionally balanced foods and beverages to sustain daily activities and to promote growth and development; adhere to all or most of the guidelines

for the best outcomes.

The 24-hour integrated activity guidelines for sleep, PA and SB for Singapore children and adolescents were developed by a consensus workgroup that assessed and reviewed evidence for international guidelines for children and young people (Loo et al., 2022a; Loo et al., 2022b). The Singapore 24-hour integrated activities guidelines are largely similar to the Canadian and Australian 24-hour Movement Guidelines that were published in 2016 and 2019 respectively (Australian Government Department of Health, 2019; Tremblay et al., 2016). Slight differences in sleep, SB and PA among the country guidelines include the different age-spans for childhood and adolescence. A standout difference for the Singapore guidelines compared with guidelines from other countries is that qualitative guidance for daily food consumption and healthy nutrition are also foregrounded. The deliberate inclusion of diet and nutrition in the 24-hour integrated guidelines for Singapore is evidence-based. A healthy and nutrient-balanced diet can prevent obesity and other weight-related diseases such as diabetes (NIH: National Institute of Diabetes and Digestive and Kidney Diseases, 2021). Furthermore, adopting healthy eating habits at a young age increases the likelihood of children and adolescents making better food choices in adulthood (Ministry of Health Singapore, 2021).

### **Health-related Quality of Life in Children and Adolescents**

Health-related Quality of Life (QoL) is recognised as a key health outcome and is the most significant factor in healthcare interventions for children and adolescents (Varni & Limbers, 2009). It is defined by Hays and Reeve (2010) as “how well a person functions in his or her life and his or her perceived well-being in physical, mental, and social domains of health”. Previous research showed that QoL decreased from childhood to early adolescence in youth who were engaged in sports. Chia and Lee (2015) reported that Pediatric Quality of Life (PedsQL) scores among 137 student-athletes dropped from 77% to 72% as they transitioned from primary to secondary school over a period of six months, without any change in self-reported resilience. Nonetheless, it is important to examine youth QoL and investigate its association with adherence to the 24-hour integrated activity guidelines for Singapore in the COVID-19 epidemic.

### **Research Objectives**

PA, SB, sleep and eating constitute a full 24-hour period and any change in one behaviour might be at the expense of another (Tremblay et al., 2016). The prevalence of all four behaviours over each 24-hour cycle is important so that deviations from the recommended guidelines could be identified and ameliorative educational and intervention programmes could be initiated early.

The objective of this study was to examine the prevalence of children and adolescents aged 7 to 18 years in meeting *The Singapore Integrated 24-Hour Activity Guidelines for Children and Adolescents* and whether the number of guidelines met was associated to QoL.

## **METHODS**

### **Ethical Clearance, Recruitment, And Informed Consent**

The cross-sectional research had ethical approval from the Institutional Review Board of the university (IRB-2021-140 & IRB-2021-148). In the months of August and September 2021 in the COVID-19 pandemic, adult parents (i.e., 21 years old and above) of children and adolescents aged 7 to 18 years in Singapore were invited via social media, through a parent-based non-government agency, and a primary and secondary school, to participate in the study. Parents with online informed consent were assured of anonymity and voluntary withdrawal without penalty.

### **Survey Package**

The online parent-reported survey, shown in Appendix A and B that took 20 to 30 minutes to complete in a single sitting and consisted of two sections — The Singaporean Children Lifestyle Questionnaire and the Pediatric Quality of Life.

### **Singaporean Children Lifestyle Questionnaire**

The Singaporean Children Lifestyle Questionnaire was developed by KK Women's and Children's Hospital. Individuals aged 7 to 12 years were referred to as children while those between 13 and 18

years of age were known as adolescents. The questionnaire consisted of 40 items that solicited information about socio-demographics, PA, SB, ST, and sleep habits of the child or adolescent that parents reported on. Additional questions added to the survey (Questions 43 and 44 in appendices) solicited information on dietary habits of children and adolescents.

### **Pediatric Quality of Life (PedsQL) 4.0 Inventory**

The acute version of the parent-reported PedsQL™ (i.e., 7-day recall) is a feasible, reliable, and validated tool that has been applied across many cultures (Varni et al., 2003). The 23-item inventory generated a Total Health score from four subscales: Physical Functioning (e.g., has your child/teen had problems with running), Emotional Functioning (e.g., has your child or teen had problems with feeling angry), Social Functioning (e.g., has your child or teen had problems with getting along with other children/teens), and School Functioning (e.g., has your child or teen had problems with paying attention in class). The Total Health score ranged from 0 to 100, with higher scores signifying better QoL.

### **Data Cleaning And Statistical Analysis**

The data cleaning process involved checking for responses that were invalid or not interpretable to the researchers. Forty-seven responses were removed from the dataset due to invalid data (i.e., no unit of measurement or parent stated “don’t know”) and children or adolescents not meeting the inclusion criteria for age in the study (i.e.,  $\leq 6$  years or  $\geq 19$  years). Duration of MVPA, recreational screen use, and sleep as reported by parents in the Singapore Children Lifestyle Questionnaire were calculated with a 1:1 ratio for weekdays and weekends and reported in median (interquartile range). Meeting all four guidelines meant having, within a 24-hour period, (i)  $\geq 60$  minutes of MVPA (ii)  $\leq 2$  hours of ST (iii)  $\geq 9$  hours of sleep for children aged 7 to 13 years or  $\geq 8$  hours for adolescents aged 14 to 17 years or  $\geq 7$  hours for adolescents aged 18 years and (iv) nutrient-balanced meals planned with My Healthy Plate (College of Paediatrics & Child Health, 2021). As there were no quantitative measures for meeting the diet recommendation, responses that indicated both ‘yes’ to ‘using My Healthy Plate to plan meals for their child’ and that their child ‘always’ or ‘often’ consumed nutrient-balanced foods and drinks were considered to have met the dietary guidelines. A value of ‘1’ was coded for each of the four guidelines met while a value of ‘0’ was coded for each guideline not met. The coded values were summed up to derive the number of guidelines met.

The Shapiro-Wilk test was used to assess the assumption of normality for all relevant variables of interest. As not all variables were normally distributed ( $p < .05$ ), non-parametric tests were used to examine differences between groups. Mann-Whitney U tests were used to examine differences between age groups (children and adolescents) and gender (boys and girls) for continuous variables. Medians were reported when distribution of histograms across independent variables were adjudged similar unless otherwise stated. Effect size was reported as  $r$  whereby 0.1 indicated a small effect size, 0.3 indicated a medium effect, and 0.5 indicated a large effect (University of Sheffield, n.d.). A Chi-square test of homogeneity with Bonferroni’s adjusted  $p$ -value was run to compare the proportions of children and adolescents. A Spearman’s rank-order correlation was run to assess the relationship between PedsQL scores, and the number of guidelines met by children and adolescents. Analysis of the PedsQL-Number of guideline met showed the relationship to be monotonic, as assessed by visual inspection of a scatter plot. Statistical analyses were performed using IBM SPSS statistics (Version 26.0, IBM Corporation, Armonk, NY, USA) with a significance level of  $p < .05$  set for all tests.

## **RESULT AND DISCUSSION**

A total of 181 responses were computed in the research. Parent respondents were mostly mothers (64.1%), Chinese (62.5%) and of a mean age of  $43.2 \pm 7.5$  years. The sample consisted of 113 children (62.4%) and 68 adolescents (37.6%). Children were 51.3% boys and 48.7% girls, aged  $9.8 \pm 1.7$  years and the adolescents were 48.5% boys and 51.5% girls, aged  $15.7 \pm 1.6$  years.

### **Parent-reported Lifestyle Behaviour of Children and Adolescents**

The median and interquartile range of time spent in PA, screen-viewing, and sleep as is presented in Table 1. Results on the dietary habits of children and adolescents were expressed in relative frequencies.

Results of a Mann-Whitney U test showed significant difference in MVPA duration between both

age groups. MVPA duration was significantly higher in adolescents (median = 31.1 min) than in children (median = 17.1 min),  $U = 2666.5$ ,  $z = -3.461$ ,  $p = .001$ . Duration of MVPA reported in both children and adolescents fell short of the recommended average of 60 min of MVPA daily.

ST reported in children and adolescents were significantly different, with adolescents spending longer duration on screens (median = 3.5 h) than children (median = 2.5 h),  $U = 2344.5$ ,  $z = -4.400$ ,  $p = <.001$ . When benchmarked against the recommendation of no more than 2 h of recreational ST daily, median ST of children and adolescents exceeded the limit by 0.5 h and 1.5 h, respectively.

Results of a Mann-Whitney U test showed differences in sleep duration between children (mean rank = 107.15) and adolescents (mean rank = 64.15),  $U = 5667.5$ ,  $z = 5.377$ ,  $p = <.001$ .

The reported use of My Healthy Plate as a guide to plan meals was higher among adolescents than children (60.3% vs. 46.0%) (Table 1). 70.8% of children and 47.1% of adolescents, frequently (i.e., indicated 'always' or 'often') consumed nutrient-balanced meals.

**Table 1.** Median (IQR) MVPA, ST and sleep duration, dietary habits, and quality of life of study sample stratified by age group and gender

	Total ( <i>n</i> = 181)	Children ( <i>n</i> = 113)	Adolescents ( <i>n</i> = 68)	<i>r</i>	Males ( <i>n</i> = 91)	Females ( <i>n</i> = 90)	<i>r</i>
MVPA <sup>a</sup> (min)	21.4 (42.9)	17.1 (27.5)	31.1 (41.8)*	0.26	25.7 (42.9)	17.1 (31.1)	0.07
ST <sup>b</sup> (h)	2.5 (1.8)	2.5 (1.5)	3.5 (2.3)*	0.33	3.0 (2.0)	2.5 (2.0)	0.13
Sleep (h)	8.0 (1.7)	8.5 (1.0)	7.3 (1.7)*	0.40	8.0 (1.5)	8.0 (2.0)	0.02
Diet Follow 'My Healthy Plate'				-			-
Yes (%)	51.4	46.0	60.3		52.7	50.0	
No (%)	48.6	54.0	39.7		47.3	50.0	
Frequency of consumption of nutrient-balanced food and drink Always (%)				-			-
Often (%)							
Sometimes (%)	24.3	31.9	11.8		28.5	20.0	
Seldom (%)	37.6	38.9	35.3		35.2	40.0	
Never (%)	33.1	23.9	48.5		35.2	31.1	
	5.0	5.3	4.4		1.1	8.9	
	0.0	0.0	0.0		0.0	0.0	
Quality of Life <sup>c</sup> (out of 100)	73.9 (30.4)	69.6 (27.1)	84.2 (25.0)*	0.30	75.0 (30.4)	72.8 (30.4)	0.04

Moderate-to-vigorous intensity physical activity (MVPA)

Screen time (ST)

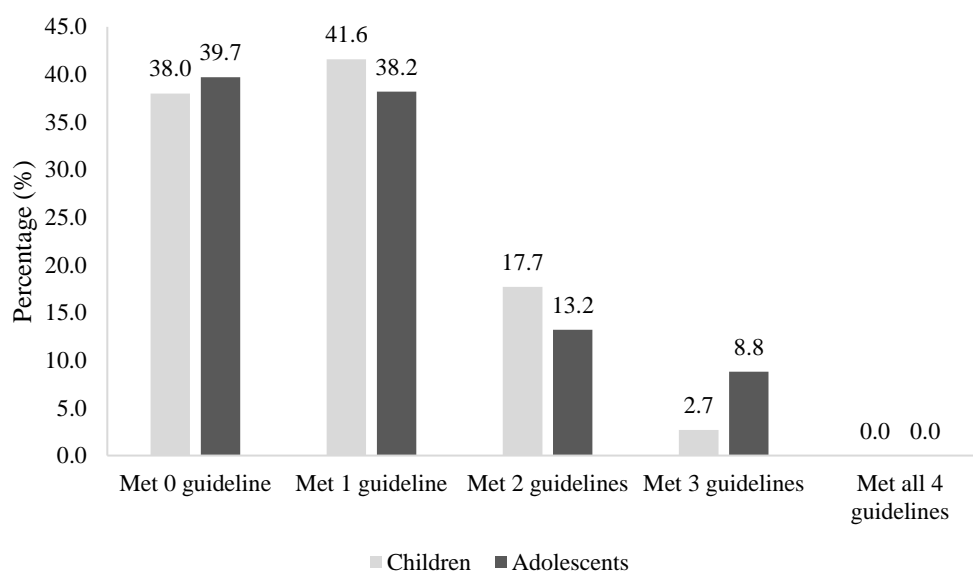
Quality of Life was measured based on parent responses to Pediatric Quality of Life (PedsQL) questionnaire.

Note. \* denotes a significant difference ( $p < .05$ ) in medians or mean ranks compared to children reported in Mann-Whitney test. No significant differences in duration of MVPA, screen media use and sleep, and quality of life score between males and females were detected by Mann-Whitney U test.

*r* symbolises effect size for non-parametric test, where according to Cohen's classification of effect size, 0.1 indicates a small effect, 0.3 indicates a medium effect, and 0.5 indicates a large effect.

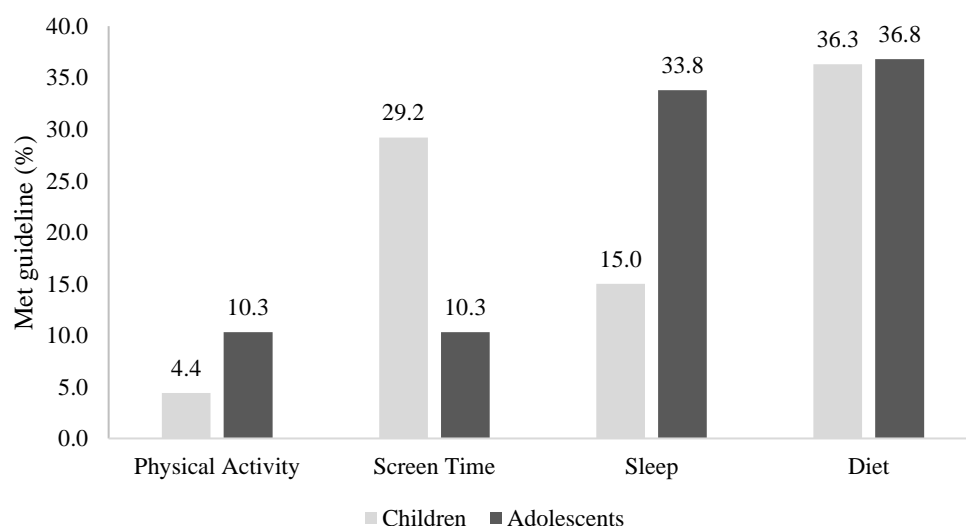
### Prevalence Of Meeting The Singapore 24-Hour Integrated Activity Guidelines

The number of guidelines met by children and adolescents are presented in Figure 1. More than one-third of children (38.0%) and adolescents (39.7%) did not meet any of the guidelines. None of the children and adolescents met all four guidelines for PA, SB, sleep, and diet. A Chi-square test of homogeneity with Bonferroni's adjusted  $p$ -value was run to compare the proportions of children and adolescents who met the 24-hour guidelines. There was no statistically significant difference between both age groups in the number of guidelines met,  $\chi^2(3) = 3.925, p = .27$ . The percentage of individual guideline compliance is depicted in Figure 2. Of the four guidelines, PA had the poorest adherence while diet had the highest guideline compliance by children and adolescents.



*Note.* No significant difference between children and adolescents in the number of guidelines met as reported in Chi-square test of homogeneity ( $p = .27$ ).

**Figure 1.** Proportion of children and adolescents meeting the 24-Hour integrated activity guidelines.



**Figure 2.** Proportion of children and adolescents meeting the individual physical activity, screen time, sleep, and diet guidelines

### Number Of Guidelines Met And Health-Related Quality Of Life

A Mann-Whitney U test was run to determine if there were differences in PedsQL scores between children and adolescents. Distributions of the scores for children and adolescents were not similar, as assessed by visual inspection of the histograms. The QoL for adolescents (mean rank = 111.67) were significantly higher than for children (mean rank = 78.70),  $U = 5247.5$ ,  $z = 4.072$ ,  $p < .001$  (Table 1).

Table 2 presents the PedsQL scores of three groups of children and adolescents (those who did not meet any guidelines, those who met 1 guideline, and those who met 2 or more guidelines). As the combined sample size of  $n = 9$  for the group that met 3 guidelines and the group that met 4 guidelines was fewer than a sample size of 5 for each level of independent variable, both groups were merged with the group that met 2 guidelines. It is reported that samples of fewer than 5 per level of independent variable may result in inaccurate p-value reported in Kruskal Wallis H test (Minitab, n.d.).

**Table 2.** Median (IQR) Quality of Life scores of children and adolescents who did not meet any guideline, met 1 guideline, and met 2 or more guidelines.

	Met 0 guideline ( $n = 70$ )	Met 1 guideline ( $n = 73$ )	Met 2 or more guidelines ( $n = 38$ )
Quality of Life <sup>a)</sup> (Upon 100)	71.2 (28.5)	75.0 (28.8)	78.8 (36.4)

a) Quality of life was measured based on parent responses to pediatric quality of life (PedsQL) questionnaire.

*Note.* Median quality of life scores was not statistically significantly different among the three groups of children and adolescents (those who did not meet any guideline, who met 1 guideline, and those who met 2 or more guidelines) ( $p = .26$ ).

The median PedsQL score for children and adolescents who did not meet any guideline was the lowest of the three groups, followed by children and adolescents who met 1 guideline, and highest in children and adolescents who met 2 or more guidelines. A Kruskal-Wallis H test was run to determine if there were statistically differences in PedsQL scores between the three groups of children and adolescents (i.e., those who did not meet any guideline, those who met 1 guideline, and those who met 2 or more guidelines). Results showed no significant difference in median PedsQL scores between the three groups,  $\chi^2(2) = 2.696$ ,  $p = .26$ . Results of Spearman's rank-order correlation showed no statistically significant correlation between the number of guidelines met and PedsQL scores,  $r_s(179) = .12$ ,  $p = .11$ .

### Sex Differences

More males than females (39.6% vs. 37.8%) did not meet any of the four guidelines. In other words, more females than males (62.2% vs. 61.4%) met at least one guideline. However, results reported that the distributions were not significantly different in males and females,  $\chi^2(2) = 0.065$ ,  $p = .968$ .

Time spent in MVPA, screen media use and sleep were not significantly different between genders (gender stratified in Table 1). PA duration was not significantly different between males (median = 25.7 min) and females (median = 17.1 min),  $U = 4437$ ,  $z = .974$ ,  $p = .33$ . ST was not significantly different between males (median = 3.0 h) and females (median = 2.5 h),  $U = 4693.5$ ,  $z = 1.703$ ,  $p = .089$ . Sleep duration was not statistically significantly different between males (median = 8.0 h) and females (median = 8.0 h),  $U = 4198.5$ ,  $z = .295$ ,  $p = .768$ . QoL measured by parent responses to PedsQL was not significantly different between males and females (median = 75.0 vs 72.8),  $U = 3903.5$ ,  $z = -.543$ ,  $p = .587$ .

The researchers investigated the proportion of children and adolescents meeting *The Singapore Integrated 24-Hour Activity Guidelines*, and whether any association exists between number of guidelines met and health-related QoL in the sample of Singapore participants.

### Prevalence of Meeting 24-hour Integrated Activity Guidelines

Taking reference from Figure 1, overall compliance to each of the four guidelines was less than 40%, with a higher proportion of adolescents than children not meeting the guidelines. In relative terms, a greater proportion of children and adolescents complied with diet guidelines (My Healthy Plate and healthy eating), followed by ST, sleep, then PA guidelines. This is somewhat expected since group sizes

(e.g., gatherings limited to no more than 5 persons) and movement restrictions (e.g., some sporting facilities are closed off) were operative in the COVID-19 pandemic. At the time of the study, vaccinations against the virus were not yet available for children and adolescents, and this could have affected the lifestyle behaviors of young people.

### **Prevalence Of Meeting The Physical Activity Guideline**

Adherence to the PA guideline was the poorest out of the four guidelines. The findings indicated that adolescents participated in longer durations of MVPA than children, but the amount of PA accumulated daily was still short of the recommended 60 minutes. This contrasted with data reported by Chia (2008) using heart rate (HR) monitoring where children participated in 24.6 minutes of MVPA while adolescents participated in 10.2 minutes on weekdays in 280 children and adolescents, aged 10 and 15 years respectively. Nonetheless, results in the cited paper showed that 86% to 94% of primary school participants and 94% to 99% of secondary school participants did not experience any MVPA (HR 140-159; HR >160 bpm) on a weekday. Some of the differences between the two studies could potentially be explained by the different methods used to estimate habitual PA and that PA in the cited study was not restrained by the Covid-19 pandemic.

As the online survey study was conducted in the COVID-19 epidemic with safe management measures in place (i.e., group size limit varied from two to five pax), the limitation on space and friends (i.e., friends playing together) as a result could have contributed to reduced PA in children. Besides, Singaporean parents place a large emphasis on education and often enroll primary school children in tuition or enrichment classes after school, which could account for less time for PA engagement or indeed signify less parental concern for PA (Müller et al., 2013). Nonetheless the abovementioned assertions require further studies.

### **Prevalence Of Meeting The Screen Time Guideline**

A majority of children and adolescents in the present study exceeded the recommended limit of two hours of recreational ST daily. High ST are prevalent in higher-income countries as electronic devices are easily accessible to children (Roman-Viñas et al., 2016). In Singapore daily high levels of ST emerged in early childhood, with 73.5% of Singaporean preschoolers aged two to four years exceeding the World Health Organization's recommendation of no more than one hour of entertainment-associated ST per day (Chia et al., 2019).

The high ST among children and adolescents was further exacerbated by the home-based learning imposed within and outside of schooling hours during the COVID-19 pandemic. In a large-scale cross-sectional study of children and adolescents across primary, secondary, and high schools in Guangzhou, China, daily ST was highest in high school students. In the study, 44.6% of caregivers reported that children and adolescents spent more than five hours per day on online study during home-based learning because of school closures caused by the COVID-19 pandemic in 2020 (Guo et al., 2021). Overall, caregivers reported that 76.9% of students experienced increased ST compared with the time before the pandemic.

Therefore, it appeared that ST increase in the COVID-19 epidemic was inevitable because of educational demands for children and adolescents to continue learning despite school closures and restrictions imposed by the government to safeguard the health of the population. Researchers proposed that it is the quality and nature of ST that made a difference to the health and well-being of children and adolescents. For example, ST used for educational purposes might or might not help with academic achievement and ST for recreational purposes might have positive outcomes (e.g., enhancing social connection with friends, provide relaxation and stress relief by accessing humorous content) or negative outcomes (e.g., cyber addiction and cyberbullying) (Thomas et al., 2020). Moving forward, it is important to strike a dynamic balance between affordances of ST engagement among children and adolescents (e.g., enhancing connectivity, self-esteem, social skills, and knowledge) and at the same time reducing its inimical impact (e.g., displacement of MVPA, excessive near-work and recreational game addiction).

### **Prevalence Of Meeting The Sleep Guideline**

Results of the research showed that 15.0% of children and 33.8% of adolescents in Singapore met the age-differentiated sleep guideline of at least 9 hours and 7-8 hours of night-time sleep, respectively.



To put things into context, in a large-scale of preschool children aged 2-5 years, parent-reported data drawn from 425 preschools in Singapore in 2019 prior to the COVID-19 outbreak showed that 70.7% met the sleep guideline of 10-13 hours of daily sleep (Chia et al., 2019). It appeared that there was a large deficit in night-time sleep in Singaporean adolescents when benchmarked against age-appropriate sleep guidelines as children transition from early childhood to childhood and to adolescence.

The shorter duration of night-time sleep in children and adolescents in the present study could be attributed by the disruptions to lifestyle routines (e.g., insufficient PA, excessive sedentary time, poor dietary habits, and poor mental health) due to the COVID-19 pandemic (Guo et al., 2021).

Excessive engagement with media devices, especially at night, might displace time away from night-time sleep and cause physiological arousal in children and adolescents, making it harder for them to relax before bedtime (Fuller et al., 2017). Exposure to electromagnetic radiation from mobile phones and intense light from screens in the evening can also decrease melatonin production, causing the circadian rhythm to be delayed (Cain & Gradisar, 2010; Higuchi et al., 2005). Therefore, ameliorative programs to improve sleep quality and quantity in children and adolescents should involve multifactorial approaches that consider universal factors (e.g., sleep hygiene and education) and cultural factors (e.g., familial sleep arrangements and bedtime routines).

### **Prevalence Of Meeting The Diet Guideline**

Compliance to the diet guideline was the highest among the four guidelines. Data shown in Table 1 suggested that the frequent consumption of nutritious food and drink daily—in adolescents was lower compared to younger children in the study (47.1% vs. 70.8%) (Table 1, % pooled for ‘often’ and ‘always’). Equivalent Singaporean data for this age span appear to be lacking. Quah et al. (2019) reported that 98% of Singaporean preschoolers were consuming sugar-sweetened beverages by the age of five years. Goh and Jacob (2011) reported that consumption of sweetened beverages increased with age, displacing the consumption of more nutrient-dense and healthier beverages such as milk. In another local study, 24-h recall dietary data collected from 561 children aged 6-12 years were assessed for diet quality. The authors reported that consumption of fruits, vegetables, and sodium of these children were frequently sub-optimal (Brownlee et al., 2019).

Of interest was a 12-country study, across five continents, which examined the adherence to 24-hour movement guidelines and dietary patterns of children aged 9-11 years. The researchers reported that meeting more movement behavior recommendations was associated with better dietary patterns in children with limiting screen time habits showing the strongest relationships (Thivel et al., 2019).

The dietary guidelines outlined in the Singapore 24-hour Integrated Activity Guidelines provides an opportunity for education and promotion to key stakeholders in the future to address deficits in nutrition in the habit-formative years of childhood and adolescence.

### **Prevalence Of Meeting The 24-Hour Integrated Activity Guidelines And Health-Related Quality Of Life**

None of the children and adolescents polled in the present study met all four lifestyle guidelines. Almost 40% of children and adolescents sampled in the present study did not meet any of the guidelines and this is of great concern as the prevalence of children and adolescents meeting none of the integrated activity guidelines is likely to increase and might cause even more challenging and complicated health conditions later in adulthood (Xiong et al., 2021).

More data on the impact of COVID-19 pandemic on the 24-hour daily habits and routines of PA, SB and sleep are emerging. Bates et al. (2020) reported significant decreases in PA, increases in SB, and disrupted sleep schedules and/or sleep quality in children and adolescents. Grgic et al. (2018) argued that these changes in lifestyle behaviours were detrimental to cardiometabolic and psychological health outcomes in the general population in the longer term if left unattended to.

Present results showed significantly higher parent-reported QoL scores in adolescents compared to children, but no significant associations were established between the number of guidelines met and QoL. This could be attributed to the smaller number of children and adolescents who met more guidelines than those who did not meet any guidelines. Our cross-sectional study results contrasted with the longitudinal study results of Xiong et al. (2021) on Australian children aged 2-15 years over 12 years from 2004 to 2016. The researchers reported a positive association between QoL and adherence to 24-hour movement guidelines for Australia. Among the three movement behaviour, the researchers reported

that adhering to the PA guideline alone contributed more to QoL than adhering to recreational ST and sleep guideline alone. There are several notable differences in the methods used to collect data between the present study and the cited researchers' study that might have contributed to the disparate results. For instance, time-use data for all three behaviour of PA, SB and sleep, and QoL in the present study were parent-reported whereas in the cited study time-use diaries were used to record the three behaviour and completed by children aged 10-15 years.

In another study that investigated the associations between adherence to the 24-hour integrated movement guidelines and QoL in children and adolescents, Sampasa-Kanyinga et al. (2017) reported that children aged 9-11 years across 12 countries who met various combinations of the movement guidelines (i.e., ST, ST+ sleep and all three), had higher QoL than those who met none. It appeared that in the present study, the number of guidelines met were not associated with QoL, which contrasted with studies elsewhere that generally report relatively higher QoL when more movement guidelines were met. Perhaps parent-reported versus child or adolescent self-reported data on time-use and QoL might account for some of these differences in findings.

### **Sex Differences**

A greater proportion of female than male children and adolescents met at least one of the four 24-hour activity guidelines in the present study, albeit no significant difference was reported. These observations contrasted with findings reported by Roberts et al. (2017) that showed that more boys than girls met the 24-hour movement guidelines, and boys also had greater MVPA than girls. Some of these differences could be attributed to differences across countries and cultures (Jeon et al., 2021). Nonetheless in the context of Singapore, interventions to remove barriers to achieve daily health-enabling behaviour and improve adherence to the 24-hour activity guidelines should be targeted at children and adolescents of both sexes and additionally to consider how parents can be involved in this pursuit.

### **Implications & Recommendations**

The COVID-19 epidemic has had a negative impact on the time-use behaviour of ST, PA and sleep in children and adolescents, and this collective impact is likely to continue. It is also likely that these changes, if left unchecked, would develop into long-term poorer health for children and adolescents (Carson et al., 2016). Bates et al. (2020) recommended using the Social-Ecological Model to frame interventions to improve adherence to meeting the 24-hour Movement or Activity Guidelines for PA, ST, sleep, and in the case for Singapore, diet as well. In essence, the model accounts for the individual within the context of the environment (e.g., school, home, and community), in cognizant with the opportunities and barriers presented in the COVID-19 pandemic.

In Singapore, children and adolescents spend a large portion of their waking hours in school for formal education and after-school activities (i.e., at least 5 hours daily) and formal and informal opportunities for schooling schedules to infuse PA (active break and recess) daily, in safe and conducive environments, could be further explored. For example, introducing movement breaks to interrupt prolonged sitting time during class sessions and using activity-based pedagogies that help enhance students' enjoyment, attentiveness, and concentration (Peiris et al., 2021). Canteen vendors in schools could be further incentivized to offer wider choices of nutrient-balanced foods and drinks and reduce the choices for deep-fried foods and sweetened beverages. Some schools already partnered the Health Promotion Board of Singapore (<https://www.hpb.gov.sg/schools>) in offering student-targeted resources and programs that help ameliorate the negative impact of COVID-19 pandemic.

At home, parents should establish regular bedtimes and wake times, remove media devices from the bedroom, and enforce limits for use of ST, especially for entertainment, to ensure that children and adolescents have sufficient sleep. To prevent blue light exposure, usage of media devices should be ceased at least 30 minutes before bedtime (Bates et al., 2020). Parents should also model positive PA behaviour like spending time outdoors with children and adolescents as a family unit even when work-from-home arrangements could pose unique barriers to such forays to be more physically active daily under COVID-19 conditions.

### Strengths and Limitations Of The Study

The study employed an online questionnaire to garner a small dataset of parent-reported time-use behaviour of PA, ST and sleep on children and adolescents. This method limited generalizations beyond the sample reported in the study. The limitations of using questionnaire self-report of recall bias and social desirability bias were acknowledged. To reduce social desirability and recall bias, respondents were assured of anonymity and the survey involved acute recall of the past seven days respectively. The use of the online questionnaire provided a fuss-free means of securing useful data on time use behaviour of children and adolescents during the COVID-19 pandemic. As 63.0% of parent-respondents were university-educated, this increased the likelihood of accurate data being reported (Short et al., 2009).

### CONCLUSION

Over 30% of children and adolescents in the present study did not meet any of the 24-hour integrated activity guidelines for diet, sleep, ST, and PA. None of the children and adolescents met all four guidelines, while 2.7% of children and 8.8% of adolescents met three guidelines. QoL was not significantly associated with the number of guidelines met. To ensure the healthy growth and development of children and adolescents, efforts should be made to educate key stakeholders (e.g., pediatricians, teachers, and parents) on The Singapore 24-Hour Integrated Activity Guidelines. To ameliorate the negative health impact of COVID-19 on children and adolescents, it would take 'everyone, everywhere and every time' to transform an obesogenic environment to an energetic one.

### Recommendations For Future Research

The current low adherence to 24-hour integrated activity guidelines in Singaporean children and adolescents are likely to remain as COVID-19 epidemic morphs into an endemic disease. Sustained monitoring of time-use of lifestyle habits of children and adolescents and timely interventions to address behavioural deficits of children and adolescents in schools, homes and the community are fertile areas for future research. As survey data continues to form the research evidence for PA, ST, sleep, and diet, more robust research designs with larger and more representative samples of children and adolescents using more objective measures like accelerometry or a combination of objective and subjective methods are proposed.

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