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Adherence to 24-hr Activity Guidelines and Quality of Life in Singapore Children: A Self-Reported Survey Study

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Abstract. There are limited data on how the lifestyle behaviours of school-aged children in Singapore fare against the Singapore Integrated 24-hr Activity Guidelines. One hundred and thirty-eight children ages 9 to 13 years self-reported their recreational screen time, moderate-to-vigorous physical activity (MVPA), night-time sleep duration, and health-related Quality of Life (HRQoL) in a survey package. Their lifestyle behaviours were then benchmarked against the Singapore Integrated 24-hr Activity Guidelines recommendations, specifically, (i) at least 1 hr/day of MVPA, (ii) no more than 2 hr/day of recreational screen time, and 7-9 hr/day of sleep. Association between the number of guideline recommendations met and HRQoL *z*-scores were explored. Of the 138 children, 6.5% met all three guideline recommendations while 29.0% did not meet any guideline recommendations. MVPA guideline recommendation was least adhered to followed by recreational screen time and sleep. The number of guideline recommendations met was significantly associated with children's HRQoL, with an increase of 0.289 in HRQoL *z*-score (5.9%) for every additional guideline met. The 24-hr activity behaviours of Singapore children was sub-optimal in which the proportion of children who did not meet any guideline recommendations is higher than those who met all guideline recommendations. Nonetheless, larger cohort studies are needed to establish its prevalence. Greater dissemination of the guidelines and ameliorative programs targeted at different groups of children should be made to help support children in adopting healthy lifestyle habits.

Key words: recreational screen time, moderate-to-vigorous physical activity, sleep, health-related quality of life, children, 24-hr activity guidelines

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INTRODUCTION

Non-communicable diseases (NCDs) are a major public health issue in southeast Asia and a high-income country like Singapore is not spared from the health burden of NCDs in its population. Diabetes, for instance, is a concerning health issue in Singapore. The estimated prevalence of diabetes in 2010 was 10.2% (among adults aged 20 to 79 years) which was the second highest among selected southeast Asian countries (Dans et al., 2011). The World Health Organisation global status report on NCDs reported that the premature mortality across NCDs (any cardiovascular disease, cancer, diabetes, or chronic respiratory disease) in Singapore was estimated at 10.5% in 2012. About one in three (32.8%) of the population (ages 18 years and above) in Singapore was estimated to be overweight (BMI≥25) and 6.2% were of a BMI≥30 in 2014. Crude-adjusted estimates of prevalence of metabolic risk factors like hypertension and elevated blood glucose in Singapore in 2014 were 14.1% and 9.8%, respectively (World Health Organization, 2014).

Childhood and adolescence are important periods for setting a foundation for future health. Many lifestyle behaviours that are known to contribute to NCDs and premature deaths later in life begin in adolescence (Blum et al., 2014; Sawyer et al., 2012). Lifestyle behaviours established during these periods of a child's life can

carry over and track into adulthood. For instance, individuals who had adopted physical activity during adolescence and thereafter continued to be physically active had lower risk of cardiovascular diseases in young adulthood (Rangul et al., 2012). Moreover, evidence suggests that lifelong physical activity starting as early as early childhood may reduce the risks of developing certain obesity-related cancers (Hidayat et al., 2019). Conversely, patterns of health-impairing behaviours over time may set precedent for risk factors that can lead to certain NCDs. For example, Magee and colleagues identified three distinct profiles of lifestyle behaviours in Australian children on the basis of sleep duration, physical activity, screen time and dietary quality. They found that children of sedentary profile (long screen time and low physical activity levels) and those who were profiled as short sleepers/ unhealthy eaters (short sleep duration and unhealthy eating habits) were more likely to be obese at 2-year follow-up compared with the healthy profile (Magee et al., 2013).

Physical Activity, Sedentary Behaviour, and Sleep among Singapore children and adolescents

There is an increasing application of time use approaches for studying lifestyle behaviours such as physical activity, sedentary behaviour, and sleep in the context of public health globally. However, studies from Singapore surrounding the time use of the lifestyle behaviours of children are scarce. Currently, the only local data comes from Quah and colleagues who collected 100 parent-reported survey responses in proxy of their children. The researchers reported that children (ages 5 to 14 years) spent an average of 3.3 hr and 4.1 hr of screen time (ST) on weekday and weekend with the proportion of children exceeding 2 hr/day of ST higher on weekend than on weekday (63.8% and 45.4% respectively). Almost one-third (32%) and 43% of children in the cited study did not participate in any moderate and vigorous physical activity in a typical week, respectively. More children had lesser than the recommended duration of night-time sleep (8 hr/day) on weekday (18.8%) than on weekend (2.1%) (Quah et al., 2021) The other local study that collected time use data of the same lifestyle behaviours is by Chia and colleagues albeit for younger children aged 5 years and below (Chia et al., 2020). The findings from Quah and colleagues' study suggested that lifestyle behaviours were sub-optimal in a sizeable proportion of children in Singapore which then spurred the development of The Singapore Integrated 24-hour Activity Guidelines for Children and Adolescents (Loo et al., 2022).

Other than the two studies mentioned above, most data on lifestyle behaviours of Singapore youths were largely solicited from studies that had investigated physical activity, sedentary behaviour, and sleep in isolation: physical activity (Chia, 2008, 2010), sedentary behaviour (Lye et al., 2015), and sleep (Li et al., 2022; Lim et al., 2021). In 2008, Chia collected heart rate monitoring data of 280 primary and secondary school students aged 10 to 15 years over 3 days and found that most youths (86-99%) were insufficiently active and sedentary. Younger children aggregated more daily moderate-to-vigorous physical activity (MVPA) on average than their older peers (24 mins vs. 10 mins). The MVPA durations of both age groups fell substantially short of the recommended duration of 60 mins advocated by Health Promotion Board at that time (Chia, 2008). In another local study that collected accelerometry data of 233 Singapore adolescents aged 13 to 15 years, the researchers reported a daily mean of 24 mins and 8 mins on MVPA on weekdays and weekends, respectively (Lye et al., 2015). Sleep data of local children was more recent. Survey data in the Growing Up in Singapore Towards healthy Outcomes (GUSTO) myopia study showed that 9-year-old children had 9.2 hr/day of sleep on average. When benchmarked against the recommended duration of ≥9 hr/day by the National Sleep Foundation, 60.0% of the 572 children sampled met the sleep recommendation and sleep duration on weekends was significantly longer than weekdays (Li et al., 2022). Other than sleep habits, physical activity levels and sedentary behaviour were also examined from the GUSTO study. The researchers had profiled movement behaviour of over 400 children at age 5.5 and 8 years based on the full continuum of 24-h movement behaviours including light physical activity, moderate physical activity, vigorous physical activity, inactivity, and sleep. They identified 4 distinct behaviour profiles and gave each an animal name—"Rabbits", "Chimpanzees", "Pandas", and "Owls"—that convey key characteristics relating to their physical activity levels, sedentary behaviour, and sleep habits (Padmapriya et al., 2021). In their study, majority of children at 5.5 and 8 years of age had movement behaviour profiles that were described as "Chimpanzees" (high levels of moderate physical activity, low inactivity levels and average night-sleep) and as "Owls" (low physical activity levels, high inactivity levels and low night-sleep). Additionally, the cited study provided novel evidence that while some children stayed in their profile, others transitioned to profiles of health-disabling behaviours like lower physical activity and higher inactivity as they got older (Padmapriya et al., 2021).

Singapore Integrated 24-hour Activity Guidelines

In 2021, the Academy of Medicine Singapore and the College of Pediatrics and Child Health Singapore published the Singapore 24-hour Integrated Activity Guidelines for Children and Adolescents between 7 and 18

years of age (hereon referred to as 'Singapore Integrated 24-hour Activity Guidelines'). The objective of the Singapore Integrated 24-hour Activity Guidelines is to encourage Singapore children and adolescents to adopt a holistic lifestyle by integrating and achieving optimal balance between all types of activities within a daily 24-hour period. These activities include light, moderate and vigorous physical activity, sedentary behaviour, sleep, eating (Academy of Medicine and the College of Pedaitrics and Child Health Singapore, 2021). These are daily activities that repeat cyclically over a 24-hour period. Having integrated activity guidelines are useful because emerging evidence suggests that physical activity, sedentary behaviour, and sleep have bi-directional impact on each other (Kim et al., 2020; Saunders et al., 2016). For instance, prolonged sitting might attenuate the benefits of physical activity while interrupting prolonged sitting with physical activity contributed to better cardiovascular and metabolic health (Loh et al., 2020). Sleep too, might be affected by intensity of physical activity and its proximal to sleeping time, albeit these data were more equivocal for children and adolescents than for adults (Dolezal et al., 2017).

Merits for adhering to integrated 24-hour guidelines for health

Rollo and colleagues reviewed the existing evidence surrounding 24-hr movement behaviours and health indicators across the lifespan (Rollo et al., 2020) and found consistent evidence that children and youths who adhered to all three 24-hr movement guidelines had favourable indicators for cardiometabolic health such as higher aerobic health, lower adiposity (Carson et al., 2017) and likelihood of obesity (Roman-Viñas et al., 2016) as well as mental, social, and emotional health (Sampasa-Kanyinga et al., 2021; Sampasa-Kanyinga et al., 2017). The merits of meeting integrated guidelines may even be extended to better academic performance (Tapia-Serrano et al., 2022). Among Singapore preschool-aged children (2-6 years), there is persuasive evidence showing that those who met guideline recommendations reported better quality of life (Chia et al., 2020; Xiong et al., 2022). It remains yet to be known whether such relationship between adherence to the recent Singapore Integrated 24-hour Activity Guidelines and quality of life exists among older children in Singapore.

Health-related Quality of Life (HRQoL) is widely recognised as an essential health outcome in health service research and evaluation. Past research elsewhere showed that HRQoL scores in school-going age children and adolescents increased with the number of guidelines met (Xiong et al., 2022). The cited study also found that the association between adherence to guidelines and quality of life seemed stronger in older age group (14-15 years old) compared to the younger age groups. In a multinational study that collected 24-h accelerometry data, self-reported screen time, and HRQoL data from over 6000 children (9 to 11 years old) from 12 countries in 5 continents, researchers observed differences in HRQoL scores between country study sites within combination of movement behaviours met by children (Sampasa-Kanyinga et al., 2017). Currently, the only local study was in preschool children aged 5 years and below. Chia and colleagues found from 2384 parent-reported survey data that HRQoL of preschool-aged children increased with the number of guidelines met (Chia et al., 2020). It is unclear whether such an association exists in older Singaporean children making it especially worthy of research attention.

Research objectives

In view of the limited data on Singapore primary school children, the objective of the present study was to describe their recreational ST, MVPA, and night-time sleep durations through a self-reported questionnaire. In addition, we aimed to estimate the proportion of Singapore primary school children who met the guideline recommendations for recreational ST, MVPA and sleep durations and its association with HRQoL *z*-scores.

METHODS

Participants and Study Design

Survey data collected from two larger studies (A Follow-up of the Singapore Kindergarten Impact Project Cohort in Middle Childhood (SKIP-UP) and The Research on The Development of an Online Surveillance of Digital Media Use in Childhood Questionnaire) were combined. The final dataset comprised data from 138 participants, of which 95 were from the SKIP-UP cohort while 43 were from the latter study. Participants were from one of the three primary schools in Singapore recruited using a convenience sampling method. Participants completed a survey package (see *Materials*) that was hosted on the online survey platform (Qualtrics®^{XM}). The survey package consists of two questionnaire measures. In the first segment, participants were asked to recall what their lifestyle behaviours in the most typical week of their life are like. The second segment of the survey package is a self-rating of their quality of life or well-being. Different survey instruments were used for the second segment; the 5-item World Health Organization Well-Being Index (WHO-5) was used

in the SKIP-UP study while the Pediatric Quality of Life Inventory (PedsQL™) was used in the other study. Survey responses were anonymous to the researchers. Both studies received approval for ethics considerations from the ethics committee of the university (IRB-2021-03-022 and IRB-2020-04-020) and informed consent was obtained from participants prior to their participation.

Child-surveillance of digital media habits in childhood Questionnaire (Child-smalQ26)

A validated questionnaire called the Surveillance of digital Media hAbits in earLy chiLdhood Questionnaire (SMALLQ®) was used to collect parent-reported data on screen media habits and off-screen media behaviours such as physical activity and sleep of preschool-aged children in Singapore (Chia et al., 2019). Given that the SMALLQ® was developed for the use with parents of preschool children, it emerged as the primary choice for adaptation for primary school-aged children. Furthermore, a self-reported questionnaire that encompasses screen media, physical activity and sleep habits of primary school children was hardly available at the time of this research. Thus, an adaptation of SMALLQ® to extend the need for a similar instrument targeted at primary school children was foregrounded in the present study. This led to a revised pool of items called the Child-surveillance of digital media habits in childhood Questionnaire (Child-smalQ26®). Key sections of the Child-smalQ26® include (i) digital home environment in terms of accessibility and ownership of digital media devices, (ii) child's digital media habits (iii) child's attitudes toward digital media use (its usefulness and harmfulness), (iv) child non-digital habits such as outdoor play and sleep, (v) health guidelines that the child follows for sedentary screen use and activity time and (vi) general information about child. Reliability (stability) of the ST data (weekday and weekend day as input items) was computed and yielded an acceptable Cronbach's alpha value of 0.87.

Daily total recreational ST. Durations spent on screen media for non-school related activities (i.e., accessing information, communicating, creating content, entertainment) reported by child were summed to derive total recreational ST on a weekday and on a weekend day, respectively. Daily total recreational ST was averaged using a ratio of 1:1 (1 weekday and 1 weekend day).

Daily MVPA duration. In Child-smalQ26®, MVPA was described as physical activities which make the child breathe heavier and faster. Children reported the proportion of time ranging from 0 to 100% that they engaged in physical activities which make them breathe heavier and faster that is of MVPA. Outdoor playtime in hours reported in Child-smalQ26® was multiplied by the % of time engaged in activities which make breathing heavier and faster (i.e., Duration of MVPA (hrs) = outdoor playtime (hrs) x % of time engaged in activities which make breathing heavier and faster). Daily MVPA was averaged using a ratio of 1:1 (1 weekday and 1 weekend day).

Daily sleep duration. Respondents reported their duration of night-time sleep on average on a weekday and weekend in Child-smalQ26®. Daily sleep duration was averaged using a ratio of 1:1 (1 weekday and 1 weekend day).

Pediatric Quality of Life Inventory Version 4.0 (PedsQL™4.0)

The PedsQL™ 4.0 Generic Core Scales is an established psychometric instrument widely used for estimating HRQoL in young people. The child self-reported version of the 23-item questionnaire for children between ages 8 and 12 years was used in the present study. The application of self-reported scales in children were previously detailed and demonstrated that young children can reliably and validly self-report their HRQoL from PedsQL™ 4.0 (Varni et al., 2007; Varni et al., 2001). The PedsQL™ 4.0 Generic Core Scale is made up of 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). Participants responded to each questionnaire item by indicating 'Never', Almost never', 'Sometimes', 'Almost always' or 'Always'. During data curation, the 5-point scale was reverse-scored by the researchers, with 'Never' transformed to a score of 100, 'Almost never' transformed to a score of 75, 'Sometimes' transformed to a score of 50, 'Almost always' transformed to a score of 25 and 'Always' transformed to a score of 0. A Total Health score is yielded by dividing the sum of all item scores with the number of items completed. The Total Health score ranges between 0 and 100 with greater scores signifying better quality of life.

World Health Organization Well-Being Index (WHO-5)

For children who were not administered the PedsQL™ 4.0 in this study, the WHO-5 was used instead. The WHO-5 is commonly used as a generic global rating scale for measuring subjective well-being. It contains 5

positively phrased statements that reflect positive well-being. The WHO-5 items are: (1) I feel cheerful and in good spirits, (2) I feel calm and relaxed, (3) I feel active and vigorous, (4) I wake up feeling fresh and rested, (5) My daily life is filled with things that interest me. Participants were asked to rate how frequently they felt the same way as each of the 5 statements over the last 14 days. Each of the 5 answer items are scored from 0 (at no time) to 5 (all the time). The raw score was calculated by summing the scores of the 5 answer items and ranges from 0 (absence of well-being perceived) to 25 (best possible well-being perceived). Thereafter, the raw score was multiplied by 4 to obtain a standardised percentage scale that ranges between 0 and 100 to be comparable with most scales measuring HRQoL. Likewise, the higher the scores, the better the HRQoL. The WHO-5 was adjudged to have adequate validity and appraised to be a useful tool for assessing and monitoring subjective wellbeing of healthy individuals and individuals with medical conditions (Topp et al., 2015).

*Health-related Quality of life z-score***.** In the present study, HRQoL data were collected from a subset of children who had completed either the WHO-5 or the PedsQL 4.0. The percentage scores yielded from both scales were transformed into standardised *z*-scores.

Statistical analysis

Two hundred and forty-three online survey responses were collected at the end of data collection. Survey responses to Child-smalQ26® were checked for missing data and presence of 'out-of-range' values. Responses with fewer than 95% of survey questions answered were deemed incomplete responses and were subsequently omitted from the study sample. Responses with total activity durations greater than 24 hours (i.e., total recreational ST, MVPA and sleep durations summed up) on either day (weekday or weekend) were excluded from the study.

Categorical variables were presented as frequencies. The three dependent variables (i.e., recreational ST, MVPA and duration of sleep) in the sample were adjudged to be not normally distributed by Kolmogorov-Smirov's tests of normality ($p < .05$), *z*-scores for skewness and kurtosis (±2.58) and visual inspection of histograms and Q-Q plots. As assumptions of normality were not satisfied for all 3 time-use behaviours, non-parametric tests were carried out instead. Daily ST, MVPA and sleep durations were calculated with a 1:1 ratio for weekdays and weekends and reported in both median (interquartile range) and mean±standard deviation. Wilcoxon signed-rank test was used to determine whether differences in time use for each of the 3 behaviours (recreational screen media use, MVPA, and sleep) between a weekday and a weekend exist. Mann-Whitney U tests were run to determine if there were differences in the 3 lifestyle behaviours between males and females. Comparison of continuous variables between groups were reported in medians unless otherwise stated. The level of statistical significance for all tests was set at $p \leq .05$.

The 3 corresponding guidelines used as benchmark are (i) at least an average of 60 minutes of MVPA/ day, (ii) no more than 2 hours of ST, and (iii) at least 9 hours of sleep for children aged 7 to 13 years (Academy of Medicine, 2021). Each and all possible combinations of the 3 guidelines met by respondents were examined (i.e., did not meet any guidelines, met exclusively MVPA guideline, met exclusively ST guideline, met exclusively sleep guideline, met MVPA + ST guidelines, met MVPA + sleep guidelines, met ST + sleep guidelines, met all 3 guidelines; see Figure 1). A value of '1' was coded for every guideline met while a value of '0' was coded for each not met. Statistical analyses were performed using IBM SPSS statistics Version 28.0 (IBM Corporation, Armonk, New York).

RESULTS AND DISCUSSION

Participant Characteristics

One hundred and thirty-eight (138) primary school children (mean age±sd: 10.6±0.8 yrs; age range: 9-13 yrs; 50.0% boys) completed the online questionnaire in a median time of 18.2 mins. Over half (50.7%) of the participants reported wearing spectacles or contact lenses. Almost half (47.1%) reported to have a sport co-curriculum activity (CCA) while the others (52.9%) reported to have a non-sport CCA.

Self-reported daily recreational ST, MVPA and sleep durations of Singapore children

The median and mean daily recreational ST pooled across male and female participants in the present study were 2.8 hrs and 4.0 hrs, respectively. The median and mean MVPA duration pooled across sex were 0.6 hrs and 0.9 hrs, respectively. The median and mean night-time sleep duration pooled across sex were 8.3 hrs and 7.9 hrs, respectively.

Sex differences

Table 1 shows the median (IQR) and mean±SD recreational ST, MVPA and sleep durations stratified by sex. Results of the Mann-Whitney U test suggests that median screen time was not significantly different between boys (Mdn hrs= 3.2) and girls (Mdn hrs= 2.8), U = 2309.000, z = -0.304, p = .761. MVPA duration reported by male participants (Mdn hrs= 0.8) was significantly longer than that reported by female participants (Mdn hrs= 0.4), U = 1879.000, z = -2.136, p = .033. Sleep duration was not significantly different between male and female participants (Mdn hrs= 8.0 vs. 8.5), U = 2794.000, z = 1.762, p = .078.

Weekday-weekend differences

Recreational ST, MVPA and sleep durations on a weekday and a weekend pooled across sex were presented in Table 1. Wilcoxon signed-rank tests were used to determine whether weekday-weekend differences in recreational ST, MVPA and sleep durations exist, respectively. There was an increase in median recreational ST from a weekday (Mdn hrs= 2.8) to a weekend day (Mdn hrs= 3.0) albeit not significant between days, z = 1.169, p = .242. The median time participants engaged in MVPA on a weekday and on a weekend (both Mdn hrs= 0.5 hrs) was not significantly different from each other (z = -0.878 p = .380). Participants reported significantly longer sleep duration on a weekend compared to a weekday (Mdn hrs= 8.9 vs. 8.0), z = 3.950, p < .001.

Table 1. Daily recreational screen time, MVPA and sleep duration of primary school children in Singapore

			Stratified by sex					
	Pooled (n = 138)		Male (n = 69)		Female (n = 69)		p	r
	Median (IQR)	mean±SD	Median (IQR)	mean±SD	Median (IQR)	mean±SD		
Daily recreational ST (hr)	2.8 (4.4)	4.0±3.3	3.2 (4.6)	4.1±3.4	2.8 (4.3)	3.9±3.2	.761	0.026
Daily MVPA duration (hr)	0.6 (1.0)	0.9±1.0	0.8 (1.1)	1.1±1.2	0.4 (0.8)	0.7±0.7	**.033**	0.182
Daily Sleep duration (hr)	8.3 (2.5)	7.9±2.3	8.0 (2.7)	7.6±2.4	8.5 (2.4)	8.1±2.2	.078	0.150
			Stratified by day					
	Pooled (n = 138)		Weekday		Weekend		p	r
	Median (IQR)	mean±SD	Median (IQR)	mean±SD	Median (IQR)	mean±SD		
Recreational screen time (hr)	2.8 (4.4)	4.0±3.3	2.8 (4.2)	4.0±3.6	3.0 (4.6)	4.0±3.4	.242	0.100
MVPA (hr)	0.6 (1.0)	0.9±1.0	0.5 (1.0)	0.9±1.1	0.5 (1.1)	0.9±1.0	.380	0.075
Sleep (hr)	8.3 (2.5)	7.9±2.3	8.0 (2.5)	7.5±2.3	8.9 (3.0)	8.2±2.7	**<.001**	0.336

Note. ST: Screen-viewing Time; MVPA: Moderate-to-Vigorous intensity Physical Activity

Recreational ST, MVPA and sleep durations were gathered through children's responses to the Child-surveillance of digital media habits in childhood Questionnaire (Child-smalQ26®).

Recreational ST was derived by summing up child-reported ST on non-school related work (e.g., use screen media for accessing information, communicating with others, creating content, for entertainment). MVPA was described in child-smalQ26® as physical activities that made a child breathes heavier and faster.

r symbolises effect size, where 0.1 indicates a small effect, 0.3 indicates a medium effect, and 0.5 indicates a large effect.

As the data was not normally distributed, Mann-Whitney U tests were used to test for sex differences and Wilcoxon signed-rank tests were used to test for weekday-weekend differences.

Figure 1 shows the proportions of participants who did not meet any guidelines, who met exclusively one guideline, and who met the different combinations of guidelines. One-third (33.3%) of participants met the MVPA guideline (i.e., 14.5%+5.1%+6.5%+7.2%). More than a third (35.5%) met the recreational ST guideline (i.e., 15.2%+8.7%+5.1%+6.5%). More than one-third (36.2%) met the sleep guideline (i.e., 13.8%+8.7%+6.5%+7.2%). In terms of number of guidelines met, 29.0%, 43.5%, 21.0% and 6.5% of participants met none of, 1, 2, and all 3 guidelines, respectively.

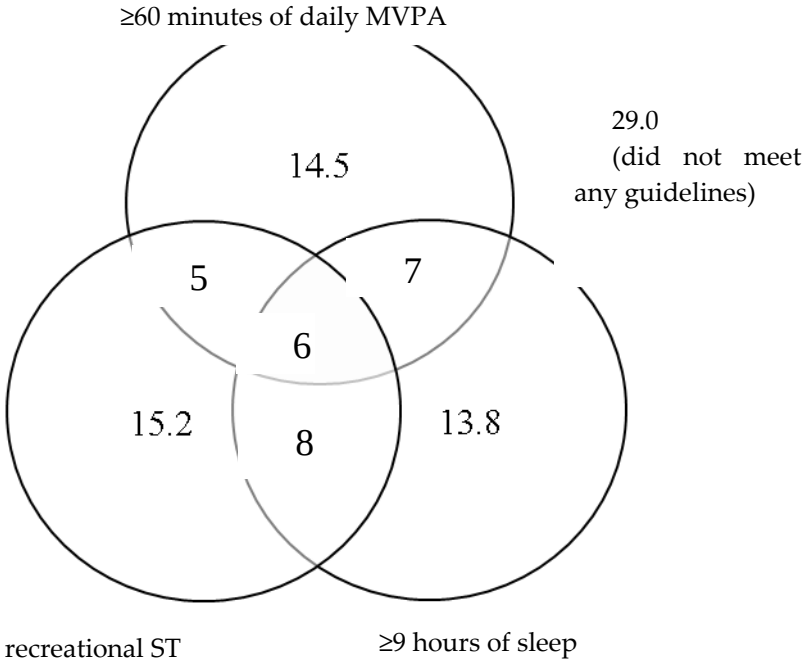

Figure 1. Venn diagram showing proportions of Singapore children (9-13 years old) that did not meet any of the 3 guidelines, met exclusively each guideline, and met a combination of guidelines in the study sample (*n*= 138)

Note. ST: Screen Time, MVPA: Moderate-to-Vigorous intensity Physical Activity

The Singapore Integrated 24-hr Activity Guidelines for Children and Adolescents were adapted and used as a benchmark in the present study. The specific guidelines are (i) accumulate at least an average of 60 minutes of MVPA daily, (ii) have no more than 2 hrs of daily recreational SVT (iii) have at least 9 hours of sleep for 7- to 13-year-olds within each 24-hr period

Association between number of guidelines met and HRQoL

Health-related Quality of life (HRQoL) percentage score and *z*-score of a subset of participants (*n*= 111) were computed. The group mean HRQoL percentage score was 63.0±20.3%. A Spearman's rank-order correlation was run to assess the relationship between number of guidelines met and HRQoL *z*-scores. The relationship was found to be monotonic, as assessed by visual inspection of a scatterplot. Results show that the number of guidelines met was positively associated to HRQoL *z*-scores. Correlation between both variables was significant and weak, $r_s(115) = .250$, $p = .008$. In addition, a multiple regression was run to determine if the number of guidelines met, sex, and age of participants are predictors of HRQoL *z*-scores. The multiple linear regression model significantly predicted HRQoL *z*-scores, $F(3, 107) = 8.055$, $p < .001$, $R^2 = .184$, adj. $R^2 = .161$. All predictor variables except sex added significantly to the prediction following Bonferroni correction ($p * df < .05$). Regression coefficients and standard errors can be found in Table 2 below.

Table 2. Multiple regression results for HRQoL *z*-scores

HRQoL *z*-score	*B*	95% CI for *B (LL, UL)*	*SE B*	β	*p*-value
Model	3.468	(1.156, 5.780)	1.166		**.004**
No. of guidelines met	0.289	(0.094, 0.483)	0.098	0.259	**.004**
Age	-0.379	(-0.592, -0.166)	0.107	-0.310	**<.001**
Gender	0.130	(-0.215, 0.475)	0.174	0.065	0.457

Note. B = unstandardized regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit; SE B = standard error of coefficient; β = standardized coefficient

Self-reported recreational ST, MVPA and sleep durations of Singapore children

The present study gave new insights into the time-use behaviour, specifically, recreational screen use, MVPA and sleep durations of children aged 9 to 13 years in Singapore. We found from child self-reported survey responses that they spent a median of 2.8 hrs, 0.6 hrs, and 8.3 hrs on recreational screen use, MVPA and night-time sleep, respectively. Male children engaged longer duration of MVPA than female children in the present study. This observed difference in self-reported MVPA duration between sex concurs with previous local studies that used objective measurements like accelerometry in adolescents aged 13 to 15 years (Lye et al., 2015). In our study, children reported longer duration of sleep on a weekend than on a weekday. This observation of children 'sleeping in more' on weekends concurs with a recent local study that collected parents' proxy-reported survey responses (Quah et al., 2021). The start times of primary schools in Singapore on weekdays are typically around 6.30 am and since schools are closed on weekends, it is plausible that some children get up later on weekends. Interestingly, participants in our study had shorter sleep duration compared to children of similar ages in another Singapore study (mean hrs= 7.9 hrs vs. 9.9 hrs). The researchers compared parents' responses about their child's sleep patterns before and during school closure (in the national circuit breaker period) when schools had shifted to home-based learning due to the COVID-19 pandemic (Lim et al., 2021). Not having to commute or travel to school for face-to-face classes, children's rise times became later and that resulted in longer sleep duration during home-based learning when lessons were conducted online. To the best of our recollection, data collection was performed when face-to-face lessons in schools were taking place following the resumption of school activities from the heightened COVID-19 measures. The resumption of school activities and lifting of circuit breaker may plausibly explain why participants in our study had fewer hours of sleep. Sedentary behaviours can be of screen-based and non-screen based activities. In our study, we use recreational ST as a proxy measure of sedentary behaviour. Our findings of recreational ST (a median of 2.8 hrs), exceeds the recommended limit of 2 hrs/day in the Singapore Integrated 24-hr Activity Guidelines. This observation of excessive sedentary behaviour is in support to what other local studies have also found in children across different school-going ages (Chia et al., 2020; Lim et al., 2021; Quah et al., 2021).

Adherence to the Singapore 24-hr integrated activity guidelines

This study also estimated the proportions of children that met the daily recommended duration for MVPA, recreational screen use, and sleep in the Singapore 24-hr Integrated Activity Guidelines. The recommended guidelines are, specifically, at least an average of 60 minutes of MVPA, no more than 2 hrs of recreational ST, and at least 9 hours of sleep for 7- to 13-year-olds. Of the three guidelines, MVPA guideline recommendation was least adhered by children in our study. Approximately two-thirds (66.7%) did not meet the minimum recommended MVPA duration of 60 mins/day. We could see indirect parallels between our findings and that of Quah and colleagues' study. They reported that 30% and 40% of Singaporean children did not engage in vigorous or moderate physical activity (PA), respectively. In terms of number of guidelines met, the proportion of children who did not meet any guidelines was greater than those who met all 3 guidelines (29.0% vs. 6.5%). This trend of low adherence to integrated activity guidelines among children was observed in several other countries. A large, multinational study involving 12 countries across different continents included 6106 children of 9 to 11 years old and reported that an overall of 7.2% met all three recommendations. The mean daily MVPA (0.9 hrs) reported in our study was comparable to their data of similarly aged children in high income countries like Canada, Portugal, and United States (50.1-58.4 min/day). In the cited study, children in countries of the same region as Singapore (Australia and China) reported lower screen time and longer sleep duration (Sampasa-Kanyinga et al., 2017). A study in Australia collected time-use diaries of 8246 children aged 5 to 13 years and found that 22.1% and 8.5% met all 3 recommendations and did not meet any recommendations, respectively. Their findings were in contrary to what we found in our study whereby more children did not meet any guidelines than those who met all 3 guidelines. Children in the cited study had an average of 2.7 hr/day of ST, 1.8 hr/day of PA, and 10.0 hr/day of sleep (Xiong et al., 2022). Compared to their

findings, children in our study reported more ST and fewer hours of PA and sleep. The sedentary lifestyle (excessive ST and insufficient PA) of Singapore children is very telling in view of the creeping obesity rate among Singapore youths in recent times. From 2017 to 2021, the proportion of school-going youths aged below 18 years who were overweight (BMI-for-age at or above the 90th percentile) had grown from 13.0% to 16.0% with the increase mainly observed in the last two years as a result of the COVID-19 pandemic (Ministry of Health, 2022).

The second aim of the present study was to explore whether quality of life was associated with meeting of the Singapore Integrated 24-hour Activity Guidelines. We found that the number of guidelines met was positively associated to the HRQoL *z*-scores in children (r_s = 0.250) with an increase of 0.289 in HRQoL *z*-score (5.9% in percentage score) for every one guideline met. HRQoL *z*-scores was also associated with age. While there are slight nuances between the Singapore Integrated 24-hour Activity Guidelines s that was used in the present study and other countries' 24-hour movement guidelines recommendations, our findings are consistent with previous studies in suggesting that the more guidelines children meet, the better their HRQoL are. An Australian longitudinal study included time-use behaviour data and PedsQL scores of 8919 children across different age groups (2-4 years, 5-13 years, and 14-15 years) found positive associations between number of guidelines met and HRQoL. The authors reported that the association was strongest in children aged 14 to 15 years (Xiong et al., 2022). Of the different combinations of meeting guidelines, the cited authors found that meeting both recreational screen time and physical activity guidelines has the strongest positive association with HRQoL scores in children and adolescents. This associative pattern between combination of guidelines met and HRQoL scores was not examined in the present study due to its small sample size. However, Xiong and colleagues' findings have important implications that we can glean from considering that in our study most children did not meet the recreational ST and MVPA guidelines. In a multinational study involving 12 countries, Sampasa-Kanyinga and colleagues concluded from accelerometry and self-reported data of 6106 children aged 9 to 11 years that when children meet movement guidelines their self-reported HRQoL are higher (Sampasa-Kanyinga et al., 2017). Self-reported HRQoL scores of participants who met all recommendations (physical activity, screen time and sleep) were collectively higher compared to children who did not meet any guidelines. However, this observed findings of HRQoL in favour of children who met all guidelines was not evident in two countries separately. The cited authors found that children in Portugal and Kenya who met all 3 guidelines reported significantly lower HRQoL score than their peers who did not meet any guidelines. This observed difference in HRQoL between country sites underscore the need for researchers to collect and establish baseline time use behaviours and HRQoL information of children in their own countries before country- and context-specific interventions aimed at improving time use behaviours and HRQoL can be developed.

Study strengths and limitations

The present study collected timely data on the time-use behaviours (recreational ST, MVPA and sleep) and HRQoL of children aged 9 to 13 years old in Singapore. Unlike previous local surveys that were based on parent-reported responses, the present study solicited responses from the children themselves. This study is not without any limitations. We recognise that subjective method like questionnaire is subject to the accuracy of participants' recall and to social desirability bias in reporting one's time-use behaviours (under-reporting of less desirable behaviour or over-reporting of good behaviour). To mitigate recall error, participants were instructed in the questionnaire to limit their span of memory recall to no longer than two weeks, for example, over the last one week in PedsQL and over the last two weeks in the WHO-5, otherwise a span of memory recall of any longer may lead to inaccuracy in recalling their behaviours. In our effort to mitigate social desirability bias, participants were assured of the anonymity of their responses. This study also has limitations in its generalisability due to its small sample size and the use of a convenience sampling approach when recruiting primary schools. As such, additional studies of larger cohort or at a population level are needed to confirm these findings.

This study offers an insight into the current prevalence of physical activity, sedentary behaviour, and sleep among children and adolescents in Singapore when benchmarked against the Singapore 24-hour integrated movement guidelines. It is important to elucidate these time-use behaviour as these activities add up to form a large portion of a 24-hr period and are inter-linked to health benefits. These data provide 'current-state' evidence to help inform stakeholders (e.g., public health practitioners, school educators, parents) in developing ameliorative programmes or initiatives to better support children and adolescents in building healthy lifestyle habits.

Recommendations for future research

It is important to mention that diet is a key component in the Singapore 24-hour integrated movement guidelines that was not examined in the present study. It is equally vital to elucidate what children and adolescents' eating patterns are as better diet quality is associated with healthy body mass. Future surveys could consider including questions asking about children's dietary habits (e.g., nutritionally-balanced foods in suitable portions as shown in the My Health Plate) for the purpose of benchmarking it against the recommended guidelines. The next steps for researchers would be further monitoring of children's lifestyle behaviours following a greater dissemination of these guidelines to the masses (e.g., through schools).

CONCLUSION

Findings from this study show that a considerable proportion of primary school-aged children and adolescents in Singapore were not meeting the recommended durations for MVPA, recreational screen time, and sleep in the Singapore 24-hour integrated movement guidelines. Greater efforts should be made in dissemination of these guidelines and in creating ameliorative programmes to support children get on track with better lifestyle habits.

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