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24-hour movement behaviours and flourishment in children and adolescents

YANG SU

ntsuyang1981@163.com

Nanjing Sport Institute

Research Article

Keywords: flourishing, 24-hour movement behaviours, physical activity, screen time, sleep

Posted Date: May 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9536270/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

This study examined the associations between meeting 24-hour movement guidelines and flourishing in youth aged 6–17 years.

Methods

A cross-sectional design based on five waves (2018–2022) of the National Survey of Children's Health was conducted using a large sample of children and adolescents aged 6–17 years. Movement behaviours were assessed based on adherence to PA, ST, and sleep guidelines. Flourishing was assessed as a composite outcome, including curiosity, task completion, and emotional control. Weighted descriptive statistics were used to characterize the sample. Logistic regression models were applied to estimate associations between movement behaviours and outcomes, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs).

Results

Most participants met one or two movement guidelines (41.51% and 32.21%); 8.66% met all three. Overall, 61.34% were classified as flourishing. Significant differences in guideline adherence were observed between flourishing and non-flourishing groups (both *p* < 2.2×10^{-16}). A clear dose–response relationship emerged: compared with meeting no guidelines, meeting one, two, and three guidelines was associated with progressively higher odds of flourishing (OR = 1.44, 95% CI: 1.27–1.63; OR = 2.21, 95% CI: 1.93–2.52; and OR = 3.28, 95% CI: 2.72–3.94, respectively). Similar patterns were observed for curiosity, task completion, and emotional control. Regarding behaviour combinations, meeting all three guidelines showed the strongest association with flourishing (OR = 3.32, 95% CI: 2.76–4.00). Combinations such as PA + ST (OR = 2.69), ST+sleep (OR = 2.23), and PA+sleep (OR = 1.97) were all significantly associated with higher odds. In contrast, meeting PA alone was not significant (OR = 1.27, 95% CI: 0.96–1.68).

Conclusion

Adherence to multiple 24-hour movement behaviour guidelines is associated with higher levels of flourishing in children and adolescents. The findings highlight a clear gradient, with greater adherence linked to better outcomes, and emphasize the importance of combined behaviour patterns rather than single behaviours. Promoting balanced daily movement behaviours, including sufficient PA, limited ST, and adequate sleep, may support positive mental health and development in youth.

1 Introduction

Childhood and adolescence are critical periods for establishing physical, psychological, and social foundations that shape health across the life course. During these stages, behavioural patterns and psychosocial resources influence emotional regulation, learning engagement, and interpersonal functioning [1, 2]. In recent years, increasing emphasis has been placed on positive indicators of youth well-being, particularly flourishing.

Flourishing is a multidimensional construct that reflects resilience, curiosity, self-regulation, and social-emotional competence, and is considered a central marker of healthy development [3, 4]. However, a substantial proportion of children and adolescents do not meet criteria for flourishing, with declines observed in several countries and social groups, especially during periods of social disruption such as the COVID-19 pandemic [5]. At the same time, physical inactivity, excessive screen exposure, and insufficient sleep have become increasingly prevalent, highlighting the need to understand how daily behaviours contribute to holistic youth well-being.

Movement behaviours (MBs), including physical activity (PA), sedentary behaviour, and sleep, are widely recognized as key determinants of child and adolescent health [6, 7]. Regular PA is associated with improved psychological well-being, reduced emotional distress, and stronger academic engagement [4, 8]. In contrast, excessive recreational screen time (ST) and prolonged sedentary behaviour are linked to poorer mental health, lower school engagement, and behavioural difficulties [5, 9]. Adequate sleep duration and quality are also essential for emotional regulation, attention, and cognitive functioning, with insufficient sleep increasing the risk of anxiety, irritability, and learning problems [10]. Importantly, these behaviours are interdependent, as time devoted to one activity necessarily reduces time available for others. Consequently, contemporary research increasingly emphasizes the need to examine daily MBs within an integrated framework.

The 24-hour MB paradigm conceptualizes daily time use as a combination of moderate-to-vigorous PA, sedentary behaviour, and sleep within a finite 24-hour period [11]. This perspective underpins the Canadian 24-Hour Movement Guidelines, which recommend at least 60 minutes of daily PA, no more than two hours of recreational ST, and sufficient age-appropriate sleep [12]. These guidelines have been adopted internationally and reflect growing recognition that health and well-being are shaped by the balance among multiple behaviours rather than by single activities alone. Within this context, emerging evidence indicates that individual MBs are also directly related to flourishing. Higher levels of PA have been associated with greater resilience, curiosity, and emotional stability in children and adolescents [4, 8]. Conversely, excessive ST has been linked to reduced interest in learning and lower levels of psychosocial well-being [5, 9]. Sleep has likewise been shown to support self-regulation and positive mood, which are core components of flourishing [10]. These findings suggest that both individual behaviours and their combined patterns may play important roles in shaping positive developmental outcomes.

Recent research adopting the 24-hour MB framework has demonstrated that adherence to multiple movement recommendations is associated with more favourable psychosocial outcomes, including higher life satisfaction, better emotional health, and stronger school engagement[13, 14]. Systematic reviews further suggest cumulative benefits, whereby meeting a greater number of recommendations corresponds to progressively better mental and social well-being [15, 16]. Nevertheless, important gaps remain. Flourishing has rarely been examined as a primary outcome within the 24-hour MB literature, with most studies emphasizing negative outcomes such as obesity or mental health problems. Additionally, evidence is dominated by cross-sectional designs and self-reported measures, and findings vary across age groups and sociocultural contexts [17]. Addressing these gaps is essential to inform integrated, guideline-based strategies that promote positive development. Therefore, the present study aims to (1) examine the associations between the number of 24-hour MB guidelines met and flourishing and its subcomponents, (2) assess the associations between specific MB combinations and flourishing outcomes and its subcomponents.

2 Method

2.1 Study Design and Data Source

This study used a cross-sectional design based on five waves (2018–2022) of the National Survey of Children's Health (NSCH). The NSCH is a nationally representative survey of non-institutionalized children and adolescents aged 0–17 years in the United States, administered by the U.S. Census Bureau with support from the Maternal and Child Health Bureau [18]. The survey applies a stratified, address-based sampling design and collects data through parent- or caregiver-reported questionnaires. It includes detailed information on children's physical health, mental health, and daily behaviours[18, 19]. Pooling multiple survey waves increases statistical power and improves the stability of estimates across population subgroups.

2.2 Participants and Sampling

The analytic sample included children and adolescents aged 6–17 years, as both flourishing and PA variables are only available for this age group. Data processing followed a structured procedure. First, participants with missing data on flourishing items were excluded. Second, cases coded as "not in universe" were removed, as these responses indicate inapplicable questions. Third, responses coded as "no valid response" were treated as missing and handled using multiple imputation with 20 datasets. After applying these criteria, the final analytic sample included 36837 participants. Survey weights were applied to account for unequal selection probability and non-response, allowing results to be generalized to the U.S. population. The complex sampling design was addressed using strata (stratum) and primary sampling units (household ID) [18].

2.3 Measures

2.3.1 Flourishing

Flourishing was assessed using three parent-reported items in the NSCH that capture key aspects of positive development: curiosity, task persistence, and emotional regulation [5]. Parents reported how often their child (1) shows interest and curiosity in learning new things, (2) works to finish tasks they start, and (3) stays calm and in control when faced with a challenge. Response options included "never," "sometimes," "usually," and "always." Each item was dichotomized, with "usually" or "always" coded as 1 and "sometimes" or "never" coded as 0. A composite variable (Flourishing_Status) was created by summing the three items. Participants were classified as flourishing (1) only if all three criteria were met (total score = 3); otherwise, they were classified as not flourishing (0). This approach is consistent with prior NSCH-based studies [5].

2.3.2 24-Hour Movement Behaviours

MBs were assessed using parent-reported NSCH items and categorized according to established 24-hour movement guidelines [11, 12]. PA was measured as the number of days in the past week the child engaged in at least 60 minutes of PA. Participants who reported activity on all 7 days ("every day") were classified as meeting the guideline (1), while all others were classified as not meeting the guideline (0) [12, 13]. ST captured average daily recreational screen use. Participants reporting ≤ 2 hours per day (less than 1 hour, 1 hour, or 2 hours) were classified as meeting the guideline (1), while those reporting ≥ 3 hours were classified as not meeting the guideline (0) [9, 12]. Sleep duration was assessed as the average hours of sleep on weeknights. Age-specific recommendations were applied. For children aged 6–12 years, 9–12 hours was classified as meeting the guideline; for adolescents aged 13–17 years, 8–10 hours was classified as meeting the guideline. All other durations were coded as not meeting the guideline, including excessively long sleep [10, 12]. To reflect the integrated nature of daily behaviours, three binary variables (PA, ST, sleep) were summed to create a composite score (MB Number), ranging from 0 to 3, representing the number of guidelines met. In addition, a categorical variable (MB Combination) was constructed to capture specific behaviour patterns: none met, PA only, ST only,

sleep only, PA + ST, PA + sleep, ST + sleep, and all three behaviours met. This approach aligns with the 24-hour movement framework, which emphasizes the joint effects of behaviours within a finite day [11, 15].

2.3.3 Covariates

Several covariates were included to control for potential confounding. Demographic variables included age (continuous or categorized), sex (male/female), and race/ethnicity. Socioeconomic status was assessed using household poverty level and parental education. Family characteristics included family structure and primary household language. Physical health variables included body mass index category and general health status. These variables were coded according to standard NSCH procedures [18, 19].

2.3 Statistical Analysis

All analyses were conducted using SPSS, with statistical significance set at $p < 0.05$. Survey weights, strata, and cluster variables were applied to account for the complex sampling design. Descriptive statistics were calculated to summarize sample characteristics. Means and standard deviations were reported for continuous variables, and proportions were reported for categorical variables. Group differences were assessed using t-tests or analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. Logistic regression models were used to examine associations between MBs and flourishing. Model 1 included unadjusted associations, while Model 2 adjusted for all covariates. Analyses were conducted in two steps: first, examining the independent effects of each MBs; second, assessing the combined effects using MB Number and MB Combination variables. To evaluate dose–response relationships, MB Number was treated as an ordinal variable and tested for linear trends. Stratified analyses by sex and age group were conducted to assess potential subgroup differences. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

3 Results

3.1 Participant Characteristics

The weighted sample included 51.24% male and 48.76% female participants (Table 1). The largest age group was 14–17 years (35.10%), followed by 10–13 years (33.14%) and 6–9 years (31.76%). Regarding adherence to 24-hour MB guidelines, 41.51% of participants met one guideline, 32.21% met two guidelines, 17.61% met none, and 8.66% met all three. For specific MB combinations, the category was meeting the ST and sleep guidelines (24.50%), followed by sleep only (26.74%) and none met (17.61%). Smaller proportions met PA only (2.83%), PA + ST (3.03%), and PA + sleep (4.68%). Overall, 61.34% of participants were classified as flourishing, while 38.66% were not. Among the three flourishing indicators, curiosity had the highest proportion (83.93%), followed by task completion (80.94%) and emotional control (71.43%).

3.2 Differences Between Flourishing and Non-Flourishing Groups

Sex differed significantly between flourishing and non-flourishing groups ($p = 1.93 \times 10^{-8}$) (Table 2). In the flourishing group, 48.97% were male and 51.03% were female. In the non-flourishing group, 51.03% were male and 45.14% were female. Age was not significantly associated with flourishing status ($p = 0.514$). The weighted proportions across age groups were similar between flourishing and non-flourishing participants. The number of MB guidelines met differed significantly between groups ($p < 2.2 \times 10^{-16}$). Among flourishing participants, 36.25% met two guidelines and 10.86% met all three, whereas 13.45% met none. Among non-flourishing participants,

24.21% met none and 44.80% met one guideline, while only 25.80% met two and 5.18% met all three. Significant differences were also observed for MB combinations ($p < 2.2 \times 10^{-16}$). A higher proportion of flourishing participants met all three guidelines (flourishing vs not flourishing: 10.86% vs. 5.18%), PA + ST (flourishing vs not flourishing: 3.54% vs. 2.23%), and ST + sleep (flourishing vs not flourishing: 27.62% vs. 19.55%). In contrast, a higher proportion of non-flourishing participants met none (flourishing vs not flourishing: 24.21% vs. 13.45%) or sleep only (flourishing vs not flourishing: 30.42% vs. 24.43%).

Table 1
Baseline Characteristics of the Study Population

Variables	Unweighted n	Unweighted %	Weighted %	95% CI	
Sex					
Male	18962	51.5	51.24	50.23	52.26
Female	17875	48.5	48.76	47.74	49.77
Age					
6–9 years	9625	26.13	31.76	30.80	32.73
10–13 years	11639	31.60	33.14	32.18	34.09
14–17 years	15573	42.28	35.10	34.16	36.04
MB number					
0	6319	17.15	17.61	16.82	18.40
1	15409	41.83	41.51	40.51	42.51
2	11862	32.20	32.21	31.28	33.15
3	3247	8.81	8.66	8.12	9.21
MB combination					
None met	6319	17.15	17.61	16.82	18.40
PA only	917	2.49	2.83	2.48	3.17
ST only	3786	10.28	11.94	11.24	12.65
Sleep only	10706	29.06	26.74	25.86	27.62
PA + ST	1028	2.79	3.03	2.71	3.36
PA + Sleep	1681	4.56	4.68	4.25	4.25
ST + Sleep	9153	24.85	24.50	23.64	25.36
All three met	3247	8.81	8.66	8.12	9.21
Flourishing					
Yes	21865	59.4	61.34	60.37	62.31
No	14972	40.6	38.66	37.69	39.63
Curiosity	30514	82.84	83.93	83.21	84.65
Task Completion	29232	79.36	80.94	80.16	81.72
Emotional Control	26018	70.64	71.43	70.52	72.33

Note: MB: Movement behaviour, PA: Physical activity, ST: Screen time.

Table 2
Comparison of Characteristics Between Flourishing and Non-Flourishing Groups

Variables	Flourishing			Not Flourishing			P
	Unweighted n	Unweighted %	Weighted % (95% CI)	Unweighted n	Unweighted %	Weighted %(95% CI)	
Sex							1.93×10^{-8}
Male	10701	48.94	48.97 (47.65–50.29)	8261	55.18	54.86 (53.22–56.50)	
Female	11164	51.06	51.03 (49.71–52.35)	6711	44.82	45.14 (43.50–46.78)	
Age							0.514*
6–9 years	5552	25.39	32.12 (31.05–33.19)	4073	27.20	31.21 (30.12–32.30)	
10–13 years	6883	31.48	32.89 (31.77–34.01)	4756	31.77	33.53 (32.41–34.65)	
14–17 years	9430	43.13	35.00 (33.86–36.14)	6143	41.03	35.26 (34.18–36.34)	
MB number							$<2.2\times10^{-16}$
0	2849	13.03	13.45 (12.51–14.39)	3470	23.18	24.21 (23.19–25.23)	
1	8733	39.94	39.44 (38.25–40.63)	6676	44.59	44.80 (43.41–46.19)	
2	7895	36.11	36.25 (35.00–37.50)	3967	26.50	25.80 (24.81–26.79)	
3	2388	10.92	10.86 (10.09–11.63)	859	5.74	5.18 (4.93–5.43)	
MB combination							$<2.2\times10^{-16}$
None met	2849	13.03	13.45 (12.51–14.39)	3470	23.18	24.21 (23.19–25.23)	
PA only	508	2.32	2.41 (2.10–2.72)	409	2.73	3.48 (3.19–3.77)	

Note: MB: Movement behaviour, PA: Physical activity, ST: Screen time.

Variables	Flourishing			Not Flourishing			P
	Unweighted n	Unweighted %	Weighted % (95% CI)	Unweighted n	Unweighted %	Weighted %(95% CI)	
ST only	2416	11.05	12.60 (11.67–13.53)	1370	9.15	10.90 (10.26–11.54)	
Sleep only	5809	26.57	24.43 (23.31–25.55)	4897	32.71	30.42 (29.30–31.54)	
PA + ST	693	3.17	3.54 (3.06–4.02)	335	2.24	2.23 (1.96–2.50)	
PA + Sleep	1067	4.88	5.09 (4.63–5.55)	614	4.10	4.02 (3.67–4.37)	
ST + Sleep	6135	28.06	27.62 (26.50–28.74)	3018	20.16	19.55 (18.64–20.46)	
All three met	2388	10.92	10.86 (10.09–11.63)	859	5.74	5.18 (4.93–5.43)	

Note: MB: Movement behaviour, PA: Physical activity, ST: Screen time.

3.3 Association Between Number of Guidelines Met and Outcomes

Compared with meeting no guidelines, meeting one guideline was associated with higher odds of all outcomes (Table 3). The odds ratio (OR) for overall flourishing was 1.44 (95% CI: 1.27–1.63). For curiosity, the OR was 1.47 (95% CI: 1.27–1.70); for task completion, 1.37 (95% CI: 1.19–1.58); and for emotional control, 1.36 (95% CI: 1.19–1.55). Meeting two guidelines showed stronger associations. The OR for overall flourishing was 2.21 (95% CI: 1.93–2.52). The ORs were 2.40 (95% CI: 2.03–2.83) for curiosity, 2.00 (95% CI: 1.71–2.34) for task completion, and 1.89 (95% CI: 1.64–2.18) for emotional control. Meeting all three guidelines showed the highest outcomes. The OR for overall flourishing was 3.28 (95% CI: 2.72–3.94). The ORs were 4.68 (95% CI: 3.42–6.42) for curiosity, 2.60 (95% CI: 2.04–3.32) for task completion, and 2.80 (95% CI: 2.31–3.39) for emotional control. Across all outcomes, the ORs increased as the number of guidelines met increased.

Table 3
Association Between Number of Guidelines Met and Outcomes

Number of Guidelines Met	Flourishing	Curiosity	Task Completion	Emotional Control
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
0 guidelines	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
1 guideline	1.44 (1.27–1.63)	1.47 (1.27–1.70)	1.37 (1.19–1.58)	1.36 (1.19–1.55)
2 guidelines	2.21 (1.93–2.52)	2.40 (2.03–2.83)	2.00 (1.71–2.34)	1.89 (1.64–2.18)
3 guidelines	3.28 (2.72–3.94)	4.68 (3.42–6.42)	2.60 (2.04–3.32)	2.80 (2.31–3.39)
Note: MB: Movement behaviour, PA: Physical activity, ST: Screen time.				

3.4 Association Between Movement Behaviour Combinations and Outcomes

Table 4 presents the odds ratios (ORs) for overall flourishing across different MB combinations, with 95% confidence intervals. Compared with participants who met no guidelines, all combinations except PA only showed higher odds of flourishing. The strongest association was observed for meeting all three guidelines reported in Table 4 (OR = 3.32, 95% CI: 2.76–4.00). Elevated odds were also observed for PA + ST (OR = 2.69, 95% CI: 2.07–3.49), ST + sleep (OR = 2.23, 95% CI: 1.88–2.64), and ST only (OR = 2.03, 95% CI: 1.66–2.49). Meeting PA + sleep was associated with moderately increased odds (OR = 1.97, 95% CI: 1.56–2.48), while sleep only showed smaller but statistically significant associations (OR = 1.26, 95% CI: 1.06–1.49). In contrast, PA only was not significantly associated with flourishing (OR = 1.27, 95% CI: 0.96–1.68).

Table 4 shows the distribution of outcome scores across MB combinations using box plots for overall flourishing, task completion, and emotional control. The pattern of distributions aligns with the magnitude of associations reported in Table 4. Participants who met all three guidelines showed the highest outcome levels, with ORs of 2.63 (95% CI: 2.08–3.33) for task completion, and 2.84 (95% CI: 2.34–3.44) for emotional control. Participants meeting PA + ST and ST + sleep also demonstrated relatively higher outcome levels. For PA + ST, the ORs were 2.69 (95% CI: 2.07–3.49) for flourishing, 2.15 (95% CI: 1.52–3.04) for task completion, and 2.46 (95% CI: 1.86–3.26) for emotional control. For ST + sleep, the ORs were 2.23 (95% CI: 1.88–2.64), 2.05 (95% CI: 1.63–2.58), and 1.90 (95% CI: 1.59–2.26), respectively. Moderate levels were observed for PA + sleep and ST only. For PA + sleep, the ORs were 1.97 (95% CI: 1.56–2.48) for flourishing, 1.80 (95% CI: 1.32–2.45) for task completion, and 1.67 (95% CI: 1.30–2.14) for emotional control. For ST only, the corresponding ORs were 2.03 (95% CI: 1.66–2.49), 1.80 (95% CI: 1.38–2.35), and 1.76 (95% CI: 1.42–2.17). Lower outcome levels were observed among participants who met sleep only or PA only. Sleep only was associated with ORs of 1.26 (95% CI: 1.06–1.49) for flourishing and 1.23 (95% CI: 1.03–1.46) for emotional control, while the association with task completion was not significant (OR =

1.22, 95% CI: 0.97–1.53). PA only showed no significant associations across outcomes, with ORs ranging from 1.26 to 1.44 and all confidence intervals including 1.00. Overall, groups meeting multiple guidelines showed higher outcome levels, whereas those meeting fewer or no guidelines showed lower levels.

Table 4
Association Between Movement Behaviour Combinations and Outcomes

Number of Guidelines Met	Flourishing	Curiosity	Task Completion	Emotional Control
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
None met	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
PA only	1.27 (0.96–1.68)	1.50 (0.99–2.27)	1.44 (0.97–2.15)	1.26 (0.92–1.72)
ST only	2.03 (1.66–2.49)	2.04 (1.45–2.88)	1.80 (1.38–2.35)	1.76 (1.42–2.17)
Sleep only	1.26 (1.06–1.49)	1.31 (0.97–1.76)	1.22 (0.97–1.53)	1.23 (1.03–1.46)
PA + ST	2.69 (2.07–3.49)	2.35 (1.50–3.66)	2.15 (1.52–3.04)	2.46 (1.86–3.26)
PA + Sleep	1.97 (1.56–2.48)	2.54 (1.71–3.77)	1.80 (1.32–2.45)	1.67 (1.30–2.14)
ST + Sleep	2.23 (1.88–2.64)	2.39 (1.76–3.26)	2.05 (1.63–2.58)	1.90 (1.59–2.26)
All three met	3.32 (2.76–4.00)	4.71 (3.25–6.83)	2.63 (2.08–3.33)	2.84 (2.34–3.44)
Note: MB: Movement behaviour, PA: Physical activity, ST: Screen time.				

4 Discussion

4.1 Main Findings

The present study examined the associations between 24-hour MBs, including PA, ST, and sleep, and flourishing among children and adolescents. Several key findings emerged. First, a clear gradient was observed, whereby higher adherence to MB guidelines was associated with more favourable outcomes across overall flourishing and its subcomponents, including curiosity, task completion, and emotional control. Second, meeting all three guidelines showed the strongest associations across all outcomes. Third, combinations of behaviours were more strongly associated with flourishing than single behaviours, indicating the importance of integrated daily

behaviour patterns. These findings were consistent across all outcomes, suggesting a robust relationship between 24-hour MBs and positive mental health indicators.

In addition to these primary results, the descriptive findings provide important context. A relatively small proportion of participants met all three guidelines, while most met only one or two. At the same time, a majority of participants were classified as flourishing, although substantial proportions did not meet individual behavioural recommendations. These patterns suggest that optimal MB profiles are not yet widely achieved, even among generally healthy populations. Furthermore, differences observed between flourishing and non-flourishing groups reinforce the central role of MBs. Participants who were flourishing were more likely to meet multiple guidelines and less likely to meet none, while sex differences indicated a higher proportion of males in the non-flourishing group. In contrast, age was not significantly associated with flourishing, suggesting that the observed relationships are relatively stable across developmental stages.

4.2 Interpretation of the Dose–Response Relationship

A central finding of this study is the presence of a clear dose–response relationship between the number of MB guidelines met and flourishing outcomes. As adherence increased from zero to three guidelines, the likelihood of favourable outcomes increased in a stepwise manner across all indicators. This pattern indicates that each additional healthy behaviour contributes incrementally to children's mental well-being. This finding aligns with the conceptual foundation of the 24-hour MB framework, which emphasizes that PA, sedentary behaviour, and sleep are interdependent components of a finite 24-hour day [12]. From this perspective, improvements in one behaviour are likely to influence others, resulting in cumulative effects on health outcomes [20, 21]. The observed gradient in this study provides empirical support for this integrated model. Previous research has reported similar dose–response patterns. For example, Carson et al. [22] found that meeting a greater number of movement guidelines was associated with better physical and mental health indicators in children. Likewise, Sampasa-Kanyinga et al. [23] reported that combinations of PA, ST, and sleep were jointly associated with depressive symptoms and well-being. The current findings extend this evidence by demonstrating consistent associations across multiple domains of positive functioning, rather than focusing solely on the absence of mental health problems. Importantly, the dose–response pattern was evident across all outcomes, including curiosity, task completion, and emotional control. This consistency suggests that the benefits of adhering to multiple guidelines are not limited to a single aspect of functioning but instead reflect broader developmental advantages.

4.3 Interpretation of Movement Behaviour Combinations

The analysis of specific MB combinations provides further insight into how daily behaviour patterns relate to flourishing. Participants who met all three guidelines consistently showed the most favourable outcomes, reinforcing the importance of balanced behaviour across the 24-hour day. Among dual-behaviour combinations, those including ST and sleep were both common and strongly associated with flourishing. This pattern may reflect the foundational role of adequate sleep and limited screen exposure in supporting cognitive and emotional processes. Sleep has been consistently linked to attention, emotional regulation, and overall well-being in youth [24], while excessive ST has been associated with poorer mental health and reduced psychosocial functioning [25]. Combinations that included PA were also associated with improved outcomes, particularly when paired with other healthy behaviours. PA has been widely shown to support psychological well-being, including reduced symptoms of anxiety and depression and improved self-esteem [26]. However, the present findings indicate that PA alone was not significantly associated with flourishing, suggesting that its benefits may depend on the broader behavioural context. This observation is consistent with emerging evidence that single-behaviour approaches may

be insufficient to capture the complexity of health-related behaviours [16]. Instead, combinations of behaviours appear to exert synergistic effects, with the joint presence of multiple healthy behaviours providing the greatest benefit. These findings underscore the importance of considering the full spectrum of daily activities rather than focusing on individual behaviours in isolation.

4.4 Differential Patterns Across Flourishing Domains

Although the overall pattern of associations was consistent, some variation was observed across different domains of flourishing. In general, associations were strongest for curiosity, followed by emotional control and task completion. Curiosity, which reflects engagement in learning and openness to new experiences, showed the most pronounced associations with MB adherence. This may be explained by the strong links between sleep, ST, and cognitive functioning. Adequate sleep is essential for attention, memory, and learning processes [27], while excessive ST may displace cognitively enriching activities and reduce opportunities for exploration [25]. Emotional control and task completion also showed positive associations, although the magnitude was somewhat smaller. These domains are closely related to self-regulation, which is influenced by both biological and environmental factors. PA has been associated with improved emotional regulation and resilience [28], while sleep plays a critical role in maintaining emotional stability. Single-behaviour patterns, particularly sleep only, showed weaker or inconsistent associations across outcomes. This suggests that while sleep is essential, it may not be sufficient on its own to support all aspects of flourishing. Instead, a combination of behaviours appears necessary to achieve optimal outcomes across multiple domains.

4.5 Implications and practice

The findings of this study offer several practical implications. First, they support the 24-hour movement behaviour framework by showing that PA, ST, and sleep should be addressed together rather than in isolation. Health promotion programs for children and adolescents may benefit from targeting all three behaviours simultaneously. Second, the results highlight the importance of behaviour combinations. Interventions that aim to increase PA, reduce ST, and improve sleep hygiene at the same time may be more effective for enhancing flourishing than those focusing on a single behaviour [12]. Third, the observed dose–response relationship suggests that even partial adherence to guidelines is beneficial. Public health strategies can encourage incremental improvements, such as adding one day of PA or reducing ST by one hour, as these small changes may still contribute to better outcomes. Finally, schools, families, and community programs should prioritize balanced daily routines, given that meeting multiple guidelines was consistently associated with higher odds of flourishing across all subcomponents.

5 Conclusion

This study examined the associations between adherence to 24-hour MB guidelines and flourishing among children and adolescents. The findings indicate that greater adherence to recommended levels of PA, ST, and sleep is consistently associated with more favourable outcomes across overall flourishing and its key components, including curiosity, task completion, and emotional control. A clear gradient was observed, with higher numbers of guidelines met corresponding to progressively better outcomes. In addition, combinations of MBs showed stronger associations with flourishing than any single behaviour alone. Overall, this study extends existing research by focusing on flourishing as a positive indicator of well-being and by demonstrating the relevance of combined MBs. Promoting adherence to multiple movement guidelines may represent an effective strategy for supporting healthy development and well-being in children and adolescents.

Declarations

Ethics approval and consent to participate

This study involved a secondary analysis of publicly available, de-identified data from the National Survey of Children's Health (NSCH). The original NSCH data collection was approved by the NCHS Research Ethics Review Board, and informed consent was obtained from all participants or their legally authorized representatives. As this study used fully anonymized secondary data, further ethical approval was waived by the institutional review board of Nanjing Sport Institute.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Clinical trial number

Not applicable.

Funding

None.

Author Contribution

Yang Su is the sole contributor to this work and has read and approved the final manuscript.

Acknowledgements

None.

Availability of data and materials

The datasets analysed during the current study are available in the National Survey of Children's Health repository, accessible at: https://mchb.hrsa.gov/data-research/national-survey-childrens-health.

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