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Associations between Media Use and Executive Dysfunction among Preschool Children in Bangkok, Thailand

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Abstract

This study aims to describe the relation between media use characteristics and executive dysfunction in Thai preschoolers. Secondary data were retrieved from a cross-sectional study to compare two Thai executive functions (EFs) assessment forms. Questionnaire data from 110 caregivers of preschool children were analyzed. The research materials included a sociodemographic information form, parenting style and dimensions questionnaire, a 1-week screen time diary, and the behavior rating inventory of executive function-preschool version (BRIEF-P). Findings showed a 23.6% prevalence of executive dysfunction among Thai preschool children. Children's media use characteristics associated with global executive dysfunction included less co-viewing time with caregivers. Shorter co-viewing time was linked to a deficiency of inhibition, emotional control, and planning and organization. Meanwhile, extended viewing of low-quality content was associated with impaired working memory. However, total screen time and setting screen time limits were not associated with executive dysfunction. Co-viewing with caregivers and limiting exposure to low-quality content must be promoted to minimize the adverse effects on EF development.

Keywords
- preschool
- executive dysfunction
- media
- use
- co-viewing
- low-quality media contents

Introduction

Executive functions (EFs) refer to multiple interrelated cognitive skills required for purposeful and goal-directed behavior. These cognitive processes are associated with critical functional outcomes such as academic achievement, social competence, adaptive skills, and mental and physical health.[1] EFs develop from the first year of life until late adolescence, with the most remarkable changes taking place during preschool (ages 3–5). The brain's frontal lobes, specifically the prefrontal cortex,[2–4] are primarily linked to EFs.

EFs are composed of three basic skills: working memory (WM; i.e., holding mental information for further utilization and evaluation to complete tasks), inhibition (i.e., the ability to control behaviors and impulses, think before acting, and manage extraneous distractions), and cognitive flexibility (i.e., the ability to revise plans and generate different solutions when faced with obstacles).[1] The skills of higher-order EFs develop from three core components: reasoning, problem-solving, and planning.[5,6]

Factors that lead to individual differences in EF include neurological differences,[7] temperament,[8] and cognitive training.[9] In addition, young children's EF development

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involves several environmental factors, including parenting styles,[10] parental education, family income,[11] birth order,[12] and screen exposure.[13] Many of these factors are beyond parental control; however, screen exposure may be a more manageable environmental component related to EF development.

Studies have established the association between longer screen time and lower EF.[13,14] One study showed that less overall media exposure at age 2 was associated with higher self-regulation at age 4.[13] In contrast, Supanitayanon et al[15] found that Thai toddlers who consumed screen media for more than 6.5 hours per day suffered from significantly higher EF impairment in inhibition, WM, flexibility, planning, and problem-solving compared with those who spent less time watching screen media. Besides screen time, the type of media that children are exposed to also affects their EF development. Research has observed the positive impact of high-quality children's television programs on children's inhibitory skills and ability to delay gratification.[16] Meanwhile, preschool children performed significantly worse on EF tasks immediately after watching fast-paced cartoons than those who watched child-directed programs.[17]

A 2010 survey in Thailand showed that Thai preschool children were exposed to screen media for almost 2 hours a day,[18] exceeding the American Academy of Pediatrics recommendation that preschool children should not consume screen media for more than 1 hour a day.[19] In addition, the most popular screen media contents among Thai children are of low quality, such as fast-paced cartoons, online games, and adult-directed programs.[18] These data indicate the seriousness of the impact of Thai children's current use of screen media on their EF. However, research on such an effect remains limited, and the viewing context (e.g., co-viewing with a parent, and rules restricting screen exposure) is also a research gap in this field. Therefore, this study investigated the association between media use characteristics (e.g., screen time, type of quality content, and co-viewing) and executive dysfunction among Thai preschoolers.

Methods

Study Design and Participants

This study used secondary data from Wattanakijthamrong et al's unpublished cross-sectional study comparing two Thai EF assessment forms.[20] A sample of 110 caregivers of preschool children was conveniently recruited from all eight kindergarten schools in Bangkok Noi District, Bangkok, Thailand. Inclusion criteria for caregivers were serving as the primary caregivers of Thai children aged 4 to 6 years and being literate in the Thai language. Caregivers were excluded if the children under their care were diagnosed with child development-related chronic illnesses such as global developmental delay, autistic spectrum disorder, epilepsy, and hearing impairment.

Data Collection

Ethical approval was obtained from the Siriraj Institutional Review Board (COA no. 833/2562 (IRB4)) for the original study that compared the EFs of preschool children using the Thai version of the behavior rating inventory of executive function-preschool (BRIEF-P) and Mahidol University's EF test (MU.EF).[20] Data were collected from July 2019 to April 2020. The original study distributed the announcement to all eight kindergarten schools in Bangkok Noi District. If the caregivers who met the inclusion criteria expressed interest in participating, the researchers of the original study approached these participants and informed them about the study. When the caregivers agreed to participate, they signed consent forms and completed the paper-based questionnaires. The original study used three questionnaires: the Thai version of the BRIEF-P, the MU.EF, and the parenting style and dimensions questionnaire-short version (PSDQ). In addition, data were collected from the demographic information of the primary caregiver and the children under their care as well as the child's screen time diary.

Research Instruments

The research instrument was a structured questionnaire consisting of four parts:

Sociodemographic Information Form

This form recorded the demographic information of both the primary caregiver and the children under their care. For the children, the information included age, sex, birth order, and screen time limits, while the sociodemographic form for the caregiver included the caregiver's age, education, and family income.

Parenting Style and Dimensions Questionnaire-Short Version

The PSDQ-short version (Thai version) evaluates parenting styles. The instrument allows caregivers to rate how often they displayed certain behaviors toward the child by responding to 32 statements. These responses were based on a 5-point Likert scale: 1 (never), 2 (once in a while), 3 (about half of the time), 4 (very often), and 5 (always). The questions in the PSDQ explore different parenting styles: 15 questions on authoritative parenting, 12 on strict authoritarian parenting, and 5 on permissive parenting. For each parenting character, the total score ranged from 1 to 5 points. The overall parenting style score was obtained through an average of items relevant to each parenting style. The internal consistency values of the PSDQ-Short Version were 0.86 for authoritative parenting, 0.82 for authoritarian parenting, and 0.64 for permissive parenting.[21]

Screen Time Diary

The caregivers used the screen time diary to evaluate problematic screen exposure. They recorded the children's daily screen time on devices such as televisions (TV), smartphones, computers, tablets, and gaming devices for 1 week (including weekends). The average daily screen time was calculated as the total screen time on weekdays and weekends divided by 7 days. Besides screen time, the caregivers were also asked about screen content and co-viewing in an open-ended format. Low-quality content included fast-paced programs,

applications with distracting and/or violent material, or adult-oriented media. Meanwhile, high-quality content included age-appropriate educational and prosocial material. Viewing time was recorded for each type of content. Co-viewing was recorded as the time the caregiver spent on media exposure and encouraging discussions about the content with the child. Topics discussed during the co-viewing period were recorded as qualitative data.

Behavior Rating Inventory of Executive Function-Preschool Version

Sixty-three items of the BRIEF-P were developed to assess everyday EF in children from ages 2 to 5 years and 11 months. The BRIEF-P consists of a single rating form designed to be completed by parents or other caregivers and has five nonoverlapping subscales: inhibition, shift, emotional control (EC), WM, and plan/organize (PO). Incorporating all BRIEF-P clinical scales is the global executive composite (GEC), an overarching summary score, which can be converted into T-scores. Responses regarding the child's behavior related to EF deficits use a three-point rating system (1 = never, 2 = sometimes, and 3 = often). T-scores equal to or greater than 65 indicate that the child tends to have a clinically elevated level of EF deficit. Executive dysfunction is considered if the T-score of GEC is greater than or equal to 65.[22] The internal correlation of the Thai version of the BRIEF-P was high with a Cronbach's α of 0.92.

Data Analysis

This study performed descriptive analysis to calculate the frequency, percentage of categorical data, means ± standard deviation, and median (min–max and interquartile range). It used the chi-squared test or Fisher's exact test to examine the association between EF deficits, including global executive dysfunction (T-score of GEC $\geq$ 65) and each EF impairment (T-score $\geq$ 65 for each EF), and demographic variables (including the child's sex and birth order, the primary caregiver's age and educational level, monthly household income, parenting style, co-viewing, and screen time restriction). Using the Mann–Whitney U test, this study analyzed the relation between the deficit of EFs and screen time and the quality of media the children were exposed to. This study also performed univariate logistic regression analysis as the first step in assessing whether there was any association between the demographics and impaired EFs. Media use factors that reached the significance level ($p < 0.2$) in the univariate regression model were included in further multiple regression models (model 1). In the final multiple logistic regression model (model 2), for which the level of significance was set at p-value less than 0.05, the media use factors were adjusted for other potential variables with a significance level of p-value less than 0.2 from the univariate logistic regression. All statistical analyses were performed using IBM SPSS Statistics for Windows version 25 (IBM Corp., Armonk, New York, United States).

Results

Sociodemographic Characteristics

A total of 110 pairs of caregivers and children participated in this study. The analysis of sociodemographic characteristics showed that about half of these primary caregivers were 30 to 39 years old (50.9%), and the majority were mothers (75.5%). Most of the primary caregivers (80.9%) completed at least a bachelor's degree. With regard to family income, 39.1% of the caregivers earned an average monthly income of less than $575, while 29.1% earned approximately $575 to $1,150, and a further 31.8% earned above $1,150. Almost all caregivers (98.2%) practiced an authoritative parenting style, and 88.2% enforced screen time rules to restrict the time that their children spent on screen (►**Table 1**).

Table 1 Demographic characteristics of participants

Demographic characteristics	Descriptive results
Sex	
Boy	69 (62.7)
Girl	41 (37.3)
Age of children (mean ± SD, years)[a]	5.51 ± 0.43
Birth order	
Firstborn child	56 (50.5)
Middle and lastborn child	54 (49.5)
Primary caregiver	
Mother	83 (75.5)
Father	21 (19.1)
Relatives	6 (5.4)
Primary caregiver's age (years)[a]	
20–29	12 (10.9)
30–39	56 (50.9)
40–49	38 (34.6)
50–59	4 (3.6)
Primary caregiver's education	
Below bachelor's degree	21 (19.1)
Bachelor's degree and above	89 (80.9)
Family monthly income (USD)	
< 575	43 (39.1)
575–1,150	32 (29.1)
> 1,150	35 (31.8)
Parenting styles	
Authoritative	108 (98.2)
Permissive	2 (1.8)
Duration of daily screen time (hours/day)[b]	2 (0,5)
Duration of high-quality program exposure (hours/day)[b]	1.75 (0.5)

(*Continued*)

Table 1 (*Continued*)

Demographic characteristics	Descriptive results
Duration of low-quality program exposure (hours/day)[b]	0 (0.3)
Co-viewing with primary caregiver	
$<$ 50% of total screen time	52 (47.3)
$\geq$ 50% of total screen time	58 (52.7)
Setting screen limit	
No	13 (11.8)
Yes	97 (88.2)

Abbreviation: SD, standard deviation.
Data presented as number (percentage), [a]Data presented as mean ± SD, [b]Data presented as median (min, max).

The children's data showed an average age of 5.51 ± 0.43 years, and the majority (62.7%) were boys. Daily screen time was 2 hours (range: 0–5 hours), and screen time spent on high-quality programs was 1.75 hours per day (range: 0–2.5 hours), while screen time spent on low-quality programs was rarely observed (range: 0–3 hours). A total of 58 children (52.7%) spent more than 50% of their total screen time with their caregivers (►**Table 1**). During the entire co-viewing period, all caregivers recorded their discussions with their children, the topics of which focused on explaining the contents viewed from the media to facilitate their children's understanding, pointing out the consequences of the character's actions, and teaching their children to express emotions and behaviors appropriately.

Prevalence of Executive Dysfunction

►**Table 2** shows that 26 preschool children (23.6%) had GEC impairment. Out of all EF components, the children were most deficient in WM (30%).

Association between Risk Factors and EF Impairments

►**Table 2** displays the sociodemographic characteristics associated with GEC impairment, which are sex ($p = 0.037$), the primary caregiver's education ($p = 0.021$), and monthly household income ($p = 0.024$). Considering each EF impairment domain, sex was linked to EC impairment, while primary caregiver education below a bachelor's degree was associated with weakened WM. Moreover, lower monthly family income had a significant association with poor WM.

Among specific media use factors, co-viewing for less than 50% of the children's total screen time ($p = 0.03$), the lack of a screen time limit ($p = 0.012$), and prolonged daily exposure to low-quality media content ($p = 0.001$) were associated with GEC impairment (►**Table 2**). Considering each EF aspect, less co-viewing time with caregivers was linked to impairment in all EF aspects (inhibition, shift, EC, WM, and PO), whereas the absence of screen time limits was associated with impairment in all EF aspects except shift.

In addition, ►**Table 3** shows differences in prolonged daily exposure to low-quality media content and EF (i.e., inhibition, EC, and WM impairments). Meanwhile, no differences were observed between total screen time and EF impairments.

Univariate Analysis and Multiple Logistic Regression of the Association between EF Impairments and Risk Factors

Results of the univariate logistic regression analysis (►**Table 4**) showed that the demographic factors contributing to the children's overall EF impairment (significant at $p < 0.2$) were being a boy (odds ratio [OR] = 2.91), being the middle to last-born child (OR = 2.49), having a primary caregiver with an education level lower than a bachelor's degree (OR = 3.35), and coming from a family with a lower monthly income (OR = 5.52). In addition, several screen media use factors that influence global EF impairment ($p < 0.2$) were children's screen utilization with co-viewing (OR = 4.20), unrestricted screen media use (OR = 4.79), duration of screen usage (OR = 1.42), and low-quality media contents (OR = 2.66). ►**Table 4** shows the associations between each EF impairment and the potential variables at p-value less than 0.2.

After the univariate logistic regression analysis, the media use variables at p-value less than 0.2 were examined using multiple logistic regression (►**Table 5**, model 1). Results showed that a co-viewing duration of less than 50% of the total screen time (OR = 3.13) and more prolonged daily exposure to low-quality content (OR = 3.70) were positively associated with global executive dysfunction ($p < 0.05$). Even after adjusting for other potential variables in the final multiple logistic regression model (►**Table 5**, model 2), less co-viewing remained significant (OR = 5.51). With regard to each EF domain, a co-viewing duration of less than 50% of the total screen time was linked to inhibition impairment in model 1 (OR = 8.81) and remained significant in model 2 after adjusting for potential variables (OR = 11.12). Less co-viewing was associated with an EC deficit in model 1 (OR = 5.74) and remained significant in model 2 (OR = 17.87). In addition, less co-viewing was linked to poor planning and organized skills in model 1 (OR = 3.67) and remained significant in model 2 (OR = 4.52). Meanwhile, a longer daily duration of low-quality content exposure was associated with impaired WM in model 1 (OR = 5.49) and remained significant in model 2 (OR = 6.97).

Discussion

EFs are vital to child development. Many factors may be associated with executive dysfunction and cause serious problems in children. This study investigated executive dysfunction among preschool children in Thailand. Our results showed that nearly a quarter of preschool subjects suffered from executive dysfunction (GEC impairment), which was a lower percentage than in Chutabhakddikul et al's findings, which indicated that 30% of preschoolers had impaired EFs.[23] This inconsistency may be attributed to the different tools for evaluating EFs. The original study in 2017 used the MU.EF to explore delayed EF development, leading to a disparity in EF criteria and evaluation.

Table 2 Chi-squared test of associations between demographic characteristics and number of children with impaired EFs

Demographic characteristics ($n = 110$)		Number of children with impaired EFs (BRIEF-P: T-score greater and equal than 65)											
		Inhibition ($n = 25$)		Shift ($n = 4$)		Emotional control ($n = 15$)		Working memory ($n = 33$)		Plan/Organize ($n = 21$)		Global executive composite ($n = 26$)	
		n (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*p*-value
Sex	Boy ($n = 69$)	18 (26.1)	0.275	2 (2.3)	0.628[a]	14 (20.3)	0.009[b]	22 (31.9)	0.669	17 (24.6)	0.078[a]	21 (30.4)	0.037[b]
	Girl ($n = 41$)	7 (17.1)		2 (4.9)		1 (2.4)		11 (26.8)		4 (9.8)		5 (12.2)	
Birth order	Firstborn child ($n = 56$)	10 (17.9)	0.215	0 (0)	0.055[a]	10 (17.9)	0.268	15 (26.8)	0.454	9 (16.1)	0.412	9 (16.1)	0.073
	Middle and lastborn child ($n = 54$)	15 (27.8)		4 (7.4)		5 (9.3)		18 (33.3)		12 (22.2)		17 (31.5)	
Primary caregiver's age	20-29 years ($n = 12$)	3 (25)	0.672[a]	1 (8.3)	0.421[a]	3 (25)	0.212[a]	5 (41.7)	0.606[a]	2 (16.7)	0.668[a]	3 (25)	0.975[a]
	30-39 years ($n = 56$)	12 (21.4)		3 (5.4)		4 (7.1)		16 (28.6)		10 (17.9)		14 (25)	
	40-49 years ($n = 38$)	10 (26.3)		0 (0)		7 (18.4)		10 (26.3)		9 (23.7)		8 (21.1)	
	50-59 years ($n = 4$)	0 (0)		0 (0)		1 (25)		2 (50)		0 (0)		1 (25)	
Primary caregiver's Education	Below bachelor's degree ($n = 21$)	8 (38.1)	0.062	1 (4.8)	0.577[a]	5 (23.8)	0.158	11 (52.4)	0.0018[b]	7 (33.3)	0.065	9 (42.9)	0.021[b]
	Bachelor's degree and above ($n = 89$)	17 (19.1)		3 (3.4)		10 (11.2)		22 (24.7)		14 (15.7)		17 (19.1)	
Monthly household income	< 575 US Dollars ($n = 43$)	13 (30.2)	0.318	2 (4.7)	0.414[a]	8 (18.6)	0.238[a]	21 (48.8)	0.002[b]	12 (27.9)	0.166[a]	15 (34.9)	0.024[b]
	575–1,150 US Dollars ($n = 32$)	6 (18.8)		0 (0)		5 (15.6)		7 (21.9)		4 (12.5)		8 (25)	
	> 1,150 US Dollars ($n = 35$)	6 (17.1)		2 (5.7)		2 (5.7)		5 (14.3)		5 (14.3)		3 (8.6)	
Parenting style	Authoritative style ($n = 108$)	24 (22.2)	0.405[a]	3 (2.8)	0.072[a]	13 (12.0)	0.018[a, b]	32 (29.6)	0.497[a]	20 (18.5)	0.347[a]	25 (23.1)	0.419[a]
	Permissive style ($n = 2$)	1 (50)		1 (50)		2 (100)		1 (50)		1 (50)		1 (50)	
Co-view	< 50% of total screen time (n = 52)	22 (42.3)	<0.001[a, b]	4 (7.7)	0.047[a, b]	13 (25)	0.001[a, b]	21 (40.4)	0.024[b]	16 (30.8)	0.003[b]	19 (36.5)	0.003[b]
	≥ 50% of total screen time ($n = 58$)	3 (5.2)		0 (0)		2 (3.4)		12 (20.7)		5 (8.6)		7 (12.1)	
Setting screen limit	No ($n = 13$)	9 (69.2)	<0.001[b]	1 (7.7)	0.400[a]	6 (46.2)	0.002[b]	7 (53.9)	0.058	6 (46.2)	0.017[b]	7 (53.9)	0.012[b]
	Yes ($n = 97$)	16 (16.5)		3 (3.1)		9 (9.3)		26 (26.8)		15 (15.5)		19 (19.6)	

Abbreviation: BRIEF-P, behavior rating inventory of executive function-preschool version; EF, executive function.
[a]The associations were assessed using Fisher's exact test.
[b]Statistically significant at p-value < 0.05.

Furthermore, in Chutabhakddikul's study, preschool children's EFs were assessed by teachers, who were closer to them and spent more time each day with them than their parents. Therefore, these teachers may have noticed defects in the EF abilities of children more quickly than their parents did. Therefore, it is no surprise that our results, which the parents reported, observed a lower prevalence of children with executive dysfunction than the previous study.

However, our findings revealed that WM was the most common executive dysfunction domain, which did not correspond with the 2017 study[23] and Chano[24], which found that preschoolers in Thailand were most impaired in their inhibition and EC skills. This discrepancy may be explained by the age range of the population from which the data were collected. Other studies[23,24] collecting data from Thai children aged 2 to 6 years found that those aged 2 to 4 years achieved higher than the standard scores for WM skill, while those aged 5 to 6 years attained average scores on this skill. In addition, Ackerman and Friedman-Krauss found that children aged 2 to 4 years had good WM abilities, which were supported by the rapid development of other skills during this age, including attention and inhibition.[25] Therefore, our participants, who were from the 4 to 6 age group, are more likely to exhibit a higher impairment prevalence in WM than in inhibition and EC.

Our study, along with other studies, showed that executive dysfunction is a common problem among preschool children, for which there is no standard therapy.[26] Therefore, experts are now focusing on addressing factors associated with executive dysfunction. For experts, one of the most crucial factors is the context of children's screen use. Our final multiple logistic regression model showed that co-viewing with caregivers for less than 50% of the total screen time contributed to impairments in global EFs among preschool children and that, when thoroughly assessed, less co-viewing time was associated with impairments in all EF subscales except WM and shifting. To understand the content that the children consumed through media and predict probable outcomes, these contents would be compared with those they have stored in their long-term memory. However, preschool children's lack of experience may

Table 3 Mann–Whitney U-test results for differences between duration of media use (including total screen time, low-quality media exposure, and high-quality media exposure) and domains of EF impairment

Domains of EFs (assessed by BRIEF-P)		Total screen time exposure (hours/day)		Low-quality media exposure (hours/day)		High-quality media exposure (hours/day)	
		Median (IQR)	*p*-Value	Median (IQR)	*p*-Value	Median (IQR)	*p*-Value
Inhibition	Impaired	2 (1,3.3)	0.357	0 (0,2)	0.001[a]	2 (1,2)	0.304
	Normal	2 (1,2.5)		0 (0,0)		1 (1,2)	
Shift	Impaired	2 (1,4)	0.896	0 (0,2.3)	0.370	2 (1,1.75)	0.536
	Normal	1 (1,2.5)		0 (0,0)		1 (1.2)	
Emotional control	Impaired	2 (1,4)	0.270	0 (0,2)	<0.001[a]	2 (1,2)	0.385
	Normal	2 (1,2.5)		0 (0,0)		1 (1,2)	
Working memory	Impaired	2 (1,2.8)	0.189	0 (0,1.5)	0.002[a]	2 (1,2)	0.625
	Normal	2 (1,2)		0 (0,0)		1.5 (1,2)	
Plan/organize	Impaired	2 (1,2.5)	0.277	0 (0,1)	0.075	2 (1,2)	0.875
	Normal	2 (1,2.5)		0 (0,0)		1.5 (1,2)	
Global executive composite	Impaired	2 (1,3.1)	0.276	0 (0,2)	0.001[a]	2 (1,2)	0.373
	Normal	2 (1,2.4)		0 (0,0)		1 (1,2)	

Abbreviations: BRIEF-P, behavior rating inventory of executive function-preschool version; EF, executive function; IQR, interquartile range.
[a]Statistically significant at p-value < 0.05.

prevent them from independently understanding all media content. Moreover, most programs viewed by children contain surreal stories/contents and even adult-directed material, which leads to more difficulties in understanding and connecting obtained information. Scientific evidence has shown that the brain requires more processing to understand fantasy or new events that children consume through screen media, which lowers dopamine levels in the prefrontal cortex until it becomes insufficient for performing tasks that require EFs.[27] Therefore, caregivers who watch media with children and provide further explanations of such content facilitate children's comprehension of the media content and their ability to relate the content to their experiences. If children could understand media content more easily, they would need less dopamine in their prefrontal cortex while watching such content, thus reducing

Table 4 Univariate logistic regression models for association between risk factors and domains of impaired EF

Domains of impaired EF	Potential factors[a]	OR (95%CI)	*p*-Value
Inhibition	**Birth order**		
	Firstborn child	Reference	
	Middle and lastborn child	1.84 (0.75, 4.53)	0.186
	Primary caregiver's education		
	Below bachelor's degree	2.75 (0.99, 7.67)	0.053
	Bachelor's degree and above	Reference	
	Co-view		
	< 50% of co-viewing screen time	13.44 (3.72, 48.63)	< 0.001[b]
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	11.39 (3.12, 41.55)	<0.001[b]
	Setting screen limit	Reference	
	Duration of total screen time exposure	1.51 (0.99, 2.32)	0.057
	Duration of low-quality media content exposure	3.06 (1.58, 5.95)	0.001[b]
Shift	**Duration of low-quality media content exposure**	1.93 (0.77, 4.85)	0.162

Table 4 (*Continued*)

Domains of impaired EF	Potential factors[a]	OR (95%CI)	*p*-Value
Emotional control	**Sex**		
	Boy	9.49 (1.2, 75.08)	0.033[b]
	Girl	Reference	
	Primary caregiver's age		
	20–29 years	Reference	
	30–39 years	0.22 (0.04, 1.14)	0.071
	40–49 years	0.66 (0.14, 3.07)	0.592
	50–59 years	1.00 (0.07, 13.64)	1.000
	Primary caregiver's education		
	Below bachelor's degree	2.59 (0.78, 8.61)	0.119
	Bachelor's degree and above	Reference	
	Monthly income		
	< 575 USD	3.67 (0.73, 18.53)	0.116
	575–1,150 USD	2.75 (0.50, 15.25)	0.247
	> 1,150 USD	Reference	
	Co-view		
	< 50% of co-viewing screen time	9.33 (1.99, 43.70)	0.005[b]
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	8.38 (2.31, 30.39)	0.001[b]
	Setting screen limit	Reference	
	Duration of total screen time exposure	1.70 (1.04, 2.78)	0.036[b]
	Duration of low-quality media content exposure	3.06 (1.62, 5.76)	0.001[b]
Working memory	**Primary caregiver's education**		
	Below bachelor's degree	3.55 (1.33, 9.47)	0.011[b]
	Bachelor's degree and above	Reference	
	Monthly income		
	< 575 USD	5.48 (1.79, 16.73)	0.003[b]
	575–1,150 USD	1.50 (0.43, 5.28)	0.528
	> 1,150 USD	Reference	
	Co-view		
	< 50% of co-viewing screen time	2.60 (1.12, 6.03)	0.026[b]
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	3.19 (0.98, 10.36)	0.054
	Setting screen limit	Reference	
	Duration of total screen time exposure	1.52 (1.02, 2.28)	0.042[b]
	Duration of low-quality media content exposure	3.07 (1.49, 6.32)	0.002[b]
Plan/Organize	**Sex**		
	Boy	2.81 (0.88, 9.01)	0.083
	Girl	Reference	

(*Continued*)

Table 4 (*Continued*)

Domains of impaired EF	Potential factors[a]	OR (95%CI)	*p*-Value
	Primary caregiver's education		
	Below bachelor's degree	2.82 (0.97, 8.23)	0.058
	Bachelor's degree and above	Reference	
	Monthly income		
	< 575 USD	2.25 (0.71, 7.15)	0.169
	575-1,150 USD	0.77 (0.19, 3.16)	0.722
	> 1,150 USD	Reference	
	Co-view		
	< 50% of co-viewing screen time	4.71 (1.58, 14.01)	0.005[b]
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	4.69 (1.38, 15.90)	0.013[b]
	Setting screen limit	Reference	
	Duration of low-quality media content exposure	1.80 (1.01, 3.21)	0.045[b]
Global executive composite	**Sex**		
	Boy	2.91 (1.00, 8.43)	0.049[b]
	Girl	Reference	
	Birth order		
	Firstborn child	Reference	
	Middle and lastborn child	2.49 (1.00, 6.18)	0.050
	Primary caregiver's education		
	Below bachelor's degree	3.35 (1.22, 9.22)	0.019[b]
	Bachelor's degree and above	Reference	
	Monthly income		
	< 575 USD	5.52 (1.45, 21.02)	0.012[b]
	575–1,150 USD	3.16 (0.76, 13.11)	0.113
	> 1,150 USD	Reference	
	Co-view		
	< 50% of co-viewing screen time	4.20 (1.59, 11.08)	0.004[b]
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	4.79 (1.44, 15.91)	0.011[b]
	Setting screen limit	Reference	
	Duration of total screen time exposure	1.42 (0.93, 2.15)	0.104
	Duration of low-quality media content exposure	2.66 (1.42, 4.99)	0.002[b]

Abbreviations: CI, confidence interval; EF, executive function; OR, odds ratio.
[a]Only potential factors with *p*-value < 0.2 are listed in the table.
[b]Statistically significant at *p*-value < 0.05.

their risk of executive dysfunction. Our qualitative data from the screen time diaries showed that during co-viewing, all caregivers initiated discussions regarding events observed through media and explained these contents further. Thus, our study considered co-viewing as a preventive factor against executive dysfunction in preschool children.

The first multiple logistic regression analysis model showed that more prolonged exposure to low-quality programs, such as fast-paced cartoons, online games, and non-age-appropriate movies, also increases the prevalence of global executive dysfunction, inhibition impairment, deficits in EC, and poor WM. However, after adjusting for potential

Table 5 Final multiple logistic regression of executive dysfunction and media use factors

Domain of impaired EF	Media use factors	Model 1[a] OR (95% CI)	Model 2[b] OR (95%CI)
Inhibition	**Co-view**		
	< 50% of co-viewing screen time	**8.81 (2.26–34.33)**	**11.12 (2.69–45.96)**
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	2.92 (0.42–20.28)	4.19 (0.55–32.22)
	Setting screen limit	Reference	
	Duration of total screen time exposure	0.52 (0.21–1.30)	0.66 (0.25–1.72)
	Duration of low-quality media content exposure	**3.47 (1.02–11.84)**	2.25 (0.62–8.24)
Shift	**Duration of low-quality media content exposure**	1.93 (0.77, 4.85)	1.93 (0.77, 4.85)
Emotional control	**Co-view**		
	< 50% of co-viewing screen time	**5.74 (1.09, 30.18)**	**17.87 (1.75, 182.18)**
	≥ 50% of total screen time	Reference	Reference
	Screen limit		
	No setting screen limit	1.79 (0.18, 17.83)	0.86 (0.06, 11.85)
	Setting screen limit	Reference	
	Duration of total screen time exposure	0.48 (0.16, 1.46)	0.58 (0.14, 2.40)
	Duration of low-quality media content	**4.58 (1.14, 18.35)**	4.77 (0.69, 32.95)
Working memory	**Co-view**		
	< 50% of co-viewing screen time	**3.04 (1.05, 8.80)**	2.24 (0.87, 5.77)
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	0.22 (0.02, 2.72)	0.10 (0.01, 1.55)
	Setting screen limit	Reference	
	Duration of total screen time exposure	0.86 (0.45, 1.66)	0.90 (0.44, 1.84)
	Duration of low-quality media content exposure	**5.49 (1.38, 21.92)**	**6.97 (1.37, 35.40)**
Plan/organize	**Co-view**		
	< 50% of co-viewing screen time	**3.67 (1.14, 11.76)**	**4.52 (1.32, 15.50)**
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	1.94 (0.32, 11.84)	1.45 (0.23, 9.16)
	Setting screen limit	Reference	
	Duration of low-quality media content exposure	1.18 (0.51, 2.71)	1.15 (0.49, 2.74)
Global executive composite	**Co-view**		
	< 50% of co-viewing screen time	**3.13 (1.10, 9.10)**	**5.51 (1.56, 19.45)**
	≥ 50% of total screen time	Reference	
	Screen limit		
	No setting screen limit	0.89 (0.12, 6.73)	0.91 (0.09, 8.88)
	Setting screen limit	Reference	
	Duration of total screen time exposure	0.65 (0.31, 1.39)	0.84 (0.36, 1.96)
	Duration of low-quality media content exposure	**3.70 (1.18, 11.63)**	2.57 (0.68, 9.71)

Abbreviations: CI, confidence interval; EF, executive function; OR, odds ratio.

[a]Model 1 is the multiple logistic regression model, including all significant media use factors from univariate logistic regression (selection criteria: $p < 0.2$).

[b]Model 2 is Model 1 adjusted for other potential factors from univariate logistic regression (selection criteria: $p < 0.2$). Final models were considered statistically significance at $p < 0.05$ and were listed bold.

confounders, this study found that WM was the only EF domain associated with daily exposure to low-quality media content. Our findings differ from those of Lillard et al[28], who observed that consuming low-quality media content causes brain processing overload because they primarily present irrational and fantasy stories/material. In addition, children cannot relate these contents with their past experiences. Hence, Lillard concluded that continuous exposure to low-quality media content was associated with overall executive dysfunction. However, Lillard's study did not adjust for the caregivers' joint media engagement, which is a crucial factor in reducing the overload of processing media information.

In contrast to other studies,[13,16] our final multiple logistic regression analysis found no association between high exposure to low-quality content and EC impairment. Such differences may be explained by our study's adjustment for the co-viewing factor. Low-quality media, such as adult-directed content and video games, mostly display violence, leading to more aggressive emotions, behaviors, and thoughts in children.[29,30] However, if caregivers could persuade children to discuss with them the violent material and aggressive behavior in the media content and identify the negative consequences of these during the co-viewing period, these children could learn more appropriate expressions of their behavior and emotions.

The final multiple logistic regression model showed no association between a more extended screen time and executive dysfunctions, which was different from Cliff et al's and Nathanson et al's studies, which found that more extended screen viewing time was related to impairment in EFs, especially in inhibition and EC.[13,14] This inconsistency could be attributed to the small number of participants in our study, which showed no association when the data were analyzed using multiple logistic regression. Similarly, according to the univariate logistic regression analysis, setting screen time limits was linked to almost all aspects of EF impairment, but the final multiple logistic regression model found no such relation.

Currently, Thailand has yet to develop a clear policy to control children's screen media use and continues to lack television channels and other media that offer content exclusively for children. Therefore, our results are essential in that they raise awareness among parents and policymakers on the importance of children's media use context, especially co-viewing, which affects children's EF.

Our study has some limitations. First, our study data was based on a comparative study between two Thai EF assessments with a small participant group. Therefore, the data obtained from this group may lead to an imperfect analysis of the association between media use and executive dysfunction in preschool children. Additionally, our results were inconsistent with those of other studies in that they cannot explain the link between executive dysfunction and screen time and setting screen limits. Our study also found a low prevalence of preschoolers with poor shifting, which made it difficult to investigate the relation between shift deficit and the sociodemographic data of children and caregivers and the context of media use. Future studies are recommended to survey a larger participant sample. Second, data were obtained from a convenience sample, that is, from caregivers who observe their children's developmental and behavioral problems. Furthermore, our convenience samples are from Bangkok—generally a group of working-age and high education-level parents. In Thailand's social context, mothers play a more significant role in caring for children than fathers or other relatives. Moreover, children in Bangkok have easy access to media, so most parents are concerned about the media use problem, leading to screen time settings in their houses. Thus, the tiny distribution of primary caregivers' type, primary caregivers' age and education, parenting styles, and setting screen limit was insufficient to analyze their relationship with EF development.

Third, caregivers' sociodemographic information, including comorbidities and mental health conditions such as depression or anxiety, marital status, and family indebtedness, are considered potential confounders affecting a child's EF. Further research should focus on analyzing these factors. Fourth, the generalizability of this study's results is limited because the participants came from only kindergarten schools in Bangkok Noi District. Future studies are encouraged to recruit research participants from many parts of the country to strengthen generalizability. Lastly, the cross-sectional study design does not allow for an inference of cause and effect. Therefore, further studies should explore other screen media use contexts in a larger sample size and investigate EF by conducting a longitudinal study to clarify the effect of screen media use on preschool children's EFs.

Conclusion

Executive dysfunction is a common problem among Thai preschoolers that impedes their long-term success in life. One of the most crucial factors associated with impaired EFs is inappropriate media use. This study found that less co-viewing time with caregivers is linked to impairments in the GEC and almost all EF subscales. Furthermore, a more extended period of consuming low-quality content is associated with impaired WM. Consequently, we encourage parents to choose high-quality programs and spend time co-viewing them with their children as well as to perform scaffolding to mitigate the negative impacts of media use on preschool children's EFs.

Ethical Approval

Ethical consideration was approved by the Siriraj Institutional Review Board (COA no. 833/2562 (IRB4)). Written informed consent was provided by the caregivers of each participant before enrollment.

Authors' Contributions

All authors approved the final article. The authors were involved with the study as follows: Prakasit Wannapaschaiyong—conceptualization, methodology, investigation and data collection, writing-original draft. Saruta Wattanakijthamrong—investigation and data collection. Kraiwuth Kallawicha—writing-review and editing. Sureelak Sutchritpongsa—conceptualization, methodology, writing-review and editing.

Conflict of Interest
None declared.

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