Children, Youth and Environments 35(1), 2025

Growing Minds: The Role of Family Residence Green Spaces and Household Chaos on Children's Executive Function

Samantha J. Iwinski
Sehyun Ju
Ledan Yang
Mayra Cuevas
Aaron Ebata
Department of Human Development and Family Studies, University of Illinois

Dina Izenstark
Department of Child and Adolescent Development, San José State University

Brent McBride
Department of Human Development and Family Studies and Division of Nutritional Sciences, University of Illinois

Kelly K. Bost
Department of Human Development and Family Studies, University of Illinois

Citation: Iwinski, S. J., Ju, S., Yang, L., Cuevas, M., Ebata, A., Izenstark, D., McBride, B., & Bost, K. K. (2025). Growing minds: The role of family residence green spaces and household chaos on children's executive function. *Children, Youth and Environments, 35*(1), 141-173. https://muse.jhu.edu/journal/850

Abstract

This study examines the relations between access to family residence green spaces, household chaos, and children's executive function, a critical component of cognitive development. The study analyzed data (N = 468) from families participating in a larger U.S. longitudinal birth cohort study when children were 24, 48, and 60 months. Findings suggest that some early access to green space and outdoor items can influence children's cognitive capacities and household environment. This research emphasizes the importance of promoting green spaces and reducing household chaos to support children's executive function development and overall well-being. Implications for education and policy are discussed.

Keywords: executive function, green space, household environment, family, nature

Introduction

Nature access and exposure are vital for children’s cognitive and social development, supporting cognitive skills, stress reduction, and social interaction (Taylor & Kuo, 2006; Dockx et al., 2022; Strife & Downey, 2009). Studies link green (trees, grass, parks) and blue (lakes, rivers) spaces to better mental health, reduced stress, and fewer physiological symptoms (Bowler et al., 2010; Chawla, 2015; Gascon et al., 2015, 2017; McCormick, 2017; Völker & Kistemann, 2015; Wheeler et al., 2012). Green spaces also support brain regions tied to memory, attention, and emotion regulation, with prenatal and postnatal exposure linked to higher IQ in some areas (Balseviciene et al., 2014; Dadvand et al., 2018; Islam et al., 2020; Lee et al., 2021). Such evidence provides a rationale for why early green space exposure may enhance children’s executive function (EF). Still, there is a strong need to explore these associations, especially using longitudinal studies across early childhood.

Green spaces also play a role in shaping family environments and promoting trust and safety. Researchers have found that green public settings encourage interaction across all ages, decrease crime, and enhance community perceptions (Kuo et al., 1998). As highlighted in the Family-Based Nature Activity framework, time spent in nature fosters positive family dynamics, creating opportunities for children to explore, develop creative thinking, and build routines and memories with family and friends (Izenstark & Ebata, 2016; Izenstark & Ebata, 2017; Izenstark et al., 2021). These interactions can help reduce household chaos—a state characterized by noise, crowding, and irregular routines—and foster more predictable family structures, such as regular mealtimes and bedtimes, which support cognitive and emotional development (Fiese & Schwartz, 2008; Fiese et al., 2002; Spagnola & Fiese, 2007; Vernon-Feagans et al., 2016).

This study builds on these findings by examining whether access to family residential outdoor green space influences the internal household environment, particularly the level of household chaos, and how this interplay affects the development of children’s executive function across time. To assess this, surveys were completed by mothers when their children were at 24, 48, and 60 months of age, and we assessed the family residential green space before the participating children were 24 months old. The surveys included questions surrounding demographics, household environment, and EF. By taking a longitudinal approach, the study seeks to advance understanding of the dynamic pathways through which family residence green spaces and outdoor items (e.g., gardens, outdoor sitting areas, and/or outdoor storage) impact family environments and children’s cognitive growth.

Literature Review

Executive Function

Executive function (EF) refers to higher-order cognitive processes critical for goal-directed, adaptive behavior, and studies routinely document the importance of EF for a range of social and academic outcomes. Executive function develops early in life and is influenced by social interactions, environments, and relationships with adults, with increased development occurring during multiple sensitive periods (Thompson & Steinbeis, 2020). From an evolutionary standpoint, these sensitive periods allow individuals to become more specialized and adapt to their environments, enabling children to use context, social cues, and exploration to understand societal norms (Fawcett & Frankenhuis, 2015; Knudsen, 2004). Executive function can be divided into cool and hot components: *cold EF* involves relatively pure cognitive processes such as inhibitory control, working memory, and cognitive flexibility, while *hot EF* refers to cognitive processes involving rewards, emotions, and motivations, as well as emotional regulation (Salehinejad et al., 2021; Zelazo & Carlson, 2012; Zelazo & Carlson, 2020). These are further described below.

Cold Executive Functions

Inhibitory control refers to controlling one's attention, behaviors, and thoughts. This can include doing what may be appropriate in a given situation, which may involve overriding internal predispositions (Diamond, 2013; Fiske & Holmboe, 2019; Garon et al., 2008). The literature suggests that rapid development and improvement in inhibitory control occurs during the toddler and preschool years (ages 2-5) and increases at a more steady pace during middle childhood (ages 6-12) (Best & Miller, 2010; Fiske & Holmboe, 2019; Garon et al., 2008; Garon et al., 2014; Miyake & Friedman, 2012; Dennis et al., 2007; Klenberg et al., 2001; Lengua et al., 2015). Working memory taps into the capacity to hold information in memory for goals or plans and allows individuals to work with the information they possess (Diamond, 2013). Working memory and inhibitory control may support each other and work together in most situations. For example, inhibitory control can assist one's working memory by keeping our mental workspace from becoming overwhelmed or cluttered. This ability can help our mind resist irrelevant information and suppress specific thoughts that may allow the mind to wander. Like inhibitory control, working memory emerges in infancy. Cognitive flexibility builds upon inhibitory control and working memory to enable a person to shift between different tasks or goals (Buttelmann & Karbach, 2017; Diamond, 2013). Cognitive flexibility may improve as a child develops, and these skills may decline during older adulthood (Cepeda et al., 2001; Kray, 2006).

Hot Executive Functions

Emotion regulation is similar to many EF components, and some researchers may refer to emotion regulation as hot EF. Emotion regulation involves internal and transactional processes that adjust emotional components by modifying experience, behavior, or emotion-eliciting situations (Diamond & Aspinwall, 2003; Eisenberg et al., 2000; Gross, 1999), as well as extrinsic and intrinsic processes that monitor, evaluate, and adapt emotional responses to achieve goals related to intensity and duration (Thompson, 1994). Children regulate their emotions through intrinsic processes like self-soothing (e.g., hugging a favorite stuffed animal when sad) and extrinsic support from caregivers who help them label and manage feelings (e.g., encouraging deep breaths during frustration). They also adapt their emotional responses to achieve goals, such as staying calm to resolve a disagreement with a peer. Among young adults, researchers have found that individuals from cultures who value self-reflection tend to use their ability for reappraisal more frequently, which is often used to study one's emotion regulation. Furthermore, individuals whose cultures value open expression of emotion tend to suppress their emotions less frequently (Haga et al., 2009; Matsumoto et al., 2008; McRae et al., 2011; McRae & Gross, 2020; Su et al., 2015; Yih et al., 2019). This may also change depending on the developmental period and how parents teach their children about emotions (Lozada et al., 2016). Research also shows that attentional control influences emotion regulation in childhood, with children gradually moving from caregiver-supported co-regulation to independent regulation (Graziano et al., 2011; Perry & Calkins, 2018; Sameroff, 2010).

Benefits of Exposure to Nature

Some researchers have explored the relationship between several EF behaviors and nature exposure. A recent meta-analysis found that almost all studies report positive impacts from nature on emotion regulation strategies and behaviors across several age groups (Vitale & Bonaiuto, 2024). Even brief exposure to nature can positively influence executive mental functioning (Bourrier et al., 2018; Schutte et al., 2017). Nature play, characterized by unstructured interactions, boosts curiosity, creativity, and resilience (Erickson & Ernst, 2011; Ernst & Burcak, 2019; Browning & Rigolon, 2019), while other nature-based activities, such as nature preschools (Zamzow & Ernst, 2020), outdoor gardens (Dillon et al., 2023), and playscapes, especially natural playgrounds (Luken et al., 2011; Dankiw et al., 2020; Luchs & Fikus, 2013; Torkar & Rejc, 2017; Zuo et al., 2020; Carr et al., 2017), have been shown to support executive function growth. Green school spaces enhance academic performance (Erickson & Ernst, 2011; Ernst & Burcak, 2019; Browning & Rigolon, 2019), and higher childhood greenness exposure is associated with lower obesity risk, increased physical activity (Barton & Pretty, 2010; Dzhambov et al., 2014; Herrington & Brussoni, 2015; Islam et al., 2020; Lovasi et al., 2011; Sanders et al., 2015), and the development of cognitive, social, and physical skills. Neighborhood greenness and green spaces may affect a multitude of health behaviors and outcomes. For example, several reviews found that physical activity, weight status, mental health, developmental outcomes, cardiovascular health, sleep, and mortality can all be associated with or affected by neighborhood greenness (De Keijzer et al., 2020; James et al., 2015). Additional researchers have found that access to green spaces is linked to various health benefits, including reduced obesity rates, cardiovascular mortality, and improved mental health outcomes such as decreased stress and enhanced mood states (Twohig-Bennett & Jones, 2018).

Researchers have also emphasized the importance of integrating nature-connectedness frameworks into urban design to enhance health outcomes for children, particularly in socioeconomically disadvantaged communities (Kuo et al., 2018; Kuo & Jordan, 2019). Such findings align with the growing body of literature that underscores the need for equitable access to natural environments to promote cognitive and emotional well-being (Boyd et al., 2024; Rigolon et al., 2018). While numerous studies have examined the impact of nature preschools and playscapes on executive function in preschool-aged children (Carr et al., 2024; Zamzow & Ernst, 2020), the influence of family residential green space on executive function remains under-researched. Existing literature highlights the benefits of structured nature-based interventions. Yet, less attention has been given to how exposure to family residential green spaces may shape cognitive development and self-regulation in young children. This gap underscores the need for further investigation into how residential green spaces contribute to family dynamics and child development.

Conceptualizing Family Residence Green Space

Nature, green space, and natural environments are often studied interchangeably due to challenges defining nature across settings (e.g., urban vs. rural) and access differences. A review of journal articles about green space found that under half of 125 studies defined green space, indicating varied definitions and approaches (Taylor & Hochuli, 2017). In this study, family residential green space is defined as the outdoor space that is connected to the participants' property or across the street. Participants lived in a wide range of properties, including apartments, townhomes, and single-family homes, and in rural and urban locations.

Conditions included in this study's assessment include location and levels of greenness (e.g., trees, grass, and other vegetation) (Izenstark & Ebata, 2016; Taylor & Hochuli, 2017), as well as the presence of outdoor items. To assess these, we considered several factors, including the amount of tree cover in their yard, the amount of grass in their yard, what is near their home (e.g., built structures, streets, parks, farm fields, waterfront, trees, and mountain ranges), and what is within the outdoor space (e.g., garden, sand, rocks, interactive play, deck or sitting area, and outside storage). We defined "near the home" as being directly adjacent to the residence or located across the street. We included the presence of outdoor items in the green space assessment because outdoor items—like sandboxes, outdoor storage, and playsets—can enhance the functionality of outdoor spaces, offering opportunities for play and interaction. Including these factors provides a more comprehensive view of how both natural and built features contribute to child development.

In addition, family behaviors and identities provide the first groundwork for growth and development for children and individuals over time (Kapur, 2023; Sharma, 2013). The term "family" may provide different implications in social, biological, or cultural settings; however, it is also important to allow participants to provide input into who is their chosen family (Hodgson & Birks, 2002; Kapur, 2023; Sharma, 2013). For this study, family is referred to as a broad term; however, it is essential to note that many of the surveys are solely completed by the mother.

Household Chaos

Household chaos refers to environments high in noise and crowding, with low regularity and routines (Vernon-Feagans et al., 2016). Predictable routines like mealtimes and bedtimes provide structure and support development, fostering shared family identity (Fiese & Schwartz, 2008; Fiese et al., 2002; Spagnola & Fiese, 2007). In contrast, chaotic households can hinder development, leading to less effective parental discipline, behavioral issues, limited attentional focus, and reduced social skills (Dumas et al., 2005). High noise levels and unpredictability may also lower caregiver attentiveness and verbal interaction (Wachs, 1993; Wachs & Camli, 1991).

While there is no literature on the relationship between household chaos and green spaces, spending time in green spaces may provide an opportunity for increased family functioning and routines within the household. It may also offer a restorative environment (Moll et al., 2022), which is essential for children if they live in a more chaotic home environment. Using family residential green space may help children restore their attention and cope with challenges within a chaotic home environment. This relationship may also depend on access to green space and an emotional connection to nature, which differs by each family.

Household Chaos and EF

Elevated household chaos is directly linked to poorer performance in EF tasks, including inhibitory control, cognitive flexibility, working memory, attention, and effortful control (Andrews et al., 2021; Berry et al., 2016; Chen et al., 2014; Hughes & Ensor, 2009; Hur et al., 2015; Martin et al., 2012; Vernon-Feagans et al., 2016). Disorganized households may specifically impair working memory, attention shifting, and inhibitory control (Berry et al., 2016), and higher chaos levels reduce children's sense of control, affecting behavior in broader social settings (Evans & Stecker, 2004). Additionally, higher household chaos has been linked to more problematic children's EF abilities at 24 months within our sample (Iwinski et al., 2021). More chaotic environments may prohibit some children from being able to predict events or interactions in their home environment, which could influence their behavior in school, neighborhood, and other social environments.

Theoretical Frameworks

Ecological systems theory emphasizes the importance of development in varying systems or environments with which individuals interact (Bronfenbrenner, 1979; Darling, 2007; Duerden & Witt, 2010; Wells & Evans, 2003). When adopting an ecological approach to studying nature, the microsystem (e.g., immediate environment) and mesosystem (e.g., connections between microsystems) are key components that may influence these associations. For example, nature and natural environments can be a part of a child's microsystem, providing regular exposure to the family's green space. Nature also offers social interaction contexts, allowing children to expand their social environment (e.g., playing with peers outdoors or participating in community events in nature).

Attention Restoration Theory (ART) highlights the connection between nature and attention, explaining how natural environments aid mental and behavioral functioning (Kaplan, 1995; Kaplan & Kaplan, 1989). Originating in environmental psychology and based on James's 1962 attention theory, ART describes two modes of attention: directed (e.g., requiring focus) and involuntary, which allows relaxation and restoration of directed attention. ART outlines four critical elements for restorative environments: (1) "being away" from stressors, (2) experiencing "extent" or expansive spaces, (3) "soft fascination" that gently engages attention, and (4) compatibility between environment and individual goals (Izenstark & Ebata, 2016; Kaplan, 1995; Kaplan & Kaplan, 1989; Ohly et al., 2016). Applied to family green spaces, children might experience “extent” by visiting a park or backyard, interacting with features like sandboxes, or listening to nature, which can support attention restoration and EF skills.

Izenstark and Ebata (2016) integrated ART with a routines and rituals framework to understand family functioning through Family-Based Nature Activities. This framework combines the idea that routines and rituals may influence family functioning through meaningful interactions, and the ways that outdoor family leisure may benefit children and families (Izenstark & Ebata, 2016). By examining families’ access to green spaces near their residences, we explored the extent to which families have opportunities for outdoor activities and spending time together outdoors. Family residential green space may provide a familiar and approachable environment for the family, especially when public green spaces are not present, difficult to travel to, or unsafe.

Present Study

This study investigated the relations between children’s hot and cold EF abilities, household chaos, and early access to family residence green space. Given the rapid development of EF in early childhood, the study assessed EF at 24, 48, and 60 months, with each research question analyzed across two models representing the hot and cold EF dimensions. The first objective was to identify the factor structure of EF within the sample. The second goal was to explore associations between household chaos, access to family residence green space, and children’s hot and cold EF abilities. We employed a structural equation modeling (SEM) framework to test each pathway, with access to family residence green space indicators as an early predictor (e.g., exposure before two years of age). We modeled household chaos and EF over time, and the model also included economic hardship variables and several demographic characteristics. Conceptual models illustrating these pathways are presented in Figures 1 and 2.

Figure 1. Conceptual model of cold EF

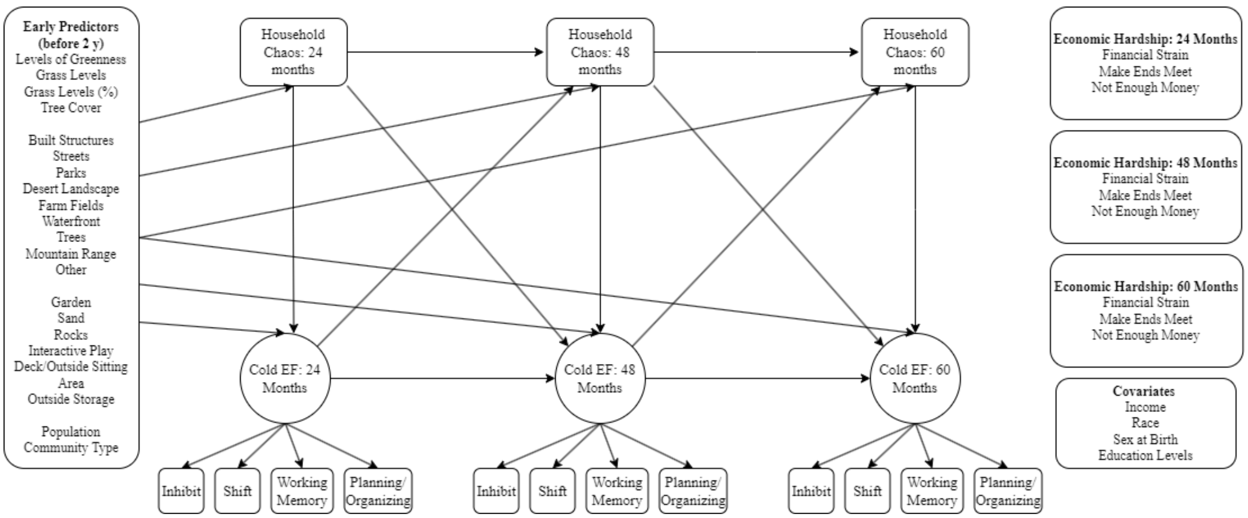
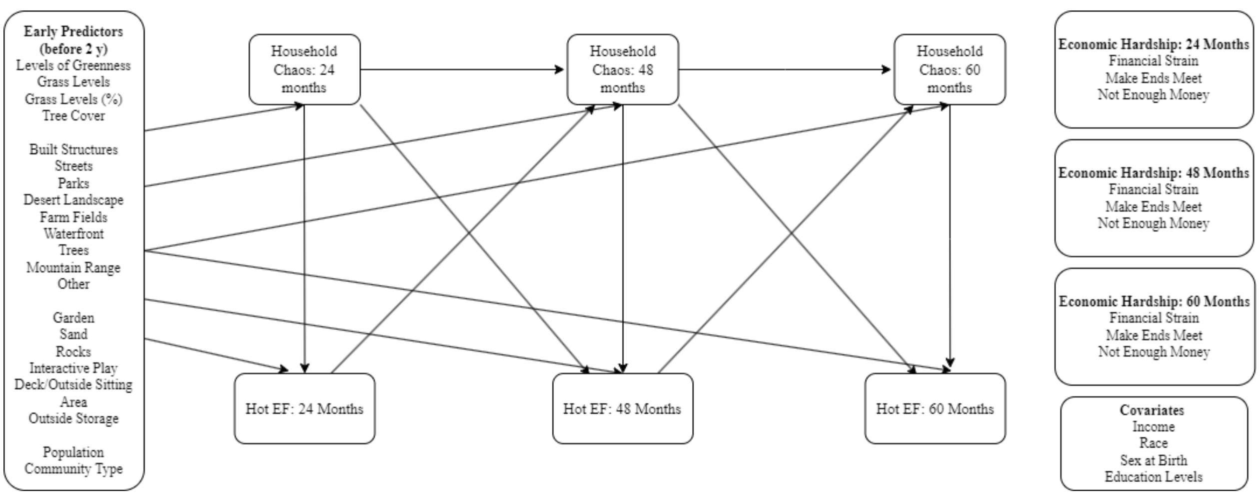


Figure 2. Conceptual model of hot EF



Methods

Participants

This analysis used data from a U.S. longitudinal birth cohort study (N = 468; Table 1) focused on predictors during the first five years of life (Fiese et al., 2019). Participants were pregnant women recruited in their third trimester through medical centers, prenatal classes, and a university-affiliated website in east-central Illinois, with exclusions for preterm births, certain medical conditions, and low birth weight. The recruitment period extended from May 2013 through January 2017. Part of a more extensive study, caregivers completed questionnaires regarding household chaos, child EF behaviors, and parent and child demographics. Mothers completed surveys when age- and developmentally appropriate for the child (6 weeks, 3, 12, 18, 24, 36, 48, and 60 months of age). Participants were included in this study if they completed all surveys and lived in Illinois, Indiana, or Missouri. The University Institutional Review Board approved this study.

Table 1. Descriptive statistics of participating families

	N	%	M	SD	Range
Child Sex at Birth					
Male	232	50.5			
Female	227	49.5			
Monthly income					
$3,000 and under	77	23.8			
$3,001-$5,000	91	28.1			
$5,001 and above	156	48.1			
Parent race/ethnicity					
American Indian/Alaska Native	2	0.5			
White	338	82.2			
Asian	28	6.8			
Black	21	5.1			
Prefer not to say	6	1.5			
Biracial	16	3.9			
Parent education level					
Some high school	2	0.6			
High school graduate	16	4.5			
Some college or technical school	59	16.5			
College graduate	120	33.5			
Post-graduate work	161	45.0			
Household Chaos: 24 months	365		26.86	7.07	13.00 – 48.00
Household Chaos: 48 months	335		28.65	7.19	10.00 – 51.00
Household Chaos: 60 months	301		28.68	7.07	15.00 – 53.00

Measures

Family Access to Residential Green Space

We assessed the participants' community type (i.e., large city (4.8%), medium city (28.9%), towns and semi-dense areas (46.3%), and rural areas (19.9%)). We then determined family access to residential green space using historical Google Earth. Google Maps and Street View have become valuable resources for social scientists to understand the built and social environment, including green and urban spaces (Vandeviver, 2014; Zhang et al., 2021). For this assessment, we used Google Earth images taken before the children were two years of age, ranging from 4/1/2013 to 4/20/2019, and excluded photos taken during the winter.

To assess the overall greenness of the family's residence, we considered several factors, including the amount of tree cover in their yard, the amount of grass in their yard, what is near the home (e.g., built structures, streets, parks, farm fields, waterfront, trees, and mountain ranges), and what is within the outdoor space (including garden, sand, rocks, interactive play, deck or sitting area, and outside storage). We defined "near the home" as being directly adjacent to the residence or located across the street. Using guidance from past studies (Taylor et al., 2001), we used a 5-point Likert scale to rate overall greenness, grass quantity, and tree cover. Similarly, we converted the grass quantity percentage to a 4-point Likert scale (1 = 25% to 4 = 100%). The lead author of the current manuscript was assigned to code all the photos, serving as a gold standard. Two reliability coders were each randomly assigned to code 38% of the images. Inter-rater reliability was established for each subscale, with ICC values of .88 for greenness, .66 for grass quantity, .68 for grass quantity percent, and .93 for tree cover, indicating acceptable reliability.

Executive Function

We assessed EF using the Behavior Rating Inventory of Executive Function-Preschool Version (BRIEF-P; Isquith et al., 2005). This survey assesses multiple components of EF, including inhibition, shifting, emotional control, working memory, and planning/organizing. Parents are asked to complete this questionnaire based on how often each behavior has been a problem in their child's life during the last six months using categories from 1 (never) to 3 (often). Higher scores on the BRIEF-P indicate worse performance on EF abilities. We calculated T-scores to account for additional child characteristics, including child sex at birth and age.

Household Chaos

We assessed household chaos and environmental levels using the Confusion, Hubbub, and Order Scale (CHAOS; Matheny Jr et al., 1995). The questionnaire consists of 15 statements surrounding participants' household environment, and each question is on a 4-point Likert scale, ranging from "very much like your home" to "not at all like your own home." A single score is obtained by summing the items, with the highest possible score of 60. A higher score indicates a higher level of chaos within the home.

Perceived Economic Hardship

The Perceived Economic Hardship Questionnaire measures financial strain, inability to make ends meet, and insufficient money for necessities (Barrera et al., 2001). Participants responded to each item on a Likert-type scale, with options ranging from "almost never" to "almost always," "with no difficulty at all" to "a great deal of difficulty," and from "strongly disagree" to "strongly agree." Scores were calculated by summing responses across items, with higher scores indicating greater perceived economic hardship.

Data Analysis Plan

This study used a comprehensive data analysis plan to test hypothesized models encompassing confirmatory factor analysis (CFA) and structural equation modeling (SEM). Initially, we utilized SPSS for data cleaning, preparation, and preliminary analyses, ensuring the dataset's readiness for advanced statistical examinations. This included checks for missing values, outliers, and the distribution normality of the variables. Following this preparatory stage, the *lavaan* package in R was used to execute CFA and SEM.

Results

These findings stem from our longitudinal study that examines developmental outcomes at three key age points: 24, 48, and 60 months. Green space exposure was assessed before the child reached 24 months of age.

Preliminary Analyses

Missing data analysis was conducted using Little's multivariate test of Missing Completely at Random. The results indicated that our data could be assumed to be missing completely at random, as the test did not reach statistical significance (24 months: ($\chi^2[48] = 56.435$, $p = .189$); 48 months: ($\chi^2[28] = 37.114$, $p = .116$); 60 months: ($\chi^2[25] = 31.456$, $p = .174$)). All correlations can be found in the supplemental information. A latent variable was created for cold EF to understand these associations further, and emotional control was used to examine hot EF.

Table 2. EF scores before hot and cold models

	N	M	SD	Range
Inhibit: 24 months (T scores)	304	49.83	10.29	34.00 – 85.00
Shift: 24 months (T scores)	320	48.61	8.27	37.00 – 74.00
Emotional Control: 24 months (T scores)	323	48.73	8.97	35.00 – 79.00
Working Memory: 24 months (T scores)	306	51.82	11.55	36.00 – 82.00
Planning/Organizing: 24 months (T scores)	315	49.59	11.09	32.00 – 78.00
Inhibit: 48 months (T scores)	317	52.37	10.57	36.00 – 91.00
Shift: 48 months (T scores)	323	51.50	9.13	38.00 – 83.00
Emotional Control: 48 months (T scores)	322	52.92	10.97	36.00 – 93.00
Working Memory: 48 months (T scores)	311	53.07	10.80	38.00 – 85.00
Planning/Organizing: 48 months (T scores)	317	52.33	11.50	34.00 – 100.00
Inhibit: 60 months (T scores)	290	52.31	10.58	36.00 – 89.00
Shift: 60 months (T scores)	288	50.92	9.74	38.00 – 84.00
Emotional Control: 60 months (T scores)	288	53.17	11.59	36.00 – 89.00
Working Memory: 60 months (T scores)	286	52.65	11.60	38.00 – 98.00
Planning/Organizing: 60 months (T scores)	292	52.23	11.91	34.00 – 90.00

Confirmatory Factor Analysis (CFA)

A CFA across all time points was conducted before SEM analyses, using maximum likelihood estimation with NLMINB optimization. Results showed strong evidence for the latent cold EF variable influencing observed indicators, with moderate model fit indices: CFI = 0.875, TLI = 0.838, RMSEA = 0.160 (90% CI: 0.142–0.180), and SRMR = 0.066. The Chi-square test indicated a significant difference from the observed data ($\chi^2[51] = 265.768$, $p < 0.001$). The model, including emotional control, showed a poorer fit ($\chi^2[86] = 752.798$, $p < 0.001$; CFI = 0.729, TLI =

0.691, RMSEA = 0.143, SRMR = 0.171), supporting the need to analyze hot and cold EF models separately. All demographic findings are within the figures.

SEM: Cold EF

SEM analysis was conducted using the *lavaan* package in R (v4.3.1) with Full Information Maximum Likelihood (FIML) to address missing data. Fit indices showed a significant Chi-square ($\chi^2 = 782.779$, df = 414, $p < .000$), with CFI = 0.854, TLI = 0.777, and robust CFI and TLI at 0.857 and 0.783, reflecting moderate fit. RMSEA was 0.065 (90% CI: 0.058–0.072), and SRMR was 0.034, suggesting a reasonable fit.

Cold EF at 24 Months

There were several significant predictors of cold EF at 24 months, including living near a park (B = 4.696, SE = 2.334, p = .044, std. all = 0.144) and household chaos at 24 months (B = 0.374, SE = 0.093, $p < .000$, std. all = 0.290). These findings indicate that higher levels of household chaos and proximity to a park are associated with poorer cold EF abilities at 24 months. Notably, the association between living near a park and reduced EF performance was unexpected. In addition, several races showed a significant relationship with cold EF at 24 months (African American: B = -8.691, SE = 4.500, p = .053, std. all = -0.180; Asian: B = -10.992, SE = 4.046, p = .007, std. all = -0.283; White: B = -7.564, SE = 3.158, p = .017, std. all = -0.288), indicating racial disparities in early EF.

Cold EF at 48 Months

In addition, there were several predictors of better cold EF at 48 months, including living near trees (B = -2.642, SE = 1.228, p = .031, std.all = -0.144), higher levels of household chaos at 24 months (B = -0.199, SE = 0.098, p = 0.042, std.all = -0.150), having a sandbox (B = -6.543, SE = 3.394, p = 0.054, std.all = -0.112) or shed/outside storage (B = -4.436, SE = 1.605, p = .006, std.all = -0.174) within the family residence green space. Furthermore, several factors were associated with a decline in cold EF, including the presence of a garden (B = 3.756, SE = 1.526, p = .014, std.all = 0.169) and higher levels of household chaos at 48 months (B = 0.390, SE = 0.098, $p < .000$, std.all = 0.311). Notably, the negative association with having a garden was unexpected. Cold EF at 24 months was also positively associated with cold EF at 48 months, suggesting consistency over time (B = 0.458, SE = 0.074, $p < .000$, std.all = 0.445). Sex at birth also significantly affected cold EF at 48 months, indicating sex at birth differences in cold EF at this stage (B = -3.604, SE = 1.053, p = .001, std.all = -0.202). Lastly, parental levels of education were associated with children’s cold EF at 48 months of age (some college or technical school: B = -20.474, SE = 7.991, p = .010, std.all = -0.731; college graduate: B = -19.215, SE = 7.972, p = .016, std.all = -1.042; post-graduate work: B = -18.135, SE = 7.980, p = .023, std.all = -1.016).

Cold EF at 60 Months

Moreover, for cold EF at 60 months, chaos at home continued to have a detrimental effect (B = 0.260, SE = 0.094, p = .005, std.all = 0.200) and earlier EF scores showed predictive value for later EF (B = 0.753, SE = 0.078, $p < .001$, std.all = 0.773). Perceived economic hardship at 24 months also displayed a significant negative association with cold EF at 60 months (B = -1.797, SE = 0.699, p = .010, std.all = -0.193), indicating that household difficulty making money may be related to better cold EF outcomes at 24 months. Lastly, race was also associated with cold EF at 60 months (B = 6.024, SE = 3.171, p = .058, std.all = .125).

Household Chaos at 48 Months

Both household chaos at 24 months (B = .597, SE = .058, p = p < .000, std.all = 0.564) and cold EF at 24 months (B = .125, SE = .049, p = .011, std.all = .152) were positively associated with chaos at 48 months, indicating higher chaos and more problematic EF abilities at 24 months were associated with more chaos at 48 months. A household's perceived economic hardship at 48 months (B = 1.989, SE = .609, p = .001, std.all = .256) is also related to more chaos at 48 months.

Household Chaos at 60 Months

Household chaos at 60 months was also associated with several important factors. The path coefficient between 48-month chaos and cold EF at 60 months was significant (B = 0.673, SE = 0.050, p < .000, std.all = 0.716), indicating higher chaos levels are associated with poorer outcomes. Levels of greenness (B = -1.287, SE = 0.503, p = .011, std.all = -0.195) and having sand or a sandbox at the home (B = -4.010, SE = 2.030, p = .048, std.all = -0.092) were significantly associated with lower chaos levels at 60 months. The path coefficient between cold EF at 48 months and chaos at 60 months was significant (B = 0.103, SE = 0.044, p = .021, std.all = 0.137), suggesting that more problematic EF abilities at 48 months are associated with more chaos later in life. Household difficulty making ends meet at 48 months (B = -1.155, SE = 0.590, p = .050, std.all = -0.158) and household financial strain at 60 months (B = -1.441, SE = 0.590, p = .014, std.all = -0.133) also showed significant effects, underscoring the nuanced role of financial conditions on child development outcomes.

SEM: Hot EF

SEM analysis was conducted in R (v4.3.1) using *lavaan* with FIML. Fit indices included: $\chi^2(38) = 80.608$, p < .001; CFI = .929; TLI = .782; RMSEA = .071 (90% CI: .049–.093); SRMR = .029.

Hot EF at 24 Months

A higher level of chaos within the home at 24 months significantly predicted increased hot EF problems at 24 months (B = 0.353, SE = 0.085, p < .001, Std.all = 0.284), indicating early exposure to chaotic environments may negatively impact children's emotional control.

Hot EF at 48 Months

At 48 months, having a deck/patio was significantly associated with better hot EF (B = -3.198, SE = 1.385, p = .021, Std.all = -0.139). A higher level of chaos within the home at 48 months significantly predicted increased hot EF problems at 48 months (B = 0.367, SE = 0.116, p = .002, Std.all = 0.240). A higher level of chaos within the home at 24 months significantly predicted better hot EF abilities at 48 months (B =-0.272, SE = 0.119, p = .023, Std.all = -0.173), which indicates differences surrounding household chaos over time. Sex at birth also had a significant effect on hot EF at 48 months, suggesting sex at birth differences at this stage (B = -6.153, SE = 1.258, $p < .001$, std.all = -0.280).

Hot EF at 60 Months

Living near a farm was related to better hot EF abilities at 60 months (B = -3.212, SE = 1.612, p = .046, Std.all = -0.099), and hot EF at 48 months strongly predicted hot EF at 60 months (B = 0.614, SE = 0.056, $p < .001$, Std.all = 0.563). Higher household chaos levels at 48 months were associated with better hot EF at 60 months (B = -0.289, SE = 0.124, p = 0.019, std.all = -0.174), and higher levels of chaos at 60 months were related to worse hot EF at 60 months (B = 0.719, SE = 0.127, $p < 0.001$, std.all = 0.406). We also found that more household financial strain at 24 months led to worse hot EF at 60 months (B = 2.706, SE = 1.045, p = 0.010, std.all = 0.181). Parental educational levels also were associated with hot EF (high school graduate: B = 15.132, SE = 7.004, p = .031, Std.all = 0.250; some college or technical school: B = 17.255, SE = 6.887, p = .012, Std.all = 0.480; college graduate: B = 15.114, SE = 6.853, p = .027, Std.all = 0.609; post-graduate work: B = 16.245, SE = 6.823, p = .017, Std.all = 0.677).

Household Chaos at 24 Months

At 24 months, greater household financial strain was related to higher reported household chaos (B = 2.291, SE = 1.205, p = 0.057, std.all = 0.133).

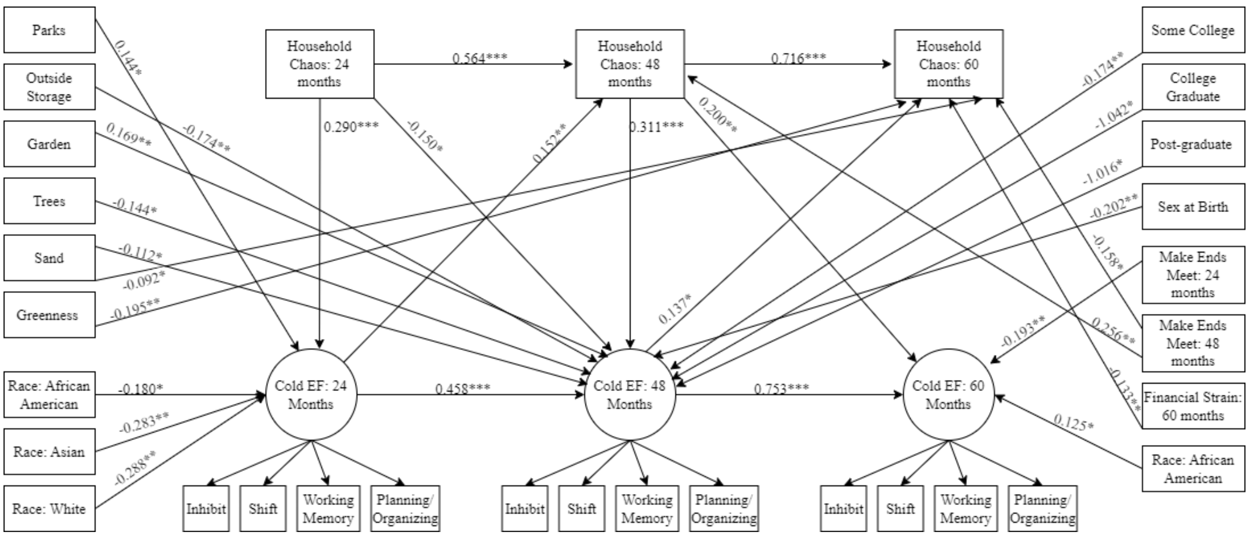
Household Chaos at 48 Months

Chaos at home shows a sustained negative impact, with chaos at 24 months predicting chaos at 48 months (B = 0.601, SE = 0.056, $p < .001$, Std.all = 0.582). More household difficulty in making ends meet at 48 months was related to higher chaos (B = 2.070, SE = 0.607, p = 0.001, std.all = 0.264). Parental educational levels were also predictors of chaos (high school graduate: B = 10.416, SE = 4.448, p = 0.019, std.all = 0.287; some college or technical school: B = 12.671, SE = 4.328, p = 0.003, std.all = 0.587; college graduate: B = 12.432, SE = 4.341, p = 0.004, std.all = 0.834; post-graduate work: B = 12.627, SE = 4.326, p = 0.004, std.all = 0.876).

Household Chaos at 60 Months

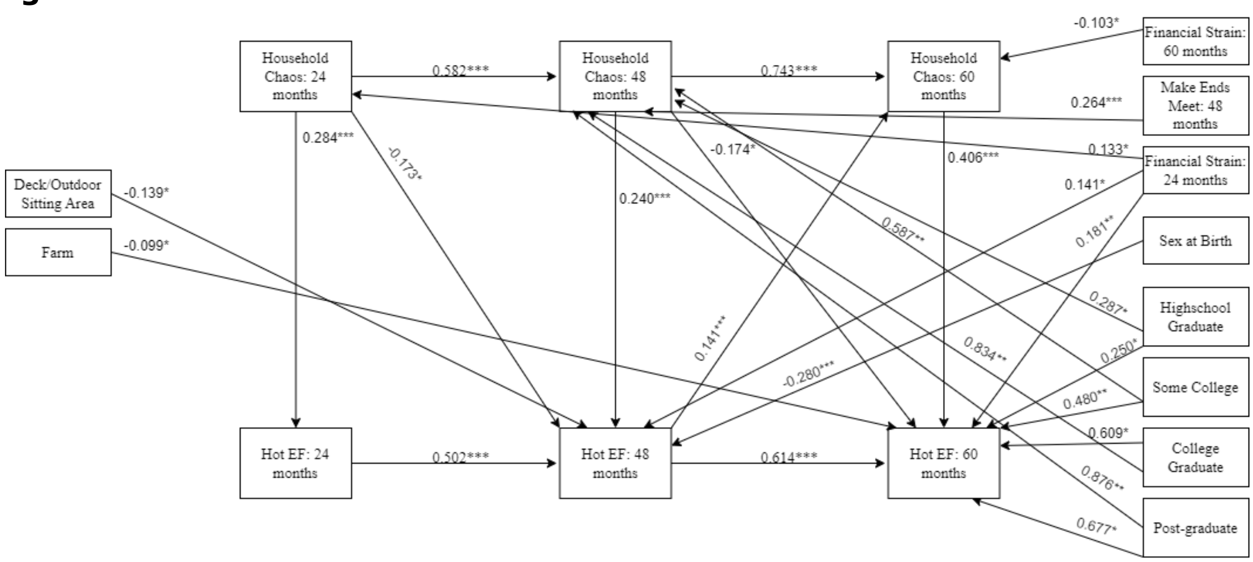
Similar to the above findings, household chaos at 48 months predicted household chaos at 60 months (B = 0.699, SE = 0.046, $p < .001$, Std.all = 0.743). Hot EF problems at 48 months predicted higher household chaos at 60 months (B = 0.087, SE = 0.030, p = 0.004, std.all = 0.141). More household financial strain at 60 months was associated with less chaos at 60 months (B = -1.163, SE = 0.596, p = 0.051, std.all = -0.103).

Figure 3. SEM model of cold EF with all variables



Note. *p < .05. **p < .01. ***p <.001. Path estimates are presented as standardized values; EF=Executive Function.

Figure 4. SEM model of hot EF with all variables



Note. * p < .05. **p < .01. ***p <.001. Path estimates are presented as standardized values; EF = Executive Function.

Discussion

Our findings highlight important distinctions between hot and cold EF, particularly in how environmental factors such as household chaos and exposure to nature influence these cognitive processes across different developmental stages. Notably, the relationships between environment and EF appear to vary depending on whether environmental variables are measured concurrently or retrospectively. This distinction is critical, as it suggests that different aspects of EF may be differentially sensitive to environmental influences depending on the timing of exposure and the type of EF being assessed. Specifically, we found that some early family residential green space indicators and household environments can influence cold or hot EF in early childhood. However, we also found results that we would not expect and do not align with the literature involving several of these topics, which will need future research to shed light on the nature of these relations. For example, having a garden was unexpectedly associated with poorer cold EF at 48 months, which has been shown to be important for child development (Dillon et al., 2023).

Given the developmental complexities of EF during early childhood, the CFAs at 24, 48, and 60 months highlight the importance of distinguishing between cold and hot EF in early childhood. Models excluding emotional control for cold EF fit better, with high correlations among latent factors over time. Significant loadings of observed variables at each time point affirm validity, and consistently high fit indices confirm the stability and reliability of the EF construct across early development. For cold EF, factors like family green space (before age two), household environment, economic hardship, and demographics were examined to see how these characteristics affect EF development over time. At 24 months, higher household chaos and proximity to parks correlated with poorer cold EF. However, park proximity's effect was unexpected, as it may not reflect actual park use or account for different developmental periods. Having a park throughout childhood, instead of just before two years of age, could have a more pronounced effect on cold EF. Demographics also played a role in cold EF at different developmental stages, with race differences notable at 24 months and parental education levels and sex differences emerging at 48 months.

Green space exposure influenced cold EF, with early outdoor features like outdoor storage, sand, and trees linked to better cold EF at 48 months, while garden access showed a surprising association with worse cold EF. Household chaos also demonstrated complex effects; higher chaos at 24 months but lower chaos at 48 months were linked to better cold EF at 48 months, suggesting that real-time chaos may disrupt EF. Still, previous levels of chaos could potentially influence later EF development in a positive way (Zhao et al., 2023). At 60 months, higher chaos at 48 months correlated with poorer cold EF, marking a change from earlier findings. Household economic strain at 24 months surprisingly predicted better cold EF at 60 months, hinting at potential resilience processes. While these results were unexpected, they highlight the importance of early life and how malleable it is. Children may be affected by the household environment and financial strain early in life; however, other factors may allow this hardship to assist with cold EF at five years old. Cold EF at 24 months and household economic challenges at 48 months were also related to higher household chaos at 48 months, indicating complex interactions between early environment and EF. Early green space predictors were also linked with lower household chaos at 60 months, including greater exposure to greenness and the presence of sand at the family residence, as well as better cold EF at 48 months. In addition, household challenges with making ends meet at 48 months and financial strain at 60 months were negatively related, indicating that hardships might be related to lower chaos levels. Cold EF and household chaos showed consistent continuity effects across time points, underscoring stable patterns in both areas across early childhood.

Analyses of hot EF revealed distinct environmental and demographic influences over time. Consistent with cold EF findings, higher household chaos at each time point was associated with poorer EF skills. However, elevated chaos at 24 months predicted better hot EF at 48 months, and chaos at 48 months was linked to improved hot EF at 60 months, suggesting that while household chaos may impair EF within time, it could contribute differently to EF at later time points. Household financial strain at 24 months was connected to higher chaos and worse hot EF at 48 and 60 months, while greater financial hardship at 48 months also corresponded to increased chaos. Interestingly, household financial strain at 60 months was linked to reduced chaos. Hot EF and household chaos showed strong continuity effects across all time points, indicating stability in these patterns. Two green space factors also positively impacted hot EF: living near a farm was associated with better hot EF at 60 months, and having a deck or outdoor seating area was linked to stronger hot EF at 48 months. Demographic factors, including birth sex and parental education levels, further influenced hot EF and household chaos, underscoring the importance of examining diverse family backgrounds, racial groups, genders, and socioeconomic statuses.

These findings point to a broader concept crucial for families: access and availability to particular environments and experiences. This encompasses access to green and outdoor spaces, improved socioeconomic status, and more stable, less chaotic home environments. These elements are consistent with Bronfenbrenner's ecological systems theory (1979), which posits that a child's development is influenced by their various environmental systems. The microsystem, which includes direct environments such as home and school, significantly impacts early development. Access to green spaces, for example, encourages physical activity and reduces mental fatigue and stress, promoting better emotional regulation and cognitive abilities (Kaplan & Kaplan, 1989). Access to green and outdoor space, outdoor items and locations (e.g., sand, outside storage, communal area), and living near more outdoor opportunities may provide additional resources for a child to develop and learn from the natural environment. Specifically, in this study, living near a farm and having an outdoor sitting area early in life were associated with better hot EF. An outdoor sitting area may provide more opportunities to play outside and be exposed to more natural light, increased social interaction (e.g., places to gather), quality family time, sensory development, and exploration. Living near a farm may also provide these opportunities with a focus on community. Farming communities can provide early learning and routine responsibilities, which could impact how and when children develop particular EF abilities. Farm life often also involves strong community ties and collective activities, fostering social support and collaboration (Furness et al., 2022). Access to outdoor spaces may also influence children directly and indirectly through its effects on parents, thereby shaping the level of household chaos experienced by children. Researchers have found that mothers reported less stress, improved mood, and more cohesive interactions after walks in nature, highlighting the potential for outdoor environments to create a more harmonious family dynamic (Izenstark et al., 2021).

A less chaotic home environment provides a stable setting for consistent learning and emotional growth, supporting cold and hot executive function skills, which are critical for managing stress and making informed decisions (Evans & Kim, 2013). These findings suggest that the cumulative impact of access to outdoor spaces extends beyond immediate individual benefits, influencing broader family systems that contribute to a child's development. Over time, these direct and indirect effects underscore the importance of holistic approaches to fostering environments that promote healthy growth and development in children.

This longitudinal study contributes to the growing body of literature on the relations between the natural environment, hot and cold EF, and family dynamics by addressing a critical gap: the influence of family residenctial green spaces on EF development. Previous research has established that exposure to nature, even briefly, can positively influence executive mental functioning and emotion regulation strategies across various age groups (Bourrier et al., 2018; Schutte et al., 2017; Vitale & Bonaiuto, 2024). More structured interactions, such as those provided by nature preschools, natural playgrounds, and outdoor spaces, have significantly benefited EF growth (Zamzow & Ernst, 2020; Luken et al., 2011; Dillon et al., 2023). Building upon these studies, the current research uniquely examines how access to green spaces and outdoor items as part of the home environment is associated with household dynamics, such as chaos, and shapes EF across developmental time points. This research emphasizes the importance of expanding access to green spaces to mitigate disparities and promote holistic development in children by situating these findings within the broader context of nature-connectedness frameworks and their relevance to equitable urban design. These contributions underscore the need for future studies to continue exploring the nuanced pathways through which green spaces impact individual and familial developmental trajectories. Exploring these ideas and topics allows us to understand further the degree to which environmental factors, internal and external to households, are particularly influential to EF at different time points in early childhood.

Despite the well-established importance of nature for child development, research indicates a troubling decline in children's engagement with natural environments (Kahn Jr. & Weiss, 2017; Strife & Downey, 2009; Taylor & Kuo, 2006). This decline may be attributed to factors such as environmental generational amnesia, technological advancements, safety concerns, neighborhood crime, and the rise of structured indoor activities (Hartig & Kahn Jr., 2016; Kahn Jr. & Weiss, 2017). Compounding this issue, inequalities in access to green spaces and health disparities persist. Recent research has identified links between nature inequality and COVID-19 outcomes, revealing that communities predominantly comprised of persons of color experienced higher case rates alongside reduced access to green spaces (Spotswood et al., 2021). Additionally, studies suggest that nature exposure was key to mental health resilience during the pandemic (Soga et al., 2021a; Soga et al., 2021b). These findings underscore a concerning reality: individuals in low-income and nature-deprived communities, disproportionately people of color, are at greater risk of health inequities related to limited green space access (Landau et al., 2020). However, green spaces hold potential as tools for advancing health equity and addressing disparities worldwide (Browning & Rigolon, 2019). Caregivers' comfort and sense of safety in natural environments also shape how children are introduced to nature, influencing emotional connections and values surrounding the environment (Collado et al., 2015). When families lack opportunities to engage with nature, it may normalize reduced exposure, perpetuating diminished nature interactions across generations (Hartig & Kahn Jr., 2016; Kahn Jr. & Weiss, 2017). Conversely, providing children access to green spaces fosters lasting benefits, as early exposure is linked to improved mental health in adulthood (Engemann et al., 2019). These findings collectively highlight the critical need for green spaces in supporting children's development and underscore the importance of advocacy for equitable access to nature where we live, work, and play.

Implications for Education and Policy

The findings highlight the importance of supporting early EF development through targeted educational and intervention strategies, as EF is foundational to academic success, social growth, and adaptive behavior. Practical implications could include how nature-based practices or exposure to green space can complement targeted interventions to enhance EF. Strategies such as outdoor memory games, nature-based mindfulness exercises, or guided walks could reduce stress and promote emotion regulation for children and parents. While these specific approaches were not part of the study, they align with broader research on the benefits of nature exposure in fostering cognitive flexibility, emotional well-being, and self-regulation. These practices could be integrated into teacher and parent workshops to complement existing interventions by modeling ways to establish routines and encourage emotional discussions in both home and school environments. To improve familial environments, workshops could also focus on strategies to reduce household chaos, such as creating organized spaces, developing consistent daily rhythms, and incorporating outdoor time into family routines. For example, structured outdoor activities, such as nature scavenger hunts or family park visits, can allow children to self-regulate while fostering cohesion among family members. These holistic approaches underscore the interconnected benefits of reducing household chaos and enhancing access to nature, ultimately leading to improved developmental outcomes for children and families.

These predictive effects should also be acknowledged at the policy level. The long-term implications of early EF development on educational attainment, stable employment, and social well-being should be recognized (Moffitt et al., 2011). Policymakers should prioritize policies that reduce household chaos and economic hardship while promoting accessible green spaces, as stable, enriched environments and access to nature positively influence EF (Diamond, 2013; Izenstark & Ebata, 2022; Taylor & Kuo, 2006). For example, policies addressing economic disparities—such as after-school programs and community centers in underserved areas—could buffer the effects of household chaos on child development (Evans & Kim, 2013). Urban planning that integrates family-friendly parks and high-quality green spaces may also support children's cognitive and emotional well-being. Diversity-informed policies tailored to various cultural and demographic contexts could also improve the effectiveness of policies and programs in fostering healthy development and family resilience. These changes could contribute to long-term societal benefits by promoting a more equitable distribution of cognitive and emotional resilience skills across populations (Bradley & Corwyn, 2002).

Future research should also investigate environmental and biological influences on EF development, identifying key factors to design targeted interventions for children facing challenges. Our findings suggest that variations in EF-environment relationships may reflect neurobehavioral nuances tied to brain maturation and developmental stages. Research indicates that EF develops across the lifespan, but a critical period between ages two and seven may be particularly influential (Zelazo & Carlson, 2012). This window of rapid prefrontal cortex maturation may heighten sensitivity to environmental factors such as household chaos and nature exposure. Future research should explore how these influences shape EF trajectories using longitudinal or neuroimaging approaches to uncover underlying neural mechanisms and inform early interventions. In addition, expanding longitudinal studies to follow diverse cohorts into later years could offer insights into how early EF predicts outcomes across education, social skills, and well-being. Understanding interventions' mediating and moderating effects on developmental outcomes would also clarify nuanced strategies that are most effective in increasing resilience and adaptability in children. Ultimately, these findings can inform policies and practices that enhance children's cognitive and emotional skills, contributing to a healthier, more equitable society.

Limitations

While the findings are novel, several limitations must be discussed. Most participants were white and identified as having a higher socioeconomic status, education, and income. Therefore, the findings are not generalizable, and diverse and varied family contexts should be examined in the future. In addition, green spaces can change over time due to seasonal variations, development, or environmental degradation. Data collected at one point might not represent green space at another time, affecting longitudinal studies. However, since this study wanted to examine early family residenctial green space factors, we were limited to photos before age two and what was available on Google Earth. This study also does not fully capture how, when, and why families use their outdoor spaces, which requires further investigation. Family residence green space research needs to incorporate multiple time points, use of the area from the family's perspective, and more advanced mapping to further understand this effect in future research.

Additionally, while the model fit indices suggest moderate to poor fit, particularly for the hot EF model, this study was exploratory in nature. Given the complexity of EF constructs, our modeling decisions were driven by theoretical considerations rather than strict adherence to fit indices. Some degree of model misspecification is expected, and future research should explore alternative factor structures, theoretically justified correlated residuals, and potential refinements to improve model performance. Although we accounted for key covariates, including economic strain, sex at birth, and parental education, other potential confounders, such as baseline cognitive ability and neighborhood socioeconomic status , were not included in the model. These factors could influence EF development and may contribute to selection bias. Future research should consider incorporating a broader range of covariates to further assess the robustness of these findings.

Conclusion

A central finding of this study is the importance of access—whether to resources, calm environments, or nature—in supporting families and promoting children's development. This study underscores access to nature's critical role in shaping family dynamics and child developmental outcomes, providing a unique perspective that expands the literature in this area. By highlighting the interplay between coordinated systems and green spaces, these findings prompt future studies to explore how integrating natural environments within family and community systems can further promote EF and overall well-being. Such research is essential to inform equitable and intentional strategies that foster social, economic, and environmental progress for future generations.

Sam Iwinski *holds a doctorate in Human Development and Family Studies from the University of Illinois Urbana-Champaign. Her research examines the intersections of executive function, parent-child relationships, household environments, and broader ecological factors shaping development.*

Co-authors ***Sehyun Ju, Ledan Yang, Mayra Cuevas, Aaron Ebata, Dina Izenstark, Brent McBride****, and* ***Kelly Bost*** *bring expertise in developmental science, psychology, family dynamics, and education. Together, their work advances the understanding of how environmental and familial contexts influence cognitive and emotional development across early development.*

References

Andrews, K., Atkinson, L., Harris, M., & Gonzalez, A. (2021). Examining the effects of household chaos on child executive functions: A meta-analysis. *Psychological Bulletin*, *147*(1), 16-32. https://doi.org/10.1037/bul0000311

Balseviciene, B., Sinkariova, L., Grazuleviciene, R., Andrusaityte, S., Uzdanaviciute, I., Dedele, A., & Nieuwenhuijsen, M. J. (2014). Impact of residential greenness on preschool children's emotional and behavioral problems. *International Journal of Environmental Research and Public Health, 11*(7), 6757–6770. https://doi.org/10.3390/IJERPH110706757

Barrera, M., Caples, H., & Tein, J. Y. (2001). The psychological sense of economic hardship: Measurement models, validity, and cross-ethnic equivalence for urban families. *American Journal of Community Psychology, 29*(3), 493–517. https://doi.org/10.1023/A:1010328115110

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, *44*(10), 3947-3955. https://doi.org/10.1021/es903183r

Berry, D., Blair, C., Willoughby, M., Garrett-Peters, P., Vernon-Feagans, L., Mills-Koonce, W. R., Cox, M., Burchinal, P., Burton, L., Crnic, K., Crouter, A., Greenberg, M., Lanza, S., & Werner, E. (2016). Household chaos and children's cognitive and socio-emotional development in early childhood: Does childcare play a buffering role? *Early Childhood Research Quarterly, 34*, 115–127. https://doi.org/10.1016/j.ecresq.2015.09.003

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development, 81*(6), 1641–1660. https://doi.org/10.1111/J.1467-8624.2010.01499.X

Bourrier, S. C., Berman, M. G., & Enns, J. T. (2018). Cognitive strategies and natural environments interact in influencing executive function. *Frontiers in psychology*, *9*, 1248. https://doi.org/10.3389/fpsyg.2018.01248

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*. Article 456. https://doi.org/10.1186/1471-2458-10-456/

Boyd, F., Allen, C., Robinson, J. M., & Redvers, N. (2024). The past, present, and future of nature and place-based interventions for human health. *Landscape Research*, *49*(1), 129-145. https://doi.org/10.1080/01426397.2023.2244430

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*(1), 371-399. https://doi.org/10.1146/annurev.psych.53.100901.135233

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Browning, M. H. E. M., & Rigolon, A. (2019). School green space and its impact on academic performance: A systematic literature review. *International Journal of Environmental Research and Public Health 16*(3), 429. https://doi.org/10.3390/IJERPH16030429

Buttelmann, F., & Karbach, J. (2017). Development and plasticity of cognitive flexibility in early and middle childhood. *Frontiers in Psychology, 8*, Article 1040. https://doi.org/10.3389/FPSYG.2017.01040

Carr, V., Brown, R. D., Schlembach, S., & Kochanowski, L. (2017). Nature by design: Playscape affordances support the use of executive function in preschoolers. *Children, Youth and Environments, 27*(2), 25-46. https://doi.org/10.7721/chilyoutenvi.27.2.0025

Cepeda, N. J., Kramer, A. F., & Gonzalez de Sather, J. C. (2001). Changes in executive control across the life span: Examination of task-switching performance. *Developmental Psychology, 37*(5), 715–730. https://doi.org/10.1037/0012-1649.37.5.715

Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, *30*(4), 433–452. https://doi.org/10.1177/0885412215595441

Chen, N., Deater-Deckard, K., & Bell, M. A. (2014). The role of temperament by family environment interactions in child maladjustment. *Journal of Abnormal Child Psychology*, *42*(8), 1251–1262. https://doi.org/10.1007/s10802-014-9872-y

Collado, S., Corraliza, J. A., Staats, H., & Ruíz, M. (2015). Effect of frequency and mode of contact with nature on children's self-reported ecological behaviors. *Journal of Environmental Psychology*, *41*, 65–73. https://doi.org/10.1016/J.JENVP.2014.11.001

Dadvand, P., Pujol, J., Macià, D., Martínez-Vilavella, G., Blanco-Hinojo, L., Mortamais, M., Alvarez-Pedrerol, M., Fenoll, R., Esnaola, M., Dalmau-Bueno, A., López-Vicente, M., Basagaña, X., Jerrett, M., Nieuwenhuijsen, M. J., & Sunyer, J. (2018). The association between lifelong greenspace exposure and 3-dimensional brain magnetic resonance imaging in Barcelona schoolchildren. *Environmental Health Perspectives, 126*(2). https://doi.org/10.1289/EHP1876

Dankiw, K. A., Tsiros, M. D., Baldock, K. L., & Kumar, S. (2020). The impacts of unstructured nature play on health in early childhood development: A systematic review. *PLOS ONE*, *15*(2): e0229006. https://doi.org/10.1371/JOURNAL.PONE.0229006

Darling, N. (2007). Ecological Systems Theory: The person in the center of the circles. *Research in Human Development*, *4*(3–4), 203–217. https://doi.org/10.1080/15427600701663023

De Keijzer, C., Bauwelinck, M., & Dadvand, P. (2020). Long-term exposure to residential greenspace and healthy ageing: A systematic review. *Current Environmental Health Reports, 7*(1), 65-88. https://doi.org/10.1007/s40572-020-00252-1

Dennis, T. A., Brotman, L. M., Huang, K. Y., & Gouley, K. K. (2007). Effortful control, social competence, and adjustment problems in children at risk for psychopathology. *Journal of Clinical Child and Adolescent Psychology*, 36(3), 442–454. https://doi.org/dc6rnb

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135-168. https://doi.org/10.1146/ANNUREV-PSYCH-113011-143750

Diamond, L. M., & Aspinwall, L. G. (2003). Emotion regulation across the life span: An integrative perspective emphasizing self-regulation, positive affect, and dyadic processes. *Motivation and Emotion*, *27,* 125–156. https://doi.org/10.1023/A:1024521920068

Dillon, A. M., Nichols, E., & Foster, A. (2023). The Superhero Garden Project: Outdoor gardening in early childhood education in the United Arab Emirates. *Children, Youth and Environments, 33*(1), 177-187. https://dx.doi.org/10.1353/cye.2023.0006.

Dockx, Y., Hermans, K., & Ruelens, L. (2022). The impact of green space on children's development: A systematic review. *Journal of Environmental Psychology*, 79, 101704. https://doi.org/10.1016/j.jenvp.2021.101704

Duerden, M. D., & Witt, P. A. (2010). An ecological systems theory perspective on youth programming. *Journal of Park & Recreation Administration*, *28*(2), 108-120.

Dumas, J. E., Nissley, J., Nordstrom, A., Smith, E. P., Prinz, R. J., & Levine, D. W. (2005). Home chaos: Sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child and Adolescent Psychology, 34*(1), 93–104. https://doi.org/10.1207/s15374424jccp3401_9

Dzhambov, A. M., Dimitrova, D. D., & Dimitrakova, E. D. (2014). Association between residential greenness and birth weight: Systematic review and meta-analysis. *Urban Forestry & Urban Greening*, *13*(4), 621-629. https://doi.org/10.1016/j.ufug.2014.09.004

Eisenberg, N., Fabes, R. A., Guthrie, I. K., & Reiser, M. (2000). Dispositional emotionality and regulation: Their role in predicting quality of social functioning. *Journal of Personality and Social Psychology*, *78*(1), 136–157. https://doi.org/10.1037/0022-3514.78.1.136

Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. C. (2019). Residential green space in childhood is associated with a lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(11), 5188–5193. https://doi.org/10.1073/PNAS.1807504116/SUPPL_FILE/PNAS.1807504116.SAPP.PDF

Erickson, D. M., & Ernst, J. A. (2011). The real benefits of nature play every day. *Exchange*, *33*(4), 97-99.

Ernst, J., & Burcak, F. (2019). Young children's contributions to sustainability: The influence of nature play on curiosity, executive function skills, creative thinking, and resilience. *Sustainability*, *11*(15), 4212. https://doi.org/10.3390/SU11154212

Evans, G. W., & Stecker, R. (2004). Motivational consequences of environmental stress. *Journal of Environmental Psychology*, *24*(2), 143–165. https://doi.org/10.1016/S0272-4944(03)00076-8

Evans, G. W., & Kim, P. (2013). Childhood poverty, chronic stress, self-regulation, and coping. *Child Development Perspectives*, 7(1), 43-48. https://doi.org/10.1111/cdep.12013

Fawcett, T. W., & Frankenhuis, W. E. (2015). Adaptive explanations for sensitive windows in development. *Frontiers in Zoology*, *12*(Suppl 1), S3. https://doi.org/10.1186/1742-9994-12-S1-S3

Fiese, B. H., Tomcho, T. J., Douglas, M., Josephs, K., Poltrock, S., & Baker, T. (2002). A review of 50 years of research on naturally occurring family routines and rituals: Cause for celebration? *Journal of Family Psychology, 16*(4), 381–390. https://doi.org/10.1037/0893-3200.16.4.381

Fiese, B. H., Musaad, S., Bost, K. K., McBride, B. A., Lee, S. Y., Teran-Garcia, M., & Donovan, S. M. (2019). The STRONG Kids 2 Birth Cohort Study: A cell-to-society approach to dietary habits and weight trajectories across the first 5 years of life. *Current Developments in Nutrition*, *3*(3). https://doi.org/10.1093/CDN/NZZ007

Fiese, B. H., & Schwartz, M. (2008). Reclaiming the family table: Mealtimes and child health and well-being. *Social Policy Report*, *22*(4), 1–20. https://doi.org/10.1002/j.2379-3988.2008.tb00057.x

Fiske, A., & Holmboe, K. (2019). Neural substrates of early executive function development. *Developmental Review*, *52*, 42–62. https://doi.org/10.1016/J.DR.2019.100866

Furness, E., Bellamy, A. S., Clear, A., Finnigan, S. M., Meador, J. E., Mills, S., ... & Sharp, R. T. (2022). Communication and building social capital in community supported agriculture. *Journal of Agriculture, Food Systems, and Community Development*, *12*(1), 63-78. doi: 10.5304/jafscd.2022.121.009

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, *134*(1), 31–60. https://doi.org/10.1037/0033-2909.134.1.31

Garon, N., Smith, I. M., & Bryson, S. E. (2014). A novel executive function battery for preschoolers: Sensitivity to age differences. *Child Neuropsychology*, *20*(6), 713-736.

Gascon, M., Triguero-Mas, M., Martínez, D., Dadvand, P., Forns, J., Plasència, A., & Nieuwenhuijsen, M. J. (2015). Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review. *International*

Journal of Environmental Research and Public Health, *12*(4), 4354-4379. https://doi.org/10.3390/IJERPH120404354

Gascon, M., Zijlema, W., Vert, C., White, M. P., & Nieuwenhuijsen, M. J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health*, *220*(8), 1207–1221. https://doi.org/10.1016/J.IJHEH.2017.08.004

Graziano, P. A., Calkins, S. D., & Keane, S. P. (2011). Sustained attention development during the toddlerhood to preschool period: Associations with toddlers' emotion regulation strategies and maternal behaviour. *Infant and Child Development*, *20*(6), 389–408. https://doi.org/10.1002/ICD.731

Gross, J. J. (1999). Emotion regulation: Past, present, future. *Cognition and Emotion*, *13*(5), 551–573. https://doi.org/10.1080/026999399379186

Haga, S. M., Kraft, P., & Corby, E. K. (2009). Emotion regulation: Antecedents and well-being outcomes of cognitive reappraisal and expressive suppression in cross-cultural samples. *Journal of Happiness Studies*, *10*(3), 271–291. https://doi.org/10.1007/S10902-007-9080-3/TABLES/5

Hartig, T., & Kahn, Jr., P. H. (2016). Living in cities, naturally. *Science*, 352(6288), 938-940. https://doi.org/10.1126/science.aaf3759

Herrington, S., & Brussoni, M. (2015). Beyond physical activity: The importance of play and nature-based play spaces for children's health and development. *Current Obesity Reports*, *4*(4), 477–483. https://doi.org/10.1007/S13679-015-0179-2/FIGURES/2

Hodgson, R., & Birks, S. (2002). *Statistics New Zealand's definition of family, its implications for the accuracy of data and effectiveness of policy targeting*. Centre for Public Policy Evaluation, Massey University.

Hughes, C. H., & Ensor, R. A. (2009). How do families help or hinder the emergence of early executive function? *New Directions for Child and Adolescent Development*, *2009*(123), 35–50. https://doi.org/10.1002/cd.234

Hur, E., Buettner, C. K., & Jeon, L. (2015). Parental depressive symptoms and children's school-readiness: The indirect effect of household chaos. *Journal of Child and Family Studies*, *24*(11), 3462–3473. https://doi.org/10.1007/s10826-015-0147-1

Islam, M. Z., Johnston, J., & Sly, P. D. (2020). Green space and early childhood development: a systematic review. *Reviews on Environmental Health*, *35*(2), 189–200. https://doi.org/10.1515/REVEH-2019-0046

Isquith, P. K., Crawford, J. S., Espy, K. A., & Gioia, G. A. (2005). Assessment of executive function in preschool-aged children. *Mental Retardation and*

Developmental Disabilities Research Reviews, *11*(3), 209–215. https://doi.org/10.1002/mrdd.20075

Iwinski, S., Donovan, S. M., Fiese, B., & Bost, K. (2021). The impact of household chaos and dietary intake on executive function in young children. *Nutrients, 13*(12), 4442. https://doi.org/10.3390/NU13124442

Izenstark, D., & Ebata, A. T. (2016). Theorizing family-based nature activities and family functioning: The integration of attention restoration theory with a family routines and rituals perspective. *Journal of Family Theory & Review*, *8*(2), 137–153. https://doi.org/10.1111/JFTR.12138

Izenstark, D., & Ebata, A. T. (2017). The effects of the natural environment on attention and family cohesion: An experimental study. *Children, Youth and Environments*, *27*(2), 93-109. https://doi.org/10.7721/CHILYOUTENVI.27.2.0093

Izenstark, D., & Ebata, A. T. (2022). Why families go outside: An exploration of mothers' and daughters' family-based nature activities. *Leisure Sciences*, *44*(5), 559-577. doi.org/10.1080/01490400.2019.1625293

Izenstark, D., Ravindran, N., Rodriguez, S., & Devine, N. (2021). The affective and conversational benefits of a walk in nature among mother–daughter dyads. *Applied Psychology: Health and Well-Being*, *13*(2), 299–316. https://doi.org/10.1111/APHW.12250

James, P., Hart, J. E., Banay, R. F., Laden, F., & Shankar, A. (2015). Residential proximity to major roads, cognitive function, and risk of dementia, Parkinson's disease, and multiple sclerosis: A population-based cohort study. *BMJ*, 353, i667. doi:10.1001/jamanetworkopen.2022.9306

Kahn Jr., P. H., & Weiss, T. (2017). The importance of children interacting with big nature. *Children, Youth and Environments*, *27*(2), 7-24. https://doi.org/10.1353/cye.2017.0009.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press.

Kapur, R. (2023). Understanding types and development processes of family. *Indian Journal of Social Science and Literature*, *3*(1), 26-32. DOI: 10.54105/ijssl.B1104.093123

Klenberg, L., Korkman, M., & Lahti-Nuuttila, P. (2001). Differential development of attention and executive functions in 3-to 12-year-old Finnish children.

Developmental Neuropsychology, 20, 407–428. https://doi.org/10.1207/s15326942dn2001_6

Knudsen, E. I. (2004). Sensitive periods in the development of the brain and behavior. *Journal of Cognitive Neuroscience*, *16*(8), 1412-1425. https://doi.org/10.1162/0898929042304796

Kray, J. (2006). Task-set switching under cue-based versus memory-based switching conditions in younger and older adults. *Brain Research*, *1105*(1), 83–92. https://doi.org/10.1016/J.BRAINRES.2005.11.016

Kuo, F. E., Sullivan, W. C., Coley, R. L., & Brunson, L. (1998). Fertile ground for community: Inner-city neighborhood common spaces. *American Journal of Community Psychology*, *26*(6), 823–851. https://doi.org/10.1023/A:1022294028903

Kuo, M., Browning, M. H., Sachdeva, S., Lee, K., & Westphal, L. (2018). Might school performance grow on trees? Examining the link between "greenness" and academic achievement in urban, high-poverty schools. *Frontiers in Psychology*, *9*, 1669. https://doi.org/10.3389/fpsyg.2018.01669

Kuo, M., & Jordan, C. (2019). The natural world as a resource for learning and development: From schoolyards to wilderness. *Frontiers in Psychology*, *10*, 1763. https://doi.org/10.3389/fpsyg.2019.01763

Landau, V. A., McClure, M. L., & Dickson, B. G. (2020). Analysis of the disparities in nature loss and access to nature. *Conservation Science Partners: Truckee, CA, USA*. https://www. csp-inc. org/public/CSP-CAP_Disparities_in_Nature_Loss_FINAL_Report_060120.pdf.

Lee, K. S., Kim, B. N., Cho, J., Jang, Y. Y., Choi, Y. J., Lee, W. S., Han, C., Bae, H. J., Lim, Y. H., Kim, J. I., Shin, C. H., Lee, Y. A., & Hong, Y. C. (2021). Associations between surrounding residential greenness and intelligence quotient in 6-year-old children. *Science of the Total Environment*, *759*, 143561. https://doi.org/10.1016/J.SCITOTENV.2020.143561

Lengua, L. J., Moran, L., Zalewski, M., Ruberry, E., Kiff, C., & Thompson, S. (2015). Relations of growth in effortful control to family income, cumulative risk, and adjustment in preschool-age children*. Journal of Abnormal Child Psychology*, 43, 705–720. https://doi.org/gg2h2r

Lovasi, G. S., Jacobson, J. S., Quinn, J. W., Neckerman, K. M., Ashby-Thompson, M. N., & Rundle, A. (2011). Is the environment near home and school associated with physical activity and adiposity of urban preschool children? *Journal of Urban Health*, *88*(6), 1143–1157. https://doi.org/10.1007/S11524-011-9604-3

Lozada, F. T., Halberstadt, A. G., Craig, A. B., Dennis, P. A., & Dunsmore, J. C. (2016). Parents' beliefs about children's emotions and parents' emotion-related conversations with their children. *Journal of Child and Family Studies*, *25*(5), 1525–1538. https://doi.org/10.1007/S10826-015-0325-1/TABLES/5

Luchs, A., & Fikus, M. (2013). A comparative study of active play on differently designed playgrounds. *Journal of Adventure Education & Outdoor Learning*, *13*(3), 206-222. https://doi.org/10.1080/14729679.2013.778784

Luken, E., Carr, V., & Brown, R.D. (2011). Playscapes: Designs for play, exploration and science inquiry. *Children, Youth and Environments, 21*(2), 325-337. https://dx.doi.org/10.1353/cye.2011.0016.

Martin, A., Razza, R. A., & Brooks-Gunn, J. (2012). Specifying the links between household chaos and preschool children's development. *Early Child Development and Care*, *182*(10), 1247–1263. 10.1080/03004430.2011.605522

Matheny Jr., A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology*, *16*(3), 429-444. https://doi.org/10.1016/0193-3973(95)90028-4

Matsumoto, D., Yoo, S. H., Nakagawa, S., Alexandre, J., Altarriba, J., Anguas-Wong, A. M., Arriola, M., Bauer, L. M., Bond, M. H., Cabecinhas, R., Chae, J., Comunian, A. L., DeGere, D. N., de Melo Garcia Bley, L., Fok, H. K., Friedlmeier, W., Garcia, F. M., Ghosh, A., Granskaya, J. V., … Zengeya, A. (2008). Culture, emotion regulation, and adjustment. *Journal of Personality and Social Psychology*, *94*(6), 925-937. https://doi.org/10.1037/0022-3514.94.6.925

McCormick, R. (2017). Does access to green space impact the mental well-being of children: A systematic review. *Journal of Pediatric Nursing*, *37*, 3–7. https://doi.org/10.1016/J.PEDN.2017.08.027

McRae, K., & Gross, J. J. (2020). Emotion regulation. *Emotion*, *20*(1), 1-9. https://doi.org/10.1037/EMO0000703

McRae, K., Heller, S. M., John, O. P., & Gross, J. J. (2011). Context-dependent emotion regulation: Suppression and reappraisal at the Burning Man festival. *Basic and Applied Social Psychology*, *33*(4), 346-350. https://doi.org/10.1080/01973533.2011.614170

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, *21*(1), 8–14. https://doi.org/10.1177/0963721411429458

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., Houts, R., Poulton, R., Roberts, B. W., Ross, S., Sears, M. R., Thomson, W. M, & Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, 108(7), 2693-2698. https://doi.org/10.1073/pnas.1010076108

Moll, A., Collado, S., Staats, H., & Corraliza, J. A. (2022). Restorative effects of exposure to nature on children and adolescents: A systematic review. *Journal of Environmental Psychology, 84*, 101884. https://doi.org/10.1016/j.jenvp.2022.101884

Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health - Part B: Critical Reviews*, *19*(7), 305–343. https://doi.org/10.1080/10937404.2016.1196155

Perry, N. B., & Calkins, S. D. (2018). A biopsychosocial perspective on the development of emotion regulation across childhood. In P. M. Cole & T. Hollenstein (Eds.), *Emotion regulation* (pp. 3-30). Routledge.

Rigolon, A., Browning, M. H. E. M., & Lee, K. (2018). Access to urban green space in cities of the global south: A systematic literature review. *Urban Science*, *2*(3), 67. https://doi.org/10.3390/urbansci2030067

Salehinejad, M. A., Ghanavati, E., Rashid, M. H. A., & Nitsche, M. A. (2021). Hot and cold executive functions in the brain: A prefrontal-cingular network. *Brain and Neuroscience Advances*, *5*, 23982128211007770. https://doi.org/10.1177/23982128211007769

Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development*, *81*(1), 6–22. https://doi.org/10.1111/J.1467-8624.2009.01378.X

Sanders, T., Feng, X., Fahey, P. P., Lonsdale, C., & Astell-Burt, T. (2015). Greener neighbourhoods, slimmer children? Evidence from 4423 participants aged 6 to 13 years in the Longitudinal Study of Australian children. *International Journal of Obesity*, *39*(8), 1224-1229. https://doi.org/10.1038/ijo.2015.69

Schutte, A. R., Torquati, J. C., & Beattie, H. L. (2017). Impact of urban nature on executive functioning in early and middle childhood. *Environment and Behavior*, *49*(1), 3-30. https://doi.org/10.1177/00139165156030

Sharma, R. (2013). The family and family structure classification redefined for the current times. *Journal of Family Medicine and Primary Care*, *2*(4), 306-310. DOI: 10.4103/2249-4863.123774

Soga, M., Evans, M. J., Cox, D. T. C., & Gaston, K. J. (2021a). Impacts of the COVID-19 pandemic on human–nature interactions: Pathways, evidence and implications. *People and Nature*, *3*(3), 518–527. https://doi.org/10.1002/PAN3.10201/SUPPINFO

Soga, M., Evans, M. J., Tsuchiya, K., & Fukano, Y. (2021b). A room with a green view: the importance of nearby nature for mental health during the COVID-19 pandemic. *Ecological Applications*, *31*(2), e2248. https://doi.org/10.1002/EAP.2248

Spagnola, M., & Fiese, B. H. (2007). Family routines and rituals. *Infants & Young Children*, *20*(4), 284–299. https://doi.org/10.1097/01.IYC.0000290352.32170.5a

Spotswood, E. N., Benjamin, M., Stoneburner, L., Wheeler, M. M., Beller, E. E., Balk, D., McPhearson, T., Kuo, M., & McDonald, R. I. (2021). Nature inequity and higher COVID-19 case rates in less-green neighbourhoods in the United States. *Nature Sustainability*, *4*(12), 1092-1098. https://doi.org/10.1038/s41893-021-00781-9

Strife, S., & Downey, L. (2009). Childhood development and access to nature: A new direction for environmental inequality research. *Organization & Environment*, *22*(1), 99-122. https://doi.org/10.1177/1086026609333340

Su, J. C., Lee, R. M., Park, I. J. K., Soto, J. A., Chang, J., Zamboanga, B. L., Kim, S. Y., Ham, L. S., Dezutter, J., Hurley, E. A., Seol, K. O., & Brown, E. (2015). Differential links between expressive suppression and well-being among Chinese and Mexican American college students. *Asian American Journal of Psychology*, *6*(1), 15–24. https://doi.org/10.1037/A0036116

Taylor, A. F., & Kuo, F. E. (2006). Is contact with nature important for healthy child development? State of the evidence. In C. Spencer & M. Blades (Eds.), *Children and their environments: Learning, using and designing spaces* (pp. 124–158). Cambridge University Press. https://doi.org/10.1017/CBO9780511521232.009

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2001). Coping with ADD: The surprising connection to green play settings. *Environment and Behavior, 33*(1), 54-77. https://doi.org/10.1177/00139160121972864

Taylor, L., & Hochuli, D. F. (2017). Defining greenspace: Multiple uses across multiple disciplines. *Landscape and Urban Planning*, *158*, 25–38. https://doi.org/10.1016/j.landurbplan.2016.09.024

Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development*, *59*(2/3), 25-52. https://doi.org/10.2307/1166137

Thompson, A., & Steinbeis, N. (2020). Sensitive periods in executive function development. *Current Opinion in Behavioral Sciences*, *36*, 98-105. https://doi.org/10.1016/j.cobeha.2020.08.001

Torkar, G., & Rejc, A. (2017). Children's play and physical activity in traditional and forest (natural) playgrounds. *International Journal of Educational Methodology*, *3*(1), 25-30. https://doi.org/10.12973/ijem.3.1.25

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research*, 166, 628-637. https://doi.org/10.1016/j.envres.2018.06.030

Vandeviver, C. (2014). Applying Google Maps and Google Street View in criminological research. *Crime Science*, *3*(1), 1–16. https://doi.org/10.1186/S40163-014-0013-2/FIGURES/2

Vernon-Feagans, L., Willoughby, M., & Garrett-Peters, P. (2016). Predictors of behavioral regulation in kindergarten: Household chaos, parenting, and early executive functions. *Developmental Psychology*, *52*(3), 430–441. https://doi.org/10.1037/dev0000087

Vitale, V., & Bonaiuto, M. (2024). The role of nature in emotion regulation processes: An evidence-based rapid review. *Journal of Environmental Psychology*, 102325. https://doi.org/10.1016/j.jenvp.2024.102325

Völker, S., & Kistemann, T. (2015). Developing the urban blue: Comparative health responses to blue and green urban open spaces in Germany. *Health and Place*, *35*, 196–205. https://doi.org/10.1016/J.HEALTHPLACE.2014.10.015

Wachs, T. D. (1993). Nature of relations between the physical and social microenvironment of the two-year-old child. *Early Development and Parenting*, *2*(2), 81–87. https://doi.org/10.1002/edp.2430020202

Wachs, T. D., & Camli, O. (1991). Do ecological or individual characteristics mediate the influence of the physical environment upon maternal behavior. *Journal of Environmental Psychology*, *11*(3), 249–264. https://doi.org/10.1016/S0272-4944(05)80186-0

Wells, N. M., & Evans, G. W. (2003). Nearby nature: A buffer of life stress among rural children. *Environment and Behavior*, *35*(3), 311–330. https://doi.org/10.1177/0013916503035003001

Wheeler, B. W., White, M., Stahl-Timmins, W., & Depledge, M. H. (2012). Does living by the coast improve health and well-being. *Health and Place*, *18*(5), 1198–1201. https://doi.org/10.1016/J.HEALTHPLACE.2012.06.015

Yih, J., Uusberg, A., Taxer, J. L., & Gross, J. J. (2019). Better together: a unified perspective on appraisal and emotion regulation. *Cognition and Emotion*, *33*(1), 41-47. https://doi.org/10.1080/02699931.2018.1504749

Zamzow, J., & Ernst, J. (2020). Supporting school readiness naturally: Exploring executive function growth in nature preschools. *International Journal of Early Childhood Environmental Education*, *7*(2), 6-16.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, *6*(4), 354–360. https://doi.org/10.1111/j.1750-8606.2012.00246.x

Zelazo, P. D., & Carlson, S. M. (2020). The neurodevelopment of executive function skills: Implications for academic achievement gaps. *Psychology & Neuroscience*, *13*(3), 273-298. https://doi.org/10.1037/PNE0000208

Zhang, J., Yue, W., Fan, P., & Gao, J. (2021). Measuring the accessibility of public green spaces in urban areas using web map services. *Applied Geography*, *126*, 102381. https://doi.org/10.1016/J.APGEOG.2020.102381

Zhao, J., Cui, H., Zhou, J., & Zhang, L. (2023). Influence of home chaos on preschool migrant children's resilience: A moderated mediation model. *Frontiers in Psychology*, *14*, 1087710. doi.org/10.3389/fpsyg.2023.1087710

Zuo, K., Wei, L., & Cong, Y. (2020). Exploration of natural playgrounds in urban parks: Promoting children's health. *Urban and Regional Planning*, *5*(4), 122-131. DOI:10.11648/j.urp.20200504.14