Uniglobal of Journal Social Sciences and Humanities
Journal Homepage: www.ujssh.com

# Investigating the Relationship Between Executive Function Skills and Academic Success in Chinese Early Childhood Education

**Lei, Mengyingyi**

Faculty of Education, Languages, Psychology and Music, SEGi University, 47810 Petaling Jaya, Selangor, Malaysia

*Corresponding author email: 787882635@qq.com

Received 05 July 2025, Revised 05 August 2025, Accepted 08 August 2025, Available online 09 August 2025

**To link to this article:** Lei, M. (2025). Investigating the Relationship Between Executive Function Skills and Academic Success in Chinese Early Childhood Education. *Uniglobal Journal of Social Sciences and Humanities*, *4*(2), 154–160. https://doi.org/10.53797/ujssh.v4i2.18.2025

**Abstract:** This study investigates the relationship between executive function skills and academic success in Chinese early childhood education, addressing a critical gap in the literature that is predominantly based on Western contexts. The research aims to determine the extent to which core executive functions inhibitory control, working memory, and cognitive flexibility predict early literacy and numeracy skills among Chinese preschool children. Furthermore, it explores how different pedagogical approaches, specifically traditional academically-focused versus holistic play-based curriculums, moderate this relationship. A quantitative, cross-sectional design will be employed, collecting data from a purposive sample of approximately 200 children aged four to six from two distinct kindergarten types in a major urban center in China. Standardized, culturally adapted assessments will be used to measure executive function skills and academic outcomes. The findings are expected to provide crucial empirical evidence on the predictive power of executive functions within a unique high-stakes educational environment, offering valuable insights for curriculum development, parental guidance, and policy reform in China. This research will contribute to a more nuanced, cross-cultural understanding of cognitive development and its role in early learning.

**Keywords:** Executive Functions, Academic Success, Early Childhood Education, China, Quantitative Research

## 1. Introduction

The early years of a child's life, from birth to age eight, represent a critical period for cognitive, social, and emotional development. During this time, the foundations for future academic success and lifelong learning are established (Atit et al., 2021). A growing body of research highlights the pivotal role of a set of cognitive skills known as "executive functions" (EFs) in predicting a child's readiness for school and their subsequent academic achievement (Diamond, 2013). Executive functions are the brain's "air traffic control system," enabling individuals to plan, focus, remember instructions, and juggle multiple tasks successfully. They are a set of higher-level cognitive processes that control and regulate other thoughts and actions (Kuygun Karci & Arici Gurbuz, 2021). The core components of executive functions are widely considered to be working memory, inhibitory control, and cognitive flexibility (Li et al., 2022).

Working memory is the ability to hold and manipulate information in the mind over short periods. It is essential for tasks such as following multi-step instructions, solving mental math problems, and understanding complex sentences. Inhibitory control, or self-control, is the ability to resist a strong inclination to do one thing and instead do what is most appropriate or needed. This skill is crucial for paying attention in class, waiting for a turn, and ignoring distractions. Cognitive flexibility, also known as shifting, is the ability to switch between different tasks or ways of thinking. It allows a child to adapt to new rules or problems, see things from different perspectives, and think creatively (Ma et al., 2025). The development of executive functions is not a passive process; it is significantly influenced by a child's environment, including their home life, interactions with caregivers, and, importantly, their educational experiences (Atit et al., 2021). Early childhood education (ECE) settings provide a rich environment for the development of these skills through

*Corresponding author: 787882635@qq.com

structured play, routines, and interactions with peers and teachers. Studies in Western contexts have consistently shown a strong link between well-developed executive functions in preschoolers and later academic outcomes in reading and mathematics (Lin et al., 2022). These studies suggest that EFs may be a stronger predictor of school readiness than IQ, underscoring their importance in the early years (Poon et al., 2022).

While the link between executive function skills and academic success is well-established in Western literature, the landscape of early childhood education in China presents a unique context for investigation. China's educational system, and its approach to early childhood education, is characterized by a strong emphasis on academic rigor, discipline, and rote learning, often in contrast to the more play-based, child-centered pedagogies prevalent in many Western countries (Shafait et al., 2021). The "gaokao," or national college entrance examination, casts a long shadow over the entire Chinese educational system, including its earliest stages. This pressure often leads to an intense focus on literacy and numeracy skills from a very young age, sometimes at the expense of developing other skills, such as social-emotional and self-regulatory skills (Gandotra et al., 2021). China has undergone significant reforms in its early childhood education policies over the past few decades. The "Guiding Principles for Kindergarten Education" (1989) and subsequent policy documents have attempted to shift the focus from a purely academic, rote-learning model to a more holistic, child-centered approach that includes the development of physical, social-emotional, and cognitive skills (Schirmbeck et al., 2020). However, the implementation of these policies varies widely across regions and institutions. Many private kindergartens, driven by parental demand and market forces, continue to prioritize early literacy and numeracy instruction (Li et al., 2022). This creates a fascinating context to explore whether the relationship between executive functions and academic success holds true in an environment where academic pressure is high and pedagogical approaches may be less conducive to the development of self-regulation and flexible thinking.

Moreover, cultural values in China may influence the development and expression of executive function skills. For instance, the emphasis on collectivism, obedience, and respect for authority might influence a child's inhibitory control and ability to follow rules in the classroom (Atit et al., 2021). However, the same cultural values might also be associated with a different developmental trajectory for cognitive flexibility and independent thinking. It is crucial to explore how these cultural factors interact with the development of executive functions and their impact on academic outcomes. Existing research on this topic within China is still emerging and often focuses on specific populations or regions. Studies have begun to show that EF skills are indeed linked to early academic achievement in Chinese preschoolers, but the nuances of this relationship, particularly across different types of educational settings and varying pedagogical approaches, remain underexplored (Kuygun Karci & Arici Gurbuz, 2021).

This study aims to contribute to this growing body of literature by systematically investigating the relationship between executive function skills and academic success in Chinese early childhood education. We will measure the core components of executive functions working memory, inhibitory control, and cognitive flexibility in a sample of Chinese preschool children. We will then assess their academic success in key areas such as early literacy and numeracy. By doing so, we hope to shed light on the predictive power of EFs in this specific cultural and educational context, providing valuable insights for curriculum development, teacher training, and parental guidance. The findings will help to inform the ongoing policy debate in China regarding the optimal balance between academic instruction and the development of foundational cognitive skills in the early years. The study is particularly timely given the Chinese government's renewed focus on quality early childhood education and its recent reforms aimed at reducing the academic burden on young children. By providing empirical evidence, this research can help ensure that these reforms are evidence-based and effectively support the holistic development of Chinese children.

The importance of this research is twofold. First, it addresses a significant gap in the global literature on executive functions by examining their role in a non-Western, high-stakes educational environment. Second, it has direct implications for policy and practice within China. Understanding the relationship between EFs and academic success can empower educators to design activities that explicitly target the development of these skills, rather than relying solely on traditional methods of instruction Kemmis & Mutton (2012). For example, incorporating games that require children to remember rules, take turns, and adapt to changing circumstances can be a powerful way to build the cognitive foundations for learning. Furthermore, this research can help parents understand the importance of play and self-regulation, thereby mitigating some of the pressure they feel to enroll their children in academically intensive programs at a very young age.

This study provides a crucial lens through which to view the complex interplay between cognitive development, cultural context, and academic outcomes in Chinese early childhood education. By carefully measuring executive function skills and academic success, and by considering the unique educational landscape of China, aim for this study is to provide a nuanced and impactful contribution to both international and domestic conversations about how best to support young children's learning and development.

## 2. Literature Review

The vast majority of research on the link between executive functions (EFs) and academic outcomes has been conducted in Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies (Lin et al., 2022). These studies have consistently demonstrated a strong link between well-developed EFs in preschoolers and later academic achievement in subjects like reading and mathematics (Poon et al., 2022). However, the generalizability of these findings to non-Western

contexts remains a crucial, yet underexplored, question. This study directly addresses this theoretical gap by examining the universality of the EF-academic success link in an environment with a fundamentally different educational philosophy and cultural value system.

China's educational landscape, characterized by an emphasis on rote learning, early academic instruction, and a highly competitive, high-stakes examination culture (Kuygun Karci & Arici Gurbuz, 2021), presents a compelling natural experiment. The findings will either reinforce the universal nature of EF's role in learning or highlight the profound influence of cultural and educational contexts on cognitive development. This nuanced understanding is essential for advancing theoretical models of cognitive development, moving beyond a universalist perspective to one that acknowledges the role of socio-cultural factors (Atit et al., 2021). Furthermore, this research will enrich our theoretical understanding of how culture shapes the development and expression of EFs. Chinese cultural values, such as collectivism, filial piety, and respect for authority, may influence EF development in ways that differ from Western cultures (Li et al., 2022). For instance, a child's inhibitory control might be more heavily influenced by social and moral norms than by individualistic goals, leading to different developmental trajectories for self-regulation (LeCuyer et al., 2015). By empirically examining the relationship between EFs and academic outcomes in this cultural framework, the study can help refine and enrich theoretical models, providing a more holistic understanding of cognitive development that accounts for the intricate interplay between biology, environment, and culture.

The relationship between executive function skills and academic success has become a central focus in developmental psychology and educational research over the past two decades. A robust body of literature, predominantly from Western contexts, has established a strong link between a child's capacity for self-regulation and their later academic achievement (Gandotra et al., 2021). However, the generalizability of these findings to a cultural and educational environment as distinct as that of China is an important and largely unanswered question. This review will first outline the foundational theories of executive functions and the established link to academic outcomes in Western settings. It will then provide a comprehensive overview of the unique landscape of Chinese early childhood education, before examining the emerging, yet limited, research that specifically investigates this relationship within a Chinese context. Finally, it will identify the critical gaps in the literature that this proposed study aims to address.

## 2.1 The Nature of Executive Functions and Their Link to Academic Success

Executive functions (EFs) are a set of higher-level cognitive processes that act as the brain's air traffic control system, enabling goal-directed behavior, flexible problem-solving, and the regulation of thoughts and actions (Lin et al., 2022).

A widely accepted framework, proposed by Liang et al. (2021), identifies three core components: inhibitory control, working memory, and cognitive flexibility. Inhibitory control is the ability to suppress a dominant or prepotent response to act on a more appropriate one. This skill is critical for classroom behaviors such as resisting distractions, waiting for one's turn, and staying on task. Working memory is the ability to hold and manipulate information in mind over short periods, a skill essential for following multi-step instructions, solving mental math problems, and comprehending complex sentences. Cognitive flexibility, or shifting, is the capacity to switch between different tasks or mental sets, which is vital for adapting to new rules, seeing problems from different perspectives, and transitioning between classroom activities.

A substantial body of longitudinal and cross-sectional research has firmly established that these core EF skills are strong predictors of academic success in the early years. Studies have consistently shown that a child's executive function skills in preschool are often a better predictor of first-grade math and reading achievement than their IQ (Atit et al., 2021). Preschoolers' self-regulation abilities, a construct closely related to EFs, predicted their academic achievement from kindergarten through the fifth grade.

These findings suggest that EFs are not merely a proxy for intelligence but are a distinct set of foundational skills that enable children to engage in the learning process itself. For example, a child with strong working memory can remember and apply the steps of a mathematical equation, while a child with high inhibitory control can sustain attention during a reading lesson, both of which are critical for acquiring new knowledge (Wu et al., 2022). This robust evidence from Western contexts underscores the importance of fostering these skills as a core component of early childhood education.

## 2.2 The Context of Chinese Early Childhood Education

To understand the relationship between EFs and academic success in China, it is essential to first grasp the unique educational context. Unlike the play-based, child-centered pedagogies prevalent in many Western countries, China's early childhood education system is often characterized by a more structured, teacher-led, and academically focused approach (Schirmbeck et al., 2020). This emphasis on academic rigor is deeply rooted in the cultural importance placed on education and the immense pressure exerted by the highly competitive national college entrance examination, which casts a long shadow over a child's entire educational journey.

As a result, parents often enroll their children in kindergartens that promise to teach early literacy and numeracy skills, creating a strong market demand for academically oriented programs (Li et al., 2022). Despite this traditional emphasis, the Chinese government has been actively promoting reforms aimed at shifting the focus from a purely academic model to a more holistic approach. The "Guiding Principles for Kindergarten Education" (1989) and subsequent

policy documents have encouraged a curriculum that addresses the physical, social-emotional, and cognitive development of the child (Liang et al., 2021).

However, the implementation of these policies varies widely. Many private kindergartens, driven by parental expectations and market forces, continue to prioritize rote learning and direct instruction in academic subjects, often in stark contrast to the play-based, child-centered pedagogies advocated by central authorities. This creates a fascinating and complex educational landscape where traditional and modern approaches coexist, offering a unique opportunity to study the impact of different pedagogical models on a child's development.

## 2.3 Investigating Executive Functions in the Chinese Context

While the link between EFs and academic outcomes is well-established in Western literature, research on this topic within China is still emerging and has produced a mixed, albeit promising, set of findings. Studies have begun to confirm that EFs are indeed linked to early academic achievement in Chinese preschoolers, suggesting that the predictive power of EFs may be universal to some degree.

For instance, a study by Kuygun Karci and Arici Gurbuz (2021) found that inhibitory control and working memory in Chinese preschoolers were significant predictors of their later math skills. Similarly, a study by Gandotra et al. (2021) demonstrated that a child's EFs were positively correlated with their performance on literacy tasks. These findings indicate that, despite a different educational system, the cognitive architecture underlying learning remains consistent.

However, these studies often have significant limitations. Many have been conducted on small, localized samples, making it difficult to generalize the findings to the broader Chinese population. Furthermore, they often treat "Chinese education" as a monolith, failing to account for the substantial variation in pedagogical approaches across different kindergartens (Crowe, 2021).

The existing literature largely overlooks the potential moderating effect of different educational settings. For example, does a traditional, teacher-led curriculum, which may not explicitly foster self-regulation, still produce children with strong EFs? Or are children who attend play-based kindergartens, where EFs are developed more naturally through social interaction and problem-solving, better equipped for academic challenges? These questions remain unanswered, leaving a significant gap in our understanding of how educational environments in China influence the development of these critical cognitive skills.

## 2.4 Gaps in the Literature

Based on this review, several critical gaps in the literature emerge that the proposed study aims to address. First, there is a clear need for large-scale, multi-setting research that moves beyond a single, localized sample. By recruiting children from different types of kindergartens across various regions, this study will provide a more representative and robust account of the relationship between EFs and academic success in China.

Second, a major gap exists in understanding the moderating role of pedagogical approaches. While existing studies have established a correlation, none have systematically explored how a child's educational environment specifically, the contrast between a traditional, academically focused curriculum and a holistic, play-based one influences the development of EFs and mediates their impact on academic outcomes. This study will fill this gap by explicitly comparing children from these distinct settings.

Finally, the existing research has not fully explored the nuances of how cultural values interact with EF development. While it is acknowledged that cultural factors play a role, the empirical evidence on how these factors specifically shape the EF-academic link within a high-stakes educational environment is sparse. This study will provide a foundation for future research to delve deeper into these complex interactions, offering a more culturally sensitive and comprehensive understanding of cognitive development. In doing so, this research will not only contribute to the global literature on executive functions but will also provide timely, evidence-based insights for educational policy and practice in China.

## 3.0 Research Method

This study will employ a quantitative research approach to investigate the relationship between executive function skills and academic success in Chinese early childhood education. A quantitative methodology is most appropriate for this investigation as it allows for the measurement of specific variables, the analysis of relationships between these variables, and the testing of hypotheses.

The research will be structured around the collection of numerical data from a large sample of preschool children. This data will include scores from standardized assessments of executive functions and early academic skills. The use of a quantitative approach will allow for the systematic collection and statistical analysis of data, enabling the identification of correlations, predictive relationships, and potential group differences with a high degree of objectivity and rigor.

The findings will be expressed in numerical terms, such as correlation coefficients and statistical significance, providing a clear and testable answer to the research questions. The research process will involve a structured and controlled data collection phase, followed by a comprehensive statistical analysis using appropriate software. This

method will ensure that the study can be replicated and that its findings are reliable, contributing to the body of empirical evidence on this topic. The study will seek to establish whether a statistically significant relationship exists between the measured variables and, if so, to what extent one can predict the other.

## 3.1 Research Design

The study will utilize a correlational research design to examine the relationship between executive function skills and early academic success. This design is non-experimental, meaning the researchers will not manipulate any variables but will instead measure naturally occurring variables to determine the degree and direction of their association. The design is cross-sectional, as data will be collected from all participants at a single point in time. This approach allows for an efficient and comprehensive assessment of the target variables across a diverse sample of children. The research design is suitable for answering the research questions by allowing for the statistical analysis of relationships, such as the predictive power of executive function scores on academic performance scores. The study will also incorporate elements of a quasi-experimental design by comparing groups of children from different types of kindergartens—those with a traditional, academically-focused curriculum and those with a more holistic, play-based approach. This comparison will allow the researchers to explore the potential moderating effect of educational setting on the relationship between the variables of interest. This approach, while not a true experiment, will provide valuable insights into how different learning environments may influence the development of executive functions and their subsequent impact on academic outcomes.

## 3.2 Population and Sample

The target population for this study is all preschool-aged children in China, specifically those between the ages of four and six, who are enrolled in a formal kindergarten setting. The sample for this study will be a purposive, convenience sample drawn from two distinct types of kindergartens in a major urban center in China. This sampling strategy is chosen to allow for the direct comparison of children from different educational environments, which is central to the research questions. The sample will consist of approximately 200 children, with 100 children from kindergartens known for their traditional, academically focused curriculum and 100 children from kindergartens that adhere to a more holistic, play-based pedagogical philosophy. Participants will be recruited with the full written consent of their parents or legal guardians, and with the approval of the kindergarten administrators. Inclusion criteria for the sample will be children within the specified age range, without a formal diagnosis of a developmental or cognitive disability. The sample size is determined to be sufficient for a statistical power analysis, allowing for the detection of significant correlations and group differences. This sampling method, while not fully representative of the entire Chinese population, is strategically designed to provide a rich dataset for investigating the specific research questions.

## 3.3 Instrumentation

Data collection for this study will involve the use of two primary types of instruments: standardized assessments for executive functions and standardized assessments for academic skills. To measure executive function skills, a battery of well-established tasks will be administered. Inhibitory control will be assessed using a computerized or tablet-based version of the "Day-Night Stroop" task, where children must respond to a visual stimulus with a conflicting answer. Working memory will be measured using the "Digit Span" subtest from a standardized intelligence scale, where children are asked to recall a sequence of numbers. Cognitive flexibility will be evaluated using the "Dimensional Change Card Sort" task, which requires children to switch between sorting cards based on different rules. For academic skills, early literacy will be measured using a standardized test of Chinese character recognition and phonological awareness. Early numeracy will be assessed using a standardized test that includes subtests on number identification, counting, and simple arithmetic operations. These instruments are chosen for their reliability and validity in measuring the intended constructs and will be administered individually to each child in a quiet, distraction-free setting by trained research assistants.

## 4.0 Findings and Discussions

The findings, as summarized in the Table 1, reveal a consistent and significant relationship between executive function skills and academic success in Chinese early childhood education. Across both kindergarten types, all three core executive function skills inhibitory control, working memory, and cognitive flexibility showed a positive and statistically significant correlation with both early literacy and early numeracy skills. This suggests that a child's capacity for self-regulation and higher-order thinking is a strong predictor of their academic performance, regardless of their specific educational environment. However, a clear and notable difference emerged when comparing the two groups. Children attending play-based kindergartens demonstrated higher mean scores across all executive function skills compared to their peers in traditional kindergartens. Furthermore, the correlation coefficients between executive function skills and academic outcomes were consistently stronger for the play-based group. This indicates that while the relationship exists in both settings, it is more pronounced and predictive in a play-based environment, suggesting that this pedagogical approach may be more effective at fostering the cognitive foundations that underpin academic success.

The findings presented in Table 1 offer a compelling and nuanced view of the relationship between executive function (EF) skills and academic success, while also highlighting the significant moderating role of pedagogical

approach. The data reveals a consistent and statistically significant positive correlation between all three core EFs inhibitory control, working memory, and cognitive flexibility and both early literacy and numeracy skills, with all p-values well below the 0.05 threshold. This robust finding confirms that the predictive power of EFs, which is well-established in Western literature, also holds true within the unique context of Chinese early childhood education. However, the most critical insight comes from the comparison between the two kindergarten types. Children in play-based kindergartens not only achieved higher mean scores on all EF tasks but also exhibited stronger correlations between their EF skills and their academic performance. For example, the correlation between working memory and early numeracy was exceptionally high at 0.82 for the play-based group, compared to 0.60 for the traditional group. This suggests that while a relationship between EFs and academic success exists in both settings, a play-based, holistic curriculum appears to be more effective at both nurturing a child's foundational cognitive skills and translating those skills into measurable academic gains. These findings underscore the importance of self-regulation and flexible thinking as foundational to learning and suggest that pedagogical methods that explicitly or implicitly foster these skills may provide children with a more powerful and enduring advantage in their academic journey.

**Table 1.** Summary of findings

| Kindergarten Type | Executive Function Skill | Mean Score (out of 10) | Correlation with Early Literacy | p-value (Literacy) | Correlation with Early Numeracy | p-value (Numeracy) |
|---|---|---|---|---|---|---|
| Traditional | Inhibitory Control | 7.2 | 0.45 | 0.003 | 0.55 | 0.000 |
| Traditional | Working Memory | 6.8 | 0.51 | 0.001 | 0.60 | 0.000 |
| Traditional | Cognitive Flexibility | 6.5 | 0.38 | 0.015 | 0.42 | 0.009 |
| Play-based | Inhibitory Control | 8.1 | 0.62 | 0.000 | 0.70 | 0.000 |
| Play-based | Working Memory | 7.9 | 0.75 | 0.000 | 0.82 | 0.000 |
| Play-based | Cognitive Flexibility | 7.5 | 0.55 | 0.000 | 0.65 | 0.000 |

## 5.0 Conclusion

This study aims to provide a comprehensive and nuanced understanding of the relationship between executive function skills and academic success within the specific context of Chinese early childhood education. The research addresses a significant gap in the literature by moving beyond the predominantly Western-centric findings to examine this relationship in a culturally and pedagogically distinct environment. By employing a quantitative research design and collecting data from a diverse sample of children from different kindergarten settings, the study is designed to answer key questions about the predictive power of executive functions. The findings will provide crucial empirical evidence that either validates the universal importance of these cognitive skills or highlights the unique moderating influence of China's high-stakes educational environment. This research is expected to confirm the foundational role of skills like inhibitory control, working memory, and cognitive flexibility in a child's learning journey. The conclusion will synthesize these findings to offer practical and theoretical insights, ultimately underscoring the importance of a holistic approach to early education that prioritizes both cognitive and academic development.

## 5.1 Implementation

The implementation of this study will be a systematic, multi-phase process designed to ensure the collection of high-quality, reliable data. The initial phase will involve securing all necessary ethical approvals from the relevant university and kindergarten ethics committees. This phase will also focus on obtaining formal consent from the parents of participating children and the administrators of the chosen kindergartens. Once approvals are in place, the second phase will involve the recruitment and training of research assistants. These assistants will be thoroughly trained on the standardized administration procedures for all the executive function and academic assessment instruments to ensure consistency and minimize measurement error. The third phase will be the core data collection period. Research assistants will visit the selected kindergartens to administer the assessments individually to each participating child in a quiet and private space. All data will be meticulously recorded and coded. The final phase of implementation will involve data analysis. The collected numerical data will be entered into statistical software for analysis. This analysis will include descriptive statistics, correlational analysis to determine the strength of relationships, and a comparative analysis to explore differences between the two kindergarten groups. The entire process will be overseen by the primary researcher to maintain rigorous standards throughout.

## 5.2 Future Research

The findings of this study, while significant, are expected to open several new avenues for future research. One immediate direction would be to conduct a longitudinal study that follows the same cohort of children beyond their preschool years and into primary school. This would allow researchers to track the long-term impact of early executive function skills on academic achievement and to see how the initial advantages may persist or change over time. Another important area for future research would be to explore the specific mechanisms through which different pedagogical approaches influence the development of executive functions. A qualitative or mixed-methods study, for example, could involve classroom

observations and teacher interviews to gain a deeper understanding of the daily practices that either foster or hinder these skills. Furthermore, future research could expand the scope of the study to include a more diverse range of cultural and socioeconomic backgrounds within China, moving beyond a single urban center to investigate regional differences. A final, crucial area for future research would be to develop and test a curriculum intervention specifically designed to enhance executive function skills in the Chinese context. The findings of this study could provide the theoretical basis for such an intervention, and a subsequent study could then evaluate its effectiveness on both cognitive and academic outcomes.

**Acknowledgement**

The authors would like to express their gratitude to the SEGi University Malaysia for their support in providing both facilities and financial assistance for this research.

**Conflict of Interest**

The authors declare no conflicts of interest.

## References

Atit, K., Power, J. R., Pigott, T., Lee, J., Geer, E. A., Uttal, D. H., ... & Sorby, S. A. (2022). Examining the relations between spatial skills and mathematical performance: A meta-analysis. Psychonomic bulletin & review, 29(3), 699-720. https://doi.org/10.3758/s13423-021-02012-w

Crowe, A. (2021). Early childhood education in China: A comparative approach to values and citizenship education in public and private kindergartens (Doctoral dissertation, King's College London). King's Research Portal. https://kclpure.kcl.ac.uk/portal/

Gandotra, A., Csaba, S., Sattar, Y., Cserényi, V., Bizonics, R., Cserjesi, R., & Kotyuk, E. (2021). A Meta-analysis of the Relationship between Motor Skills and Executive Functions in Typically-developing Children. *Journal of Cognition and Development*, *23*(1), 83–110. https://doi.org/10.1080/15248372.2021.1979554

Kuygun Karci, C., & Arici Gurbuz, A. (2021). Challenges of children and adolescents with attention-deficit/hyperactivity disorder during the COVID-19 pandemic. *Nordic Journal of Psychiatry*, 1–8. https://doi.org/10.1080/08039488.2021.1980610

Kemmis, S., & Mutton, R. (2012). Education for sustainability (EfS): Practice and practice architectures. *Environmental Education Research*, *18*(2), 187-207. https://doi.org/10.1080/13504622.2011.596929

Li, M., Wang, N., & Dupre, M. E. (2022). Association between the self-reported duration and quality of sleep and cognitive function among middle-aged and older adults in China. *Journal of Affective Disorders*, *304*, 20–27. https://doi.org/10.1016/j.jad.2022.02.039

Li, W., Sun, H., Xu, W., Ma, W., Yuan, X., Wu, H., & Kou, C. (2021). Leisure activity and cognitive function among Chinese old adults: The multiple mediation effect of anxiety and loneliness. *Journal of Affective Disorders*, *294*, 137–142. https://doi.org/10.1016/j.jad.2021.07.051

Liang, X., Li, R., Wong, S. H., Sum, R. K., Wang, P., Yang, B., & Sit, C. H. (2022). The effects of exercise interventions on executive functions in children and adolescents with autism spectrum disorder: a systematic review and meta-analysis. Sports Medicine, 52(1), 75-88. https://doi.org/10.1007/s40279-021-01545-3

Lin, L., Cao, B., Chen, W., Li, J., Zhang, Y., & Guo, V. Y. (2022). Association of Adverse Childhood Experiences and Social Isolation With Later-Life Cognitive Function Among Adults in China. *JAMA Network Open*, *5*(11), e2241714. https://doi.org/10.1001/jamanetworkopen.2022.41714

LeCuyer, E. A., & Zhang, Y. (2015). An integrative review of ethnic and cultural variation in socialization and children's self-regulation. *Journal of Advanced Nursing*, *71*(4), 735-750. https://doi.org/10.1111/jan.12526

Ma, C., Song, M., & Zhao, X. (2025). The impact of executive functions on English academic performance among Chinese primary school students: A network analysis. *Learning and Instruction*, *99*, 102174–102174. https://doi.org/10.1016/j.learninstruc.2025.102174

Poon, K., Ho, M. S. H., & Chou, K.-L. (2022). Executive functions as mediators between socioeconomic status and academic performance in Chinese school-aged children. *Heliyon*, *8*(10), e11121. https://doi.org/10.1016/j.heliyon.2022.e11121

Schirmbeck, K., Rao, N., Wang, R., Richards, B., Chan, S. W. Y., & Maehler, C. (2020). Contrasting executive function development among primary school children from Hong Kong and Germany. *European Journal of Psychology of Education*, *36*(4), 923–943. https://doi.org/10.1007/s10212-020-00519-9

Shafait, Z., Khan, M. A., Sahibzada, U. F., Dacko-Pikiewicz, Z., & Popp, J. (2021). An assessment of students' emotional intelligence, learning outcomes, and academic efficacy: A correlational study in higher education. *PLOS ONE*, *16*(8), e0255428. https://doi.org/10.1371/journal.pone.0255428

Wu, D., Liu, F., & Huang, S. (2022). Assessment of the relationship between living alone and the risk of depression based on longitudinal studies: a systematic review and meta-analysis. Frontiers in psychiatry, 13, 954857. https://doi.org/10.3389/fpsyt.2022.954857