

Longitudinal Insights into Cognitive Development in Chinese Pre-Schoolers: Evaluating Early Interventions for Autism Spectrum Disorder

Suyi Duan^{1*}

University, Central Region, Singapore, 387380

Autism Spectrum Disorder (ASD) has a significant influence on early childhood development, which underscores the global importance of prompt intervention. This research explores the cognitive development patterns of Chinese preschool children, both with and without ASD, placing particular emphasis on the role of early interventions as well as factors such as nutrition, comorbid health conditions and regional disparities. The primary objective is to examine how early diagnosis and rehabilitation efforts contribute to the cognitive advancement of pre-schoolers identified with ASD. Employing a qualitative approach, the study analysed five peer-reviewed publications using NVivo to uncover common themes. The outcomes indicate that structured programmes like TEACCH and ESDM substantially enhance language acquisition, executive functioning and social interaction abilities. Delays in cognitive development are frequently linked with deficiencies in vitamins A and D, zinc and folate. Furthermore, a delayed diagnosis and the presence of multiple health issues tend to intensify developmental challenges in these areas. The study concludes that preschool children with ASD exhibit improved cognitive capabilities when they benefit from timely interventions, adequate nutritional support and equitable healthcare services. These insights offer valuable direction for advancing inclusive early childhood initiatives in China and support the global pursuit of evidence-based inclusive education models.

Keywords: Autism Spectrum Disorder, Cognitive Development, Early Intervention, Preschool Children, Nutritional Deficiencies

Introduction and Background

Cognitive skills refer to the mental processes involved in gaining knowledge and comprehension through experiences, thoughts and

Correspondence concerning this article should be addressed to Suyi Duan Master, School of Social and Health Sciences, James Cook University, Central Region, Singapore, 387380
Email: 15652660112@163.com

sensory input. These skills form a fundamental component of child development theory, as the cognitive dimension of human experience supports the gradual development of essential areas such as learning capacity (for instance, reading proficiency), attentional control and language development in children (Blanc et al., 2021; Van der Fels et al., 2015). Cognitive abilities, which include memory, attention and problem-solving, are vital in enabling children to understand and engage with their surroundings (Babakr et al., 2019; Genovese & Butler, 2020; Morales-Hidalgo et al., 2018). Consequently, the early detection of ASD and the implementation of suitable interventions are critical for positively influencing the developmental pathways of young children.

In recent years, scholarly interest in the early diagnosis of ASD and related interventions for preschool-aged children has increased. For example, Benteuto et al. (2020) conducted an intensive study centred on parent-led interventions, revealing significant modifications in the developmental progress of preschool children with ASD when parents actively contributed to intervention strategies. Their results strongly indicated that customised interventions designed in partnership with parents can enhance children's developmental profiles. Similarly, Martin et al. (2019) identified a connection between the sleep disturbances of children with ASD and their cognitive development, linking these factors to parental mental health and stress levels. This suggests that parental behaviours, initiatives and actions are influential in shaping the cognitive growth and wellbeing of children with ASD.

Further, two earlier studies explored the benefits of early intervention in cases of severe autism by examining the impact of Exchange and Development Therapy (Blanc et al., 2021; Harstad et al., 2023). These investigations concluded that adopting specialised therapeutic methods at an early age can significantly improve children's social communication skills and behavioural flexibility. Put simply, a child's age at the time of intervention plays a crucial role in determining the success of support efforts for those with ASD. Beyond findings from Western contexts, Huang et al. (2014) examined the early developmental stages of Chinese toddlers with ASD aged 18 to 36 months in Tianjin Municipality, highlighting that recognising early indicators of autism can support efforts to address prevalence.

In China, approximately 200,000 new cases of ASD in children are recorded each year (Xinhua, 2021). To address the needs of these children, the Ministry of Health of China, together with the Hope Star Children Mental Development Center, has introduced strategic guidelines for interventions and treatments. Furthermore, the Chinese government has allocated substantial funding to support research, development and rehabilitation initiatives for children with ASD, especially in major

metropolitan centres, through collaboration among hospitals and rehabilitation facilities. A nationwide study by Zhou et al. (2020), which analysed ASD prevalence among children aged 6 to 12 years, reported that ASD affects 0.29% of the overall Chinese population. Their findings also showed that boys are more frequently diagnosed with ASD than girls and that nearly 68.8% of the children assessed experienced at least one additional mental health disorder. These insights underscore the importance of advancing intervention strategies aimed at strengthening the cognitive development of preschool children with ASD in China to contribute to reducing ASD prevalence.

Literature Review

Theoretical Frameworks

Piaget's Stage Theory for Cognitive Development

Jean Piaget's theory offers valuable insights into how children's thinking and reasoning abilities evolve over time. Piaget proposed that children advance through distinct developmental stages, each of which equips them with new skills for problem-solving and understanding their environment (Carey et al., 2015). These stages are identified as the Sensorimotor, Pre-operational, Concrete Operational and Formal Operational phases. As children's brains mature, they process information in unique ways at each developmental stage. The present study draws on Piaget's framework to identify key stages in cognitive development and to explore the specific challenges faced by children with ASD. Aligning the cognitive abilities of children with ASD to Piaget's stages provides a foundation for designing targeted support strategies to address their needs effectively.

Delving into ASD with the Lens of Theory of Mind (ToM)

The ToM describes an individual's capacity to identify and attribute mental states to both themselves and others, recognising that these mental states may differ from their own perspectives (Beaudoin et al., 2020; Carlson et al., 2013). For young individuals with ASD, the ability to interpret the attitudes and intentions of others is crucial, although it often presents considerable challenges.

Symptoms and Characteristics of ASD in Children

ASD is associated with a wide range of symptoms and traits that can profoundly affect a child's everyday functioning and their interactions within their surroundings. Research from Western contexts, such as the United States, has shown that symptoms of ASD tend to increase in visibility among children under the age of eight, with difficulties in social

engagement and repetitive behaviours being among the most prominent challenges (Christensen, 2016; Morales-Hidalgo et al., 2018). These studies highlight that identifying ASD through signs such as struggles in social interactions, challenges in both verbal and non-verbal communication and repetitive patterns of behaviour at an early stage can support timely detection. Early recognition of these features enables healthcare professionals to intervene sooner, often leading to improved outcomes.

Understanding the influence of nutrition on children with ASD is also crucial in building a clearer picture of their developmental context. Guthrie et al. (2013) examined how clinical diagnoses and symptom patterns of ASD may change or remain stable over time. Their findings indicated that although many characteristics of ASD emerge by around two years of age, the nature of these characteristics may shift as children grow older. For example, while a younger child might display difficulties with joint attention, older children may face greater challenges with abstract reasoning or interpreting complex social cues. Nutrition plays a critical role in both the physical and cognitive development of children with ASD, as inadequate nutritional intake can hinder growth in these areas. In contrast to findings from the West, research within Eastern settings has focused on the relationship between nutrition and ASD symptoms among children. Studies conducted in regions such as Chongqing and Hainan have identified links between poor nutrition and delays in cognitive development in young Chinese children with ASD. Nevertheless, there has been progress in early intervention practices in China (Liu et al., 2016; Zhu et al., 2020). These investigations argue that low nutritional levels can intensify ASD symptoms among pre-schoolers, but targeted nutritional support can help mitigate these effects. Although the body of research on pre-schoolers with ASD in China remains limited, current evidence strongly underscores the importance of early symptom monitoring and intervention.

Cognitive Developmental Issues in Children with ASD

ASD is distinguished by its core symptoms, which include difficulties in social interaction and communication, accompanied by a variety of cognitive developmental challenges. These cognitive difficulties adversely affect a child's capacity to process information effectively, engage with their surroundings and adjust to unfamiliar situations, all of which are crucial for healthy future development. The study by Cervantes et al. (2014) explored the relationship between cognitive development and behavioural difficulties in children diagnosed with ASD. Their findings highlighted that specific cognitive shortcomings, such as problems with

abstract reasoning, problem-solving and decision-making, are strongly associated with cognitive difficulties.

Children who find it hard to grasp cause-and-effect connections are more likely to display aggressive behaviours, which represents a significant concern. This suggests that cognitive developmental challenges can have substantial impacts on the behavioural patterns of children. In addition, earlier research has reported delays across various cognitive areas in children with ASD, including attention, memory and information processing (Birtwell et al., 2016; Estes et al., 2015). These cognitive delays frequently occur alongside adaptive and social difficulties, reinforcing the need for comprehensive and effective intervention strategies. Children with ASD also frequently experience difficulties in executive functioning, which involves capabilities such as planning, organisation and cognitive flexibility. Such limitations can significantly impede their ability to respond to new situations or adjust their behaviour in light of feedback.

Contemporary Strategies for ASD

Discussion on Early Intervention

Early intervention refers to addressing the symptoms of ASD at the earliest stages of a child's life, typically during the toddler years. Camarata (2014) emphasised that recognising and responding to the initial signs of ASD at an early point can significantly enhance a child's social and communication abilities. Similarly, Oono et al. (2013) demonstrated that interventions involving parents or primary caregivers actively supporting therapeutic practices have beneficial effects. In such interventions, caregivers play a direct role in creating a stable and supportive setting, helping to foster improvements in the child's development. This approach not only strengthens children's skills but also equips parents with effective strategies to encourage their children's growth and manage ASD-related challenges. Towle et al. (2020) investigated the advantages and potential limitations of early interventions by reviewing various experimental methods. Their research highlighted the necessity of early diagnosis and intervention in promoting both cognitive and social development in children with ASD. The results indicated that early interventions can meaningfully contribute to better developmental, cognitive and social outcomes. Pasco (2018) also underlined the essential role of early intervention, stressing its transformative potential in helping children with ASD achieve greater well-being and improved life prospects in adulthood.

In the context of Eastern cultures, Xu et al. (2018) conducted a pilot study that pointed to the growing importance of awareness-raising and educational strategies in supporting early interventions for children with ASD aged between two and five years. However, cultural factors were

identified as barriers that can delay the adoption of these early support measures. These conclusions are consistent with the findings of Su et al. (2013), who noted that while early intervention strategies are becoming more accepted in China for addressing ASD symptoms and associated developmental difficulties, some families continue to encounter obstacles, often linked to religious beliefs, that hinder their ability to fully engage in such interventions.

Rehabilitation Initiatives

Rehabilitation for children with ASD involves structured interventions designed to enhance functional abilities and alleviate the severity of core symptoms. Among the established rehabilitation programmes highlighted in the literature is the TEACCH (Treatment and Education of Autistic and Related Communication-handicapped Children) approach. A previous study conducted in China by Zeng et al. (2021) emphasised that the TEACCH programme centres on building upon children's existing strengths. This method employs visual supports to facilitate comprehension and learning, which has been shown to result in notable improvements for children with ASD. Another emerging strategy involves sports-based interventions. Wang et al. (2020) explored this through a study on a mini-basketball training scheme for preschool children with ASD. Their findings demonstrated that physical activities such as sports not only enhance motor abilities but also contribute positively to executive functioning, supporting a reduction in core ASD-related difficulties.

From a Western perspective, Stichter et al. (2016) highlighted the significance of conducting thorough assessments within school environments to customise support for students with ASD. Their work advocates for the application of evidence-based strategies in educational settings to promote inclusivity and better outcomes for these students. In a similar vein, Mang'ombe and Wairungu Mathenge (2022) provided a comprehensive review of recent research on ASD, with particular attention to common challenges in communication. Their findings stressed that the implementation of research-informed interventions is essential to ensure that the approaches used remain up to date and effective.

Research Gap

Although considerable research has examined the cognitive development pathways of children with ASD and the advantages of early intervention, notable gaps in the literature remain. One key gap addressed in this study concerns the scarcity of longitudinal research focusing on the cognitive development of children with ASD in China and other non-Western contexts, as most existing studies have been conducted in

Western countries. A second gap lies in the limited understanding of how early interventions and rehabilitation efforts specifically shape the cognitive development of preschool children with ASD in the Chinese setting. While early interventions aim to enhance various cognitive abilities, it remains unclear which particular domains experience the greatest benefit. A further underexplored area involves the interaction between factors such as the timing, intensity and type of intervention, and how these variables collectively affect cognitive development outcomes.

Research Questions

RQ1: In what ways do the cognitive abilities of Chinese preschool children with ASD differ from those without ASD?

RQ2: Which early intervention strategies have proven effective, and how do they influence the cognitive development of preschool children with ASD in China?

RQ3: How do factors such as intervention intensity, type, timing and socio-economic status contribute to the cognitive development outcomes of children with ASD?

RQ4: What are the current patterns and developments in treatment and rehabilitation approaches for preschool children with ASD?

Methodology

Study Design

This study will adopt a longitudinal qualitative research design to explore early intervention and rehabilitation among preschool children diagnosed with ASD. This design was chosen because it allows for the monitoring of developmental progress over time, offering important insights into how early intervention may shape future outcomes for children with ASD. The longitudinal nature of the study makes it possible to follow the evolution of cognitive abilities and to assess the long-term impact of various intervention strategies. The qualitative approach aims to capture a broad spectrum of perspectives, emotions and views from participants on the subject. This research design is particularly valuable as it enables the generation of more detailed and comprehensive explanations compared to alternative study types.

Data Collection

This research will rely on secondary data collection, guided by the principles of the PRISM model. The PRISM framework is recognised for its comprehensive, systematic and structured approach, which makes it highly valuable for this type of study (Rethlefsen et al., 2021). The use of longitudinal secondary data is appropriate, as it enables the examination

of cognitive development changes across an extended period. Therefore, data and studies produced between 2002 and 2022 will form the core of the analysis. This 20-year timeframe provides a broad perspective, encompassing different developmental phases, intervention methods and recent progress in ASD-related practices.

Analysis Methods

The secondary data in this study will be examined using a qualitative approach, with a focus on identifying and organising recurring themes. After data collection, thematic analysis will be employed to explore how patterns and findings evolve over time. This method is well suited for identifying and categorising broad trends, making it easier to trace long-term changes. The study aims to uncover clear and meaningful themes that address the research questions and illustrate the cognitive development of children with ASD who have received early intervention. NVivo software will be utilised to support this process by helping to detect themes related to ASD interventions across different periods. Given the longitudinal focus of the research, data will be drawn from various time points. NVivo's advanced data management features will facilitate the systematic organisation of information from these different stages, enabling the clear tracking of how patterns or themes progress over time (Edwards-Jones, 2014). Through the use of NVivo, the project seeks to produce detailed and well-rounded conclusions. The software also supports iterative analysis, allowing earlier interpretations to be revisited and refined as new data are incorporated, ensuring that the results remain comprehensive and accurately reflect the full dataset.

Ethical Considerations

Investigating the cognitive development of preschool children with ASD demands adherence to rigorous ethical principles. A key ethical commitment in this research is to ensure that all sources of information are properly acknowledged, with full citations provided for any data or findings drawn from existing studies. In cases where participants are involved, informed written consent will be obtained from parents or guardians, who will be made aware of their right to withdraw their child from the study at any stage without the need to provide a reason. The integrity of the data will be maintained by using it in its original form, without alterations, so that the authenticity of the findings is preserved. This commitment to honesty will also guide the data analysis process. Analytical tools such as NVivo will be employed with care to minimise the risk of introducing unintended bias into the interpretation of results.

Analysis

Introduction

This section offers a critical examination of five peer-reviewed studies that address the cognitive development of preschool children with ASD in China. Drawing on findings from a systematic review of existing literature, the analysis investigates how cognitive abilities in these children are influenced by a combination of early intervention approaches, as detailed in Table 1, nutritional factors, regional inequalities and diagnostic patterns. The studies reviewed employed diverse methodologies, including randomised controlled trials, pilot studies and surveys, providing insight into the interplay between individual characteristics and environmental contexts in shaping developmental outcomes. From this analysis, four principal themes emerged, highlighting the key factors affecting cognitive development in children with ASD in China. These themes include the importance of proper nutrition, timely and effective interventions, early identification of developmental concerns and the impact of health conditions as well as regional and socio-economic circumstances.

Nutritional Status and Its Impact on Cognitive Development

A key finding from the reviewed studies is the influence of dietary habits on the brain development of preschool children with ASD. The work of Liu et al. (2016) and Zhu et al. (2020) indicates that sufficient intake of essential vitamins and minerals can enhance cognitive functions in children with ASD and may help reduce the likelihood of more severe symptoms. In their study of children in Chongqing, Liu and colleagues assessed nutrient intake levels and monitored for deficiencies. Their findings revealed that children with ASD generally consumed less vitamin A compared to their peers without ASD. Using the CARS, they observed that those with more pronounced ASD symptoms had lower vitamin A levels, suggesting that inadequate intake of this nutrient may contribute to cognitive and behavioural challenges. The study also noted that food refusal and selective eating were linked to more intense symptoms in some children.

Building on earlier research, Zhu et al. (2020) explored the nutritional differences between children with ASD in Chongqing and Hainan, and how these differences related to cognitive abilities. Their study found that children in Chongqing exhibited more severe symptoms related to diet deficiencies than those in Hainan. The results showed that low levels of vitamin D, zinc and folate were strongly associated with greater symptom severity and weaker developmental outcomes, as measured by the Gesell Scale.

Table 1

Systematic Literature Review

Author (Year)	Country/Region	Study Focus	Sample	Intervention / Key Variables	Key Findings / Cognitive Outcomes
Zhou et al. (2020)	China (Nationwide)	Investigated ASD prevalence and diagnostic trends in children aged 6–12.	125,806 screened; 363 diagnosed with ASD	Utilised a revised version of the Chinese Autism Spectrum Rating Scale for nationwide screening	ASD prevalence was found to be 0.70%; 43.3% were first-time diagnoses; 68.8% had comorbidities. Cognitive differences observed even in mainstream schooling environments.
Liu et al. (2016)	Chongqing, China	Examined the relationship between nutritional intake and ASD behavioural traits.	154 children diagnosed with ASD	Assessed dietary intake of key nutrients (vitamins A, D, iron, folate); CARS evaluation; feeding behaviours	Deficient vitamin A levels were correlated with higher ASD severity; frequent picky eating and poor nutrient profiles were linked to cognitive and behavioural challenges.
Xu et al. (2018)	China	Tested the effectiveness of a culturally adapted early ESDM intervention.	36 total (16 in intervention, 20 in control)	Intervention over 8 weeks included 1-hour daily ESDM plus 5 hours weekly standard therapy	The intervention group demonstrated reduced symptom severity and improved social and cognitive functioning.
Zeng et al. (2021)	China	Evaluated combined effects of TEACCH and DTT on preschool cognitive outcomes.	60 children (30 intervention, 30 control)	Conducted a 6-month intervention combining TEACCH with Discrete Trial Training	Children receiving the structured intervention showed greater gains in language skills, social behaviour and self-care ability.
Zhu et al. (2020)	Chongqing and Hainan, China	Compared nutritional profiles and ASD symptoms across two provinces.	738 ASD children; 302 typically developing peers	Measured developmental outcomes using CARS, SRS, ABC; micronutrient levels; dietary intake assessments	Low levels of vitamin A, D, zinc and folate were associated with increased symptom severity and reduced cognitive scores. Regional disparities influenced outcomes.

The evidence pointed to the positive role of adequate nutrient intake in improving both cognitive performance and behaviour, emphasising that proper nutrition supports healthy development. Together, these studies highlight that nutrition is a vital yet sometimes overlooked element in supporting the brain development of preschool children with ASD. While nutrition is widely recognised for its role in growth and immunity, these findings stress that maintaining appropriate levels of specific nutrients is crucial for cognitive development and behaviour regulation in children with ASD. This reinforces the importance of incorporating nutritional support into early intervention programmes and developmental screening, particularly in areas affected by food insecurity or limited awareness of healthy dietary practices.

Early Structured Interventions and Cognitive Gains

Another significant theme identified in this review is the positive impact of structured early intervention plans on the cognitive development of young children with ASD. The studies by Xu et al. (2018) and Zeng et al. (2021) demonstrated that targeted interventions can lead to substantial improvements in both cognitive and behavioural outcomes. Xu et al. (2018) conducted a trial to assess a Chinese adaptation of the ESDM for children between 24 and 60 months of age. In this study, the intervention group received an additional hour of ESDM-based therapy each day alongside their standard intervention, while the control group continued with only the standard approach. After eight weeks, children in the intervention group showed reduced autism severity and enhanced joint attention, early communication and social interaction. These results suggest that early, well-designed interventions, particularly those involving parents and considering cultural contexts, can significantly advance the development of children with ASD.

Similarly, Zeng et al. (2021) examined the combined effects of the TEACCH approach and Discrete Trial Teaching (DTT). Their research involved two groups of 30 preschoolers with ASD, where one group received both TEACCH and DTT, and the control group received only DTT over six months. The findings revealed that children in the combined intervention group made greater gains in expressive and receptive language, emotional expression, social skills and self-care abilities. Cognitive and adaptive developments were evaluated using the CPEP-3 translation, and the results supported the study's hypothesis regarding the benefits of structured interventions. Both studies highlight the importance of early detection and timely action in promoting cognitive growth. The objectives of programmes such as ESDM and TEACCH go beyond symptom management; they also aim to equip children with

essential skills such as communication, attention and problem-solving. The evidence indicates that starting intervention at a very young age leads to far better developmental outcomes than delaying therapy.

Diagnostic Timing, Comorbidities, and Cognitive Complexity

Zhou et al. (2020) conducted a large-scale study on ASD among over 125,000 Chinese children, identifying 363 confirmed cases, nearly half of which had not been previously diagnosed. Of these, 68.8% also had conditions such as attention deficit hyperactivity disorder or intellectual disability. The findings highlight delayed diagnosis as a major barrier to early cognitive support, with late identification allowing maladaptive patterns to form. Comorbidities further complicate treatment, as children with both ASD and other neurodevelopmental disorders often face difficulties with attention, memory, and emotional regulation—key elements of learning. Despite these challenges, many affected children were enrolled in mainstream education, underscoring the need for inclusive systems that offer tailored learning strategies and direct cognitive support. In sum, cognitive challenges in ASD stem not only from the condition itself but also from overlapping developmental and behavioural factors. Comprehensive assessment must include neuropsychological, psychiatric, and developmental evaluations to fully address the cognitive needs of children with ASD.

Regional and Socioeconomic Disparities in Cognitive Outcomes

A key theme in the literature is the influence of regional and economic disparities on cognitive development in children with ASD. Studies by Liu et al. (2016) and Zhu et al. (2020) highlight that access to resources and geographical location significantly shape developmental outcomes. For instance, Zhu et al. found that children in Chongqing, a less developed region, exhibited poorer nutrition, more severe symptoms, and lower cognitive and behavioural scores compared to children in Hainan. Liu similarly reported that malnutrition among disadvantaged children contributed to greater behavioural issues and reduced cognitive performance. These findings indicate a structural gap in service access. Urban families often benefit from diagnostic services, therapies, and nutritional guidance, while rural and low-income communities face limited support. As a result, cognitive development among children with ASD varies widely across socioeconomic lines. Addressing this imbalance requires targeted policies to expand healthcare, low-cost interventions, and parental education in underserved areas. Without such efforts, disparities in developmental outcomes will likely persist.

Summary

The review of five peer-reviewed, high-quality studies offers detailed insights into the cognitive development of Chinese pre-schoolers with ASD. The findings are consistent with those from research conducted in various regions and contexts. Cognitive development in children with ASD is shown to be strongly influenced by the quality of their nutrition, the presence of timely and structured interventions, the early identification of challenges and regional disparities in access to healthcare and educational services. Programmes such as TEACCH and ESDM have contributed to meaningful improvements in language acquisition, executive function and social interaction among many pre-schoolers. Insufficient intake of vitamin A, vitamin D, zinc and folate has been linked to poorer cognitive performance and more severe ASD symptoms, particularly in under-resourced communities. The presence of additional health conditions and delays in diagnosis further hinder cognitive progress, underscoring the need for an integrated approach to both assessment and intervention. This analysis highlights the importance of prioritising early detection, structured support, nutritional provision and regional equity in policies and practice. Advancing cognitive development in children with ASD requires a coordinated focus on biological, environmental and social factors, rather than addressing each in isolation.

Discussion

Introduction

This chapter reviews findings from five studies on cognitive development and interventions for preschool children with ASD in China. Alongside theories such as Piaget's and Theory of Mind, the influence of social, nutritional, and cultural factors is examined. The discussion highlights key outcomes, proposes improvements to existing programmes and policies, and encourages further research to better support autistic children in the Chinese context.

Cognitive Development and the Impact of Early Intervention

Research over time has consistently shown that timely and appropriate support plays a crucial role in enhancing the development of children with ASD. Zeng et al. (2021) found that combining the TEACCH method with Discrete Trial Teaching led to notable progress in both social engagement and language skills among children. Similarly, Xu et al. (2018) reported that providing eight weeks of intervention resulted in reduced symptom severity and better social functioning in children in China. Drawing on Piaget's theory, it is recognised that children between the ages of two and seven express themselves through symbols, yet often struggle with logical

reasoning and understanding perspectives other than their own (Carey et al., 2015).

Interventions such as ESDM and TEACCH align with this theory by incorporating structured play, language modelling and organised routines to support cognitive development. These programmes also promote Theory of Mind, an area where many children with ASD experience challenges (Carlson et al., 2013). The interventions involve activities that foster joint attention, help children identify their own emotions and those of others, and encourage participation in social exchanges to improve self-awareness and understanding of others. The evidence supports the idea that early and focused intervention can positively influence the developmental trajectories of children with ASD. This conclusion is consistent with Camarata (2014), who emphasised that early identification and intervention greatly increase the chances of improving skills and abilities in children with ASD.

Nutritional Status and its Influence on Cognitive Function

The reviewed literature highlights an increasing emphasis on the relationship between nutritional intake and cognitive functioning in children with ASD. Liu et al. (2016) reported that children with ASD in Chongqing consumed lower levels of vitamin A and macronutrients compared to their typically developing (TD) peers. Findings based on the CARS indicated that these nutritional deficiencies were associated with more pronounced ASD symptoms. In a later study, Zhu et al. (2020) compared data from two Chinese provinces and found that deficiencies in vitamin D, zinc and folate were significantly linked to higher symptom severity and reduced cognitive development scores. These conclusions are consistent with global research indicating that a lack of key micronutrients may hinder neurological and cognitive development. Genovese and Butler (2020) argued that such micronutrients are vital to support early brain functions necessary for cognitive growth. The challenge is compounded when children with ASD experience dietary limitations or selective eating habits, which are common within this population (Liu et al., 2016). These behavioural tendencies, combined with physiological factors, can contribute to nutritional deficits, thereby impeding cognitive progress. This conclusion is supported by Birtwell et al. (2016), who also identified that nutrition-related issues may intensify cognitive impairments in children with ASD. Consequently, nutritional support should be integrated as a fundamental element of early intervention strategies for ASD in childhood.

Comorbidities and Delayed Diagnosis: Barriers to Cognitive Progress

Zhou et al. (2020) provide significant insights into the epidemiological patterns of cognitive functioning in children with ASD in China. Among the 363 cases examined, 68.8% were confirmed to have ASD, with a large proportion also displaying comorbid conditions such as ADHD or intellectual disabilities. Notably, the study revealed that 43.3% of the children were newly identified with ASD during the research, indicating that a substantial number remain undiagnosed during the critical early years of development. Delayed diagnosis poses serious risks to cognitive growth, particularly as synaptic formation and neuroplasticity are most active in the early stages of life, making interventions more effective when implemented before the age of five (Estes et al., 2015). Without early identification, children are more likely to develop secondary behavioural or emotional difficulties due to a lack of support, which can reduce the efficacy of later therapeutic efforts.

Children living in rural or under-resourced areas face additional challenges, as these regions often lack access to qualified professionals and early developmental assessments. Chu et al. (2017) highlighted that in Taiwan, service availability is significantly higher in urban centres compared to rural communities. This discrepancy contributes to delayed intervention, more severe symptom expression and reduced gains from therapy initiated at later stages. These findings align with Christensen (2016), who noted that the presence of co-occurring conditions further complicates cognitive development and increases the difficulty of delivering effective intervention in children with ASD.

Regional Disparities and Socioeconomic Inequities

Research consistently shows that both geographic location and socio-economic status significantly influence access to care and cognitive outcomes in individuals with ASD. Zhu et al. (2020) reported that children with ASD in Chongqing demonstrated weaker cognitive progress compared to those in Hainan, highlighting how regional disparities can affect developmental outcomes. Similarly, Liu et al. (2016) found that children from low-income households consumed fewer essential nutrients, contributing to developmental delays. These observations align with findings by Su et al. (2013), who emphasised that a family's level of education, financial resources and residential setting play a crucial role in timely diagnosis and access to appropriate services. Families in urban areas were generally more aware of ASD and sought early intervention, whereas rural families often misinterpreted symptoms as behavioural problems or delayed treatment until developmental concerns became more serious.

Disparities in access delay diagnosis and reduce the effectiveness of early intervention. Programmes such as TEACCH and ESDM rely on trained professionals, appropriate teaching strategies and active parental involvement, all of which are more readily available in urban environments. Xu et al. (2018) noted that these barriers highlight the need to adapt and scale interventions for under-resourced regions. Their findings stress the necessity of addressing inequalities within healthcare and education systems. Without dedicated efforts to bridge regional and socio-economic gaps, cognitive development differences among children with ASD in China may continue to grow, undermining commitments to inclusive and equitable development as promoted by both national policies and international frameworks.

Alignment with Theoretical Models

The outcomes of the reviewed research align closely with key developmental theories. According to Piaget's framework, the preschool period marks the shift into the pre-operational stage, where children begin to utilise symbolic representation and develop basic language skills. However, in the case of children with ASD, this progression is often delayed or follows an atypical pattern. Structured interventions such as ESDM and TEACCH are designed to offer consistent exposure to language-rich environments and socially engaging activities, which are essential for fostering cognitive development and facilitating advancement through Piagetian stages (Babakr et al., 2019). In addition, the ToM offers a valuable interpretive model for understanding the specific cognitive challenges commonly experienced by children with ASD. Deficits in ToM are frequently associated with limitations in social understanding, empathy and the ability to perceive others' viewpoints. A number of the reviewed studies reported that children who participated in targeted intervention programmes exhibited improvements in social communication and interactive behaviour, indicating progress in areas related to ToM (Beaudoin et al., 2020). These cognitive advancements not only help in alleviating the core symptoms of ASD but also contribute to the child's broader ability to adapt in both educational and social contexts.

Limitations of the Reviewed Research

Despite the contributions of this review, several limitations must be acknowledged. For instance, some studies, including the work by Xu et al. (2018), were preliminary in nature with relatively small participant groups, which constrains the extent to which their findings can be broadly applied. Moreover, most of the interventions reviewed were implemented over relatively short durations—typically between six and eight weeks—leaving a gap in the understanding of long-term cognitive outcomes

following early support. Another notable limitation is the absence of gender-specific analysis. Although ASD is more commonly diagnosed in males, potential differences in cognitive development between sexes were not explored in depth (Zhou et al., 2020). In addition, while the role of nutrition in influencing cognitive development was examined, the underlying biological mechanisms connecting dietary intake and cognitive outcomes in children with ASD remain insufficiently explained and warrant further investigation.

Conclusion

The synthesis of findings from the five reviewed studies indicates that the cognitive development of children with ASD in China is influenced by a wide range of interconnected factors. Structured and early interventions were shown to enhance language acquisition, social functioning and concentration, aligning with established developmental theories. However, the effectiveness of such interventions is often complicated by nutritional deficiencies, disparities in regional healthcare access and the presence of comorbid conditions. These complexities point to the need for an integrated approach in addressing the developmental needs of children with ASD. Achieving equitable cognitive outcomes requires coordinated efforts across multiple sectors, including healthcare provision, nutritional support, caregiver education and policy reform. Moving forward, future research should adopt longitudinal approaches, incorporate data from underserved rural populations and apply diverse methodologies to better understand how to promote cognitive growth in high-risk contexts.

Bibliography

- Babakr, Z. H., Mohamedamin, P., & Kakamad, K. (2019). Piaget's Cognitive Developmental Theory: Critical Review. *Education Quarterly Reviews*, 2(3), 517-524. <http://dx.doi.org/10.31014/aior.1993.02.03.84>
- Beaudoin, C., Leblanc, É., Gagner, C., & Beauchamp, M. H. (2020). Systematic review and inventory of theory of mind measures for young children. *Frontiers in psychology*, 10, 2905. <https://doi.org/10.3389/fpsyg.2019.02905>
- Bentenuto, A., Bertamini, G., Perzoli, S., & Venuti, P. (2020). Changes in developmental trajectories of preschool children with autism spectrum disorder during parental based intensive intervention. *Brain sciences*, 10(5), 289. <https://doi.org/10.3390/brainsci10050289>
- Birtwell, K. B., Willoughby, B., & Nowinski, L. (2016). Social, cognitive, and behavioral development of children and adolescents with autism spectrum disorder. <http://dx.doi.org/10.1093/med/9780199349722.003.0002>
- Blanc, R., Latinus, M., Guidotti, M., Adrien, J.-L., Roux, S., Dansart, P., Barthélémy, C., Rambault, A., Bonnet-Brilhault, F., & Malvy, J. (2021). Early intervention in severe autism: positive outcome using exchange and development therapy. *Frontiers in pediatrics*, 9, 785762. <https://doi.org/10.3389/fped.2021.785762>

- Camarata, S. (2014). Early identification and early intervention in autism spectrum disorders: Accurate and effective? *International Journal of Speech-Language Pathology*, 16(1), 1-10. <https://doi.org/10.3109/17549507.2013.858773>
- Carey, S., Zaitchik, D., & Bascandziev, I. (2015). Theories of development: In dialog with Jean Piaget. *Developmental Review*, 38, 36-54. <https://doi.org/10.1016/j.dr.2015.07.003>
- Carlson, S. M., Koenig, M. A., & Harms, M. B. (2013). Theory of mind. *Wiley Interdisciplinary Reviews: Cognitive Science*, 4(4), 391-402. <https://doi.org/10.1002/wcs.1232>
- Cervantes, P. E., Matson, J. L., Adams, H. L., & Konst, M. J. (2014). The relationship between cognitive development and conduct problems in young children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 8(10), 1287-1294. <https://doi.org/10.1016/j.rasd.2014.06.015>
- Christensen, D. L. (2016). Prevalence and characteristics of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites, United States, 2012. *MMWR. Surveillance summaries*, 65. <http://dx.doi.org/10.15585/mmwr.ss6503a1>
- Chu, C.-L., Chiang, C.-H., Wu, C.-C., Hou, Y.-M., & Liu, J.-H. (2017). Service system and cognitive outcomes for young children with autism spectrum disorders in a rural area of Taiwan. *Autism*, 21(5), 581-591. <https://doi.org/10.1177/1362361316664867>
- Edwards-Jones, A. (2014). Qualitative data analysis with NVIVO. In: Taylor & Francis.
- Estes, A., Zwaigenbaum, L., Gu, H., St. John, T., Paterson, S., Elison, J. T., Hazlett, H., Botteron, K., Dager, S. R., & Schultz, R. T. (2015). Behavioral, cognitive, and adaptive development in infants with autism spectrum disorder in the first 2 years of life. *Journal of neurodevelopmental disorders*, 7, 1-10. <https://doi.org/10.1186/s11689-015-9117-6>
- Genovese, A., & Butler, M. G. (2020). Clinical assessment, genetics, and treatment approaches in autism spectrum disorder (ASD). *International journal of molecular sciences*, 21(13), 4726. <https://doi.org/10.3390/ijms21134726>
- Guthrie, W., Swineford, L. B., Nottke, C., & Wetherby, A. M. (2013). Early diagnosis of autism spectrum disorder: Stability and change in clinical diagnosis and symptom presentation. *Journal of Child Psychology and Psychiatry*, 54(5), 582-590. <https://doi.org/10.1111/jcpp.12008>
- Harstad, E., Hanson, E., Brewster, S. J., DePillis, R., Milliken, A. L., Aberbach, G., Sideridis, G., & Barbaresi, W. J. (2023). Persistence of autism spectrum disorder from early childhood through school age. *JAMA pediatrics*, 177(11), 1197-1205. <https://doi.org/10.1001/jamapediatrics.2023.4003>
- Huang, J. P., Cui, S. S., Hertz-Picciotto, I., Qi, L. H., & ZHANG, X. (2014). Prevalence and early signs of autism spectrum disorder (ASD) among 18-36 month old children in Tianjin of China. *Biomedical and Environmental Sciences*, 27(6), 453-461. <https://doi.org/10.3967/bes2014.008>
- Liu, X., Liu, J., Xiong, X., Yang, T., Hou, N., Liang, X., Chen, J., Cheng, Q., & Li, T. (2016). Correlation between nutrition and symptoms: nutritional survey of children with autism spectrum disorder in Chongqing, China. *Nutrients*, 8(5), 294. <https://doi.org/10.3390/nu8050294>
- Mang'ombe, A., & Wairungu Mathenge, G. (2022). Autism Spectrum Disorder: A review of contemporary literature on common communication difficulties and recommended research-based intervention strategies. *Tanzania Journal of Health Research*, 23. <https://www.researchgate.net/publication/361364936>
- Martin, C. A., Papadopoulos, N., Chellev, T., Rinehart, N. J., & Sciberras, E. (2019). Associations between parenting stress, parent mental health and child sleep problems for children with ADHD and ASD: Systematic review. *Research in developmental disabilities*, 93, 103463. <https://doi.org/10.1016/j.ridd.2019.103463>
- Morales-Hidalgo, P., Roigé-Castellví, J., Hernandez-Martinez, C., Voltas, N., & Canals, J. (2018). Prevalence and characteristics of autism spectrum disorder among Spanish school-age children. *Journal of Autism and Developmental Disorders*, 48, 3176-3190. <https://doi.org/10.1007/s10803-018-3581-2>

- Oono, I. P., Honey, E. J., & McConachie, H. (2013). Parent-mediated early intervention for young children with autism spectrum disorders (ASD). *Evidence-Based Child Health: A Cochrane Review Journal*, 8(6), 2380-2479. <https://doi.org/10.1002/ebch.1952>
- Pasco, G. (2018). The value of early intervention for children with autism. *Paediatrics and Child Health*, 28(8), 364-367. <https://doi.org/10.1016/j.paed.2018.06.001>
- Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., & Koffel, J. B. (2021). PRISMA-S: an extension to the PRISMA Statement for Reporting Literature Searches in Systematic Reviews. *Syst Rev*, 10. <https://doi.org/10.1186/s13643-020-01542-z>
- Stichter, J. P., Riley-Tillman, T. C., & Jimerson, S. R. (2016). Assessing, understanding, and supporting students with autism at school: Contemporary science, practice, and policy. *School Psychology Quarterly*, 31(4), 443. <https://doi.org/10.1037/spq0000184>
- Su, X., Long, T., Chen, L., & Fang, J. (2013). Early intervention for children with autism spectrum disorders in China: A family perspective. *Infants & Young Children*, 26(2), 111-125. <http://dx.doi.org/10.1097/1YC.0b013e3182802006>
- Towle, P. O., Patrick, P. A., Ridgard, T., Pham, S., & Marrus, J. (2020). Is earlier better? The relationship between age when starting early intervention and outcomes for children with autism spectrum disorder: a selective review. *Autism research and treatment*, 2020(1), 7605876. <https://doi.org/10.1155/2020/7605876>
- Van der Fels, I. M., Te Wierike, S. C., Hartman, E., Elferink-Gemser, M. T., Smith, J., & Visscher, C. (2015). The relationship between motor skills and cognitive skills in 4–16 year old typically developing children: A systematic review. *Journal of science and medicine in sport*, 18(6), 697-703. <https://doi.org/10.1016/j.jsams.2014.09.007>
- Wang, J.-G., Cai, K.-L., Liu, Z.-M., Herold, F., Zou, L., Zhu, L.-N., Xiong, X., & Chen, A.-G. (2020). Effects of mini-basketball training program on executive functions and core symptoms among preschool children with autism spectrum disorders. *Brain sciences*, 10(5), 263. <https://doi.org/10.3390/brainsci10050263>
- Xinhua. (2021). Chinese families strive to improve lives of children with autism. <https://en.people.cn/n3/2021/0402/c90000-9835590.html>
- Xu, Y., Yang, J., Yao, J., Chen, J., Zhuang, X., Wang, W., Zhang, X., & Lee, G. T. (2018). A pilot study of a culturally adapted early intervention for young children with autism spectrum disorders in China. *Journal of Early Intervention*, 40(1), 52-68. <https://doi.org/10.1177/1053815117748408>
- Zeng, H., Liu, S., Huang, R., Zhou, Y., Tang, J., Xie, J., Chen, P., & Yang, B. X. (2021). Effect of the TEACCH program on the rehabilitation of preschool children with autistic spectrum disorder: A randomized controlled trial. *Journal of psychiatric research*, 138, 420-427. <https://doi.org/10.1016/j.jpsychires.2021.04.025>
- Zhou, H., Xu, X., Yan, W., Zou, X., Wu, L., Luo, X., Li, T., Huang, Y., Guan, H., & Chen, X. (2020). Prevalence of autism spectrum disorder in China: a nationwide multi-center population-based study among children aged 6 to 12 years. *Neuroscience Bulletin*, 36, 961-971. <https://doi.org/10.1007/s12264-020-00530-6>
- Zhu, J., Guo, M., Yang, T., Lai, X., Tang, T., Chen, J., Li, L., & Li, T. (2020). Nutritional status and symptoms in preschool children with autism spectrum disorder: a two-center comparative study in Chongqing and Hainan Province, China. *Frontiers in pediatrics*, 8, 469. <https://doi.org/10.3389/fped.2020.00469>