

Shaping ASD Pathways: Early PT vs. Late Support for Neurodiversity

Maheshkumar Baladaniya

Sr. Physical Therapist, Neighborhood Physical Therapy PC, New City, NY, USA

*Corresponding author

Maheshkumar Baladaniya, Sr. Physical Therapist, Neighborhood Physical Therapy PC, New City, NY, USA.

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Introduction and Background

Autism Spectrum Disorder (ASD) is one of a several neurodevelopmental disorders, characterized by impaired social and communicative functioning, as well as repetitive and stereotypical patterns of behaviour and interests. Autism Spectrum Disorder (ASD) is characterized by challenges in social interaction, communication, and restricted or repetitive behaviours and interests [1]. ASD affects throughout an individual's lifespan and has a very unique clinical picture due to its associated symptoms, which include hyposensitive or hypersensitive, hyperactivity, concentration and behaviour issues, and emotional, sleep, and mood abnormalities [2]. In the context of ASD, neurodiversity acknowledges that individuals on the autism spectrum have unique strengths, abilities, and ways of perceiving and interacting with the world, which are valuable and should be nurtured and supported. The DSM-5 criteria for ASD include persistent deficits in social communication and interaction, and restricted, repetitive patterns of behaviour, interests, or activities.

Worldwide, the estimated prevalence of individuals diagnosed with ASD is 1 per 100 people, according to Newschaffer and Croen [3]. Numerous research have reported on the rising number of ASD diagnoses [4, 5]. To support children's optimal development and enhance their ability to engage in daily activities and social interactions, early identification and appropriate interventions are necessary as indicated by the increasing prevalence of ASD. PT interventions for ASD focus on improving motor skills, balance, and coordination, which can indirectly support social interaction and communication skills.

In the United States, the average age of diagnosis is less than 3 years old [6]. Although many children with signs of risk for ASD will not be detected or diagnosed by this age, some children can have ASD as early as 14 months of age [7]. By the time the child is 18 months old, the diagnosis was more reliably diagnosed [8].

The Window of Opportunity: The Brain's Plasticity

The dynamic ability of the central nervous system (CNS) to adapt to experience should be before change post injury and alter physically and functionally in response to experience is known as neuroplasticity. This innate malleability is due to cellular, molecular, and genetic processes that affect the development of brain circuits and synaptic connections. The brain's heightened neuroplasticity during early developmental periods, both

prenatally and postnatally, provides a unique opportunity for early intervention in ASD. These times allow for the development and strengthening of experience-dependent neural connections [9].

For children with autism, neuroplasticity is essential to their growth and well-being. Here are some advantages of early interventions in ASD:

Early Intervention: During certain developmental windows, such as the period between birth and two years of age, the period between four and six years of age, and the period around puberty, the brain demonstrates increased plasticity. Applied behaviour analysis (ABA) therapy works best for children with autism spectrum disorder (ASD) when it starts when the child is three or four years old. Neural circuits are more flexible during these crucial times, facilitating improved learning and adaptation [10]. Neural plasticity continues throughout life. Applied Behavior Analysis (ABA), occupational therapy, speech and language therapy, and other interventions all play important roles in comprehensive ASD treatment.

Creating New Pathways: The term "neuroplasticity" describes the brain's capacity to develop new neural pathways as a result of repeatedly engaging in novel routines and activities. Children with autism undergo brain reorganization and the establishment of more efficient neural connections when they participate in activities such as learning to play an instrument or practicing social skills. Better cognitive, social, and behavioural results are achieved through increasing plasticity through repetition and exposure to novel challenges [10, 11].

Improving Learning and Adaptation: Interventions can target improving learning and adaptation skills by utilizing neuroplasticity. Children diagnosed with autism spectrum disorder can rewire certain processes and learn new skills by strengthening and developing connections between their neurons. Intentional attempts to promote plasticity can have a favorable effect on their general growth [11].

Review

Benefits of Early Intervention in ASD

The goal of physical therapy is to enhance physical function, movement, and coordination. Physical therapy seeks to address the unique motor, sensory, and social difficulties faced by people on

the autistic spectrum in the context of early autism intervention The idea that early intervention for ASD is beneficial, particularly when it comes to the important developmental stages of early social and communication skills, is supported by research findings [12].

Physical therapists create individualized intervention plans in close collaboration with people with autism and their families. Autism-related physical therapy interventions might involve a range of methods and activities. Individuals with ASD with autism who receive physical therapy in addition to early autism intervention can have notable improvements in their, motor abilities, and sensory integration. Hyperbaric oxygen therapy (HBOT), a casein-free/gluten-free diet (CF/GF), probiotics, vitamins B6, B9, B12, C, and D, omega-3, play therapy, music therapy, social skills training, sensory integration (SIT), and cognitive behaviour therapy (CBT) are the most successful common therapeutic approaches for people with autism [13-16]. Numerous autism-related symptoms, including those related to the gastrointestinal tract, neurobehavioral disorders, language, social behaviour, and general quality of life, have been observed to improve with these therapies. Various elements of autism are targeted by them, such as reduced social behaviour and communication, DNA mutations, inflammation, and brain hypoperfusion. Specialists need to consider these therapies and evaluate their efficacy to provide comprehensive and individualized treatment for individuals with autism [17].

Based on the literature reviewed for this study, many interventions show promise in reducing symptoms and improving quality of life for individuals with autism. However, the efficacy of these interventions varies, and some studies have produced conflicting results. It's important to note that the effectiveness of interventions can differ significantly among individuals with ASD. This review found that while there is support for various interventions, more research is needed to establish their long-term efficacy and to understand which interventions are most effective for different individuals on the autism spectrum.

Physical therapy for ASD often incorporates various techniques to address different aspects of motor development. General movement (GM) interventions aim to improve overall coordination and body awareness, while seated play (SP) interventions focus on fine motor skills and attention. Dance combines movement with rhythm, potentially enhancing social skills and sensory processing. Trampoline training develops balance, coordination, and vestibular processing. Balance training improves stability and postural control, supporting better motor planning. Fundamental motor skills training develops basic movement patterns crucial for daily activities, potentially enhancing independence. Each of these techniques serves a specific purpose in addressing the motor challenges often associated with ASD, collectively aiming to improve physical functioning, social interaction, and overall quality of life for individuals on the autism spectrum [18-20]. These interventions aim to improve motor skills, communication skills, and social interaction in children with autism spectrum disorder (ASD) [21, 22]. Motor interventions are effective in promoting functional upper and lower body muscle strength in children with ASD. Evaluation methods used in these interventions include the Bruininks-Oseretsky Test of Motor Proficiency, motor skill assessment scales, and Autism Diagnostic Observation Schedule. The practice of physical activity with autistic children is relevant in maintaining and improving their motor skills and communication abilities. Overall, a variety of physical therapy techniques have been utilized to address the specific needs of individuals with autism, with positive outcomes observed in terms of motor and social development.

A study by Abubakar and Kipkemoi emphasized the importance of early screening and intervention in ASD, as it can improve treatment outcomes like improved by early intervention, such as motor skills, social communication, and adaptive behaviours and help individuals with autism thrive [23]. study by Jafar Khan done comparative study with 30 subjects divided into early and late intervention groups found Early intervention for autism spectrum disorder (ASD) is important [24].

The systematic review and meta-analysis by Daniolou et al. found that early interventions for children with ASDs led to positive outcomes in daily living skills and motor skills, which can contribute to a reduction in challenging behaviours [25].

Comparative Analysis of Early vs. Later Interventions Methodology

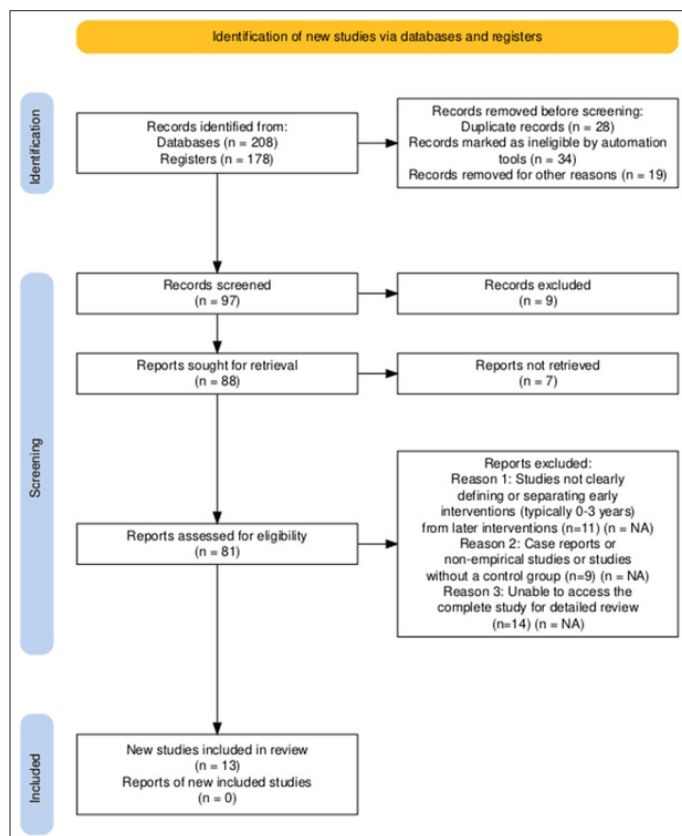


Figure 1: PRISMA flow chart of included studies

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Research Question and PICO

The research question guiding this review was: "What are the benefits of early physical therapy intervention compared to later support for individuals with autism spectrum disorder (ASD)?"

Population: Individuals diagnosed with autism spectrum disorder
Intervention: Early physical therapy intervention (typically before age 5)

Comparison: Later support or intervention (typically after age 5)

Outcomes: Motor skills development, social communication, behavioral improvements, and overall quality of life

Search Strategy

We conducted a comprehensive search of the following electronic databases: PubMed, EMBASE, PsycINFO, CINAHL, and Cochrane Library. The search was performed from inception to April 2024. The following keywords and their combinations were used:

“Autism Spectrum Disorder” OR “ASD” OR “autism”
 AND
 “physical therapy” OR “physiotherapy” OR “motor intervention”
 AND
 “early intervention” OR “early support”
 AND
 “late intervention” OR “later support”

Additionally, we manually searched the reference lists of included studies and relevant review articles to identify any additional eligible studies.

Inclusion Criteria

1. Studies involving individuals diagnosed with ASD
2. Studies comparing early physical therapy intervention (before age 5) with later intervention or support
3. Randomized controlled trials, cohort studies, or case-control studies
4. Studies published in English
5. Studies published in peer-reviewed journals

Exclusion Criteria

1. Case reports, editorials, or opinion pieces
2. Studies not directly comparing early and late interventions

3. Studies focusing solely on interventions other than physical therapy (e.g., pharmacological treatments)
4. Studies with insufficient data to extract relevant outcomes

Study Selection

Two independent reviewers screened the titles and abstracts of all identified studies. Full texts of potentially eligible studies were then assessed against the inclusion and exclusion criteria. Any disagreements were resolved through discussion with a third reviewer.

Data Extraction

Data extraction was performed independently by two reviewers using a standardized form. The following information was extracted: author(s), year of publication, study design, sample size, participant characteristics, intervention details, outcome measures, and main findings.

Quality Assessment

The quality of included studies was assessed using the Cochrane Risk of Bias tool for randomized controlled trials and the Newcastle-Ottawa Scale for non-randomized studies. Two reviewers independently performed the quality assessment, with disagreements resolved through discussion.

Data Synthesis

Due to the heterogeneity of outcome measures and interventions across studies, a narrative synthesis was conducted. Where possible, effect sizes were calculated to quantify the magnitude of the differences between early and late interventions.

Benefits Associated with Early Initiation of PT

Table 1: Summary of Research Findings on Early Intervention Benefits for ASD

Authors	Study	Method	Benefits	Key Findings
Amina Abubakar, Patricia Kipkemoi [23] 23 Jun 2022	-	The authors conducted an overview of reviews to synthesize early intervention literature for very young children at risk for ASD. They aimed to identify which interventions have the strongest evidence base for impact.	Early intervention for autism spectrum disorder (ASD) improves treatment outcomes. Caregiver Skills Training program addresses communication and behavioral problems in ASD.	Early intervention for autism spectrum disorder (ASD) is crucial for better treatment outcomes. There is a lack of research on ASD interventions in low- and middle-income countries (LMICs).
Abubakar Khan, A. Arora [24] 15 Jul 2023-	Comparative study with 30 subjects divided into early and late intervention groups. Study duration of six weeks with pre and post-treatment evaluations conducted	Comparative study with 30 subjects divided into early and late intervention groups. Study duration of six weeks with four training sessions per week	Early intervention for Autism Spectrum Disorder (ASD) is important. The study calls for larger sample sizes and rigorous study designs in future research.	The study found a higher proportion of younger individuals in the early intervention group. There were no statistically significant variations in cognitive ability between the two groups according to the chi-square test.
Sofia Daniolou, Nikolaos Pandis, Hansjörg Znoj [25] 30 Aug 2022	The study investigated the efficacy of early interventions for children with autism spectrum disorders (ASDs). The study included 33 randomized controlled trials (RCTs) with a total sample of 2581 children.	The study conducted a systematic review of randomized controlled trials (RCTs). The meta-analysis was performed using the random effects model.	Early interventions for children with ASDs have positive outcomes for cognitive ability, daily living skills, and motor skills. However, the results should be interpreted with caution due to variability in participant and intervention characteristics.	Early interventions for children with autism spectrum disorders (ASDs) led to positive outcomes for cognitive ability, daily living skills, and motor skills. No positive outcomes were found for receptive language, adaptive behavior, and expressive language.

Clay Brites [26] 05 Mar 2022	-	Early intervention is the best treatment for Autism Spectrum Disorders (ASD). Specific methods and approaches can improve core signs of ASD.	Early intervention in Autism Spectrum Disorders (ASD) improves core signs. It helps preserve cognitive aspects, IQ size, language, and emotional self-regulation.	Early intervention is the best treatment for improving core signs of autism. Specific methods and approaches can help preserve cognitive aspects, language, and emotional self-regulation.
T. Mary Minolin, M Benjamin Sagayaraj, Raakhee Vijayaraghavan [27] 21 Oct 2022-	The study focuses on the effectiveness of evidence-based nursing intervention on ASD children. The intervention includes the use of the picture exchange communication system (PECS) and parent-implemented intervention (PII).	Sixty ASD children were selected and assigned into control and experimental groups. For six months, the experimental group underwent evidence-based treatment using PII and PECS.	Evidence-based intervention improves socialization, communication, and quality of life in ASD children. Picture exchange communication systems (PECS) and parent-implemented intervention (PII) are effective strategies.	PECS and PII intervention improved socialization, communication, and quality of life in ASD children. Significant differences were observed between the experimental and control groups in the post-test.
Francesca Cucinotta, Luigi Vetri, Liliana Ruta, Laura Turriziani, Loredana Benedetto, Massimo Ingrassia, Roberta Maggio, Eva Germanò, Rosamaria Siracusano, Michele Roccella, Antonella Gagliano [28] 01 Sep 2022-	The study compared the impact of different early interventions on toddlers with autism spectrum disorder. The results showed that the Early Start Denver Model intervention was more effective in improving developmental profiles.	A retrospective chart review study Compared the impact of different types of early interventions on toddlers with autism spectrum disorder	Early intervention can reduce the severity of autism symptoms in toddlers. The Early Start Denver Model intervention is more effective in improving developmental profiles.	Early intervention can reduce the severity of autism symptoms in toddlers. The Early Start Denver Model intervention is more effective for improving developmental profiles.
S Nela Maksimovic, Masa Marisavljevic, Nina Stanojević, Milica Ćirović, Silvana Punišić, Tatjana Adamović, Jelena Đorđević, Miško Subotić [29] 01 Jan 2023-	The study focused on the effect of early intervention on reducing autistic symptoms and speech-language deficits in children with Autism Spectrum Disorder. The study sample consisted of 29 children diagnosed with ASD who received integrative therapy.	The study used the GARS-3 questionnaire to assess autistic symptoms. The ESLD subscale was used to evaluate speech and language development.	Early intervention reduces autistic symptoms in children with ASD. Age at the start of treatment does not significantly affect speech-language development.	Early intervention is more effective in reducing autistic symptoms. No significant effect of early intervention on speech-language abilities.
Michel Godel, François Robain, Nada Kojovic, Martina Franchini, Hilary Wood de Wilde, Marie Schaefer [30] 22 Jun 2022-	The Early Start Denver Model (ESDM) approach was used to provide two years of care for preschoolers with autism. The study examined the developmental trajectories of these children. Finding early markers of responsiveness to intervention was the study's main goal.	Cluster analysis was used to identify subgroups based on cognitive trajectories. For clustering, two variables were used: the composite DQ at baseline and the composite DQ SPC during the two-year intervention period. For young autistic children, early intervention greatly improves developmental outcomes.	Early intervention significantly improves developmental outcomes in young children with autism. Close monitoring during the first 6 months of intervention can predict treatment response.	Children with mild cognitive delay at baseline showed good developmental outcomes. Children with severe cognitive delay had two different patterns of response to intervention: significant improvement or modest improvement.
Andrea McGlade, Koa Whittingham, Jacqui Barfoot, Roslyn N. Boyd [31] 10 Apr 2023	The study is a systematic review and meta-analysis. It assesses the effectiveness of very early therapies for young children who are diagnosed with autism or who are at higher risk of developing the disorder.	Systematic review and meta-analysis conducted Eight databases searched for relevant studies	Very early interventions have limited impact on neurodevelopmental outcomes by age 3 years. Clinician-assessed outcomes did not show significant treatment effects for autism symptomatology, cognitive outcome, receptive language, or expressive language.	Very early interventions for infants and toddlers with autism have limited impact on neurodevelopmental outcomes by age 3 years. Clinician-assessed outcomes did not show significant treatment effects for autism symptomatology, cognitive outcome, receptive language, or expressive language.
Rebecca Landa [32] 14 Mar 2018	-	The review focuses on efficacy studies published within the past 15 years. The review discusses the neurodevelopmental context for early intervention and primary intervention approaches.	Young children with autism spectrum disorders (ASD) benefit from early intervention. Parent-coaching intervention helps parents implement child-responsive engagement strategies.	Young children with autism spectrum disorders (ASD) benefit from early intervention. Combining parent-mediated and direct clinician-implemented intervention maximizes child developmental gains.

Allison S. Nahmias [33] 10 May 2018	The study is about the effectiveness of community-based early intervention for children with autism spectrum disorder. The results of the study showed modest but statistically significant improvements in social, cognitive, communicative, and adaptive functioning.	Systematic search was used to identify studies of community-based early intervention for children with ASD. Changes in cognitive, communication, and adaptive functioning assessments were used using standardized mean gain scores.	Community-based early intervention programs for children with autism spectrum disorder (ASD) show small but statistically significant gains in cognitive, communication, social, and adaptive functioning. Programs associated with universities and hospitals are more effective for cognitive and adaptive behavior outcomes.	Community-based early intervention programs for children with autism spectrum disorder (ASD) show small but statistically significant gains in cognitive, communication, social, and adaptive functioning. When it comes to improving cognitive and adaptive behavior outcomes, EI programs connected to universities and hospitals do better than other community-based initiatives.
Eid G. Abo Hamza and Ahmed A. Helal [34] 22 Oct 2018	The study tests the effectiveness of an integrated training program for early intervention. The study shows positive effects on modifying stereotyped behavior patterns.	Utilizing an experimental strategy with control and experimental groups. Three-time interval assessments (pre, post, and follow-up).	The integrated training program based on Applied Behavioral Analysis (ABA) has a positive effect on modifying stereotyped behavior patterns. The positive effect is observed in the post-assessment and the first follow-up assessment.	The integrated training program based on ABA was effective in modifying stereotyped behavior patterns. The positive effect of the intervention program was observed in the post-assessment and first follow-up assessment.
Lorna French, Eilis Kennedy, Eilis Kennedy [35] 01 Apr 2018-	The study is a systematic review of early interventions for autism spectrum disorder (ASD). The review identified 48 randomized controlled trials (RCTs) evaluating 32 different intervention models.	The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards. A literature search was conducted using PubMed and PsycINFO databases.	The review aims to identify the evidence base for early intervention in ASD. Only a small number of studies had a low bias risk rating.	Only 12.5% of the included studies were rated as low risk of bias. Long-term follow-up is important for assessing the sustained effects of interventions.
María Magán-Maganto [36] 01 Dec 2017-	The study focuses on early detection and intervention of Autism Spectrum Disorder (ASD). It aims to analyze the impact of screening procedures and provide a European framework for early intervention programs.	The review analyzes the impact of screening procedures and intervention programs. It discusses the effectiveness of comprehensive treatment models and focused intervention practices.	Early detection and intervention of Autism Spectrum Disorder (ASD) can lead to improved quality of life for children with ASD and their families. Early screening programs can help identify children with ASD at an early age and reduce the age of diagnosis.	High-intensity comprehensive treatments and focused intervention practices have positive intervention results. Early intervention programs for ASD in Europe are based on models developed in other regions.

Communication Skills

A systematic review and meta-analysis by Sofia Daniolou et al. found that early interventions led to positive outcomes for cognitive ability, daily living skills, and motor skills in preschool children with ASDs [25]. Early intervention in autism spectrum disorder (ASD) can be effective in enhancing communication skills in children [26-28].

Studies focused on early intervention in children with ASD and found that starting treatment at an early age can lead to a reduction in autistic symptoms and language deficits [29-36]. Yu et al. concluded that ABA-based interventions can have a positive effect on socialization, communication, and expressive language in children with ASDs [37]. Warren et al., Makrygianni et al., and Reichow et al. concluded that early intervention is efficient in improving the language and adaptive behavior of children with ASDs [38].

Strong Social Skills Development

Strong social skills are a crucial aspect of development, and research has shown that early intervention programs can significantly improve them in children with autism spectrum disorders (ASDs). Studies by Rogers, Warren, Makrygianni, and others demonstrate the effectiveness of programs like the Early Start Denver Model (ESDM) and early intensive behavioural intervention (EIBI) in enhancing social communication skills [39, 40]. Studies by Rogers,

Warren, Makrygianni, and others demonstrate the effectiveness of programs like the Early Start Denver Model (ESDM) and early intensive behavioural intervention (EIBI) in enhancing social communication skills [40, 41]. These interventions focus on building foundational skills like joint attention and symbolic play, which are essential for social interaction.

Further research by Reichow and Kasari et al. strengthens the connection between early intervention and social development in children with ASDs [42, 43]. Their studies explore the positive impact of parent-mediated interventions like JASPER (Joint Attention, Symbolic Play, Engagement, and Regulation) and PRT (Pivotal Response Treatment) on social communication skills [44]. These programs empower parents to actively participate in their child's development, fostering stronger social connections.

The evidence from Dawson and Oono et al. solidifies the importance of early intervention for social skills in children with ASDs [45, 46]. Their findings highlight the effectiveness of comprehensive programs like ESDM, particularly those grounded in applied behaviour analysis (ABA) principles. Early intervention not only equips children with vital social skills but also offers long-term benefits for their overall development and social integration.

Reduced Challenging Behaviours

Research by Kakoura and Driga highlighted the use of digital

tools as a good practice for differentiated teaching and inclusion of students with Autism, which can help in reducing challenging behaviours [47]. Another study by Khan and Arora conducted a systematic review and meta-analysis comparing the efficacy of early intervention and late intervention for individuals with ASDs. Although the timing of intervention did not strongly influence the distribution of challenging behaviours, early intervention is widely recognized as crucial for improving outcomes in individuals with ASDs and they explored the neurodevelopmental context of early intervention for ASD and discussed various therapeutic approaches [48]. The Early Start Denver Model (ESDM) was highlighted as an evidence-based early intervention approach, which can contribute to reducing challenging behaviours [48].

Improved Learning Potential

Strong social skills are a crucial aspect of development, and research has shown that early intervention programs can significantly improve them in children with autism spectrum disorders (ASDs). These interventions focus on building foundational skills like joint attention and symbolic play, which are essential for social interaction.

Challenges and Limitations of Later Interventions

Research indicates that individuals who receive an ASD diagnosis at age 12 or later often experience more severe mental health challenges compared to those diagnosed earlier. This later diagnosis is associated with a higher prevalence of co-occurring psychiatric conditions, potentially due to years of unaddressed ASD-related difficulties and accumulated stress. According to a recent study, adults with an adult diagnosis of autism are almost three times more likely than those with a childhood diagnosis to report having psychiatric disorders [49].

An increasing body of research has attempted to characterize the traits of children who are identified with autism later on, as the objective of timely diagnosis has been pursued in many health systems. The goal of this type of investigation is to find risk factors for late diagnosis that can be utilized to adjust treatment, and it can also demonstrate how much a late diagnosis can reflect a period when a kid has unmet clinical requirements [50].

Later interventions for ASD, while still beneficial, face several specific challenges and limitations compared to early intervention. These include reduced neuroplasticity, more ingrained behavioural patterns, missed developmental milestones, and an increased risk of secondary mental health issues. Individuals diagnosed later may have accumulated significant educational and social gaps, and may face limited access to age-appropriate services. Additionally, family involvement in treatment may be reduced in later interventions. Despite these challenges, it's important to note that tailored interventions can still provide significant benefits for individuals diagnosed later in life, albeit potentially requiring more intensive and specialized approaches to address these accumulated difficulties. While later interventions for autism spectrum disorder (ASD) can still be beneficial, they face several challenges and limitations as we discussed above, compared to early intervention [51, 52].

Effects on Emotion and Psychology

A late autism diagnosis can be a double blow to self-esteem and social connection. Struggling to understand how autism relates to their past and facing new social expectations can lead to anxiety, sadness, and isolation. However, with supportive therapy and a new understanding of themselves, individuals can begin to navigate these challenges.

Developmental Delays

A late autism diagnosis can significantly impact an individual's development across various domains. Previously unrecognized delays in speech, motor skills, and even daily living skills like budgeting and housekeeping may become apparent. This lack of early intervention can have lasting consequences, as the brain's natural ability to adapt (neuroplasticity) weakens with age. As a result, interventions implemented later in life may be less effective in promoting positive changes in neural pathways compared to early childhood.

These developmental challenges can extend to career prospects. Individuals with a late diagnosis may struggle to find suitable employment due to difficulties adjusting to workplace dynamics. Additionally, missed opportunities for early skill development, particularly in areas like language and social interaction, can limit their potential for significant improvement.

Future Directions and Recommendations

Access and equity in early intervention physical therapy for individuals with autism can be hindered by several barriers. One common barrier is the geographical distribution of families, with non-metro/rural areas experiencing shorter delays in accessing services compared to metro/urban areas [53]. Another barrier is the lack of awareness and accessibility of organized physical activity programs, as reported by caregivers [54]. Autistic individuals may also face intrapersonal, interpersonal, environmental, and policy barriers to physical activity participation, which can vary depending on the context [55]. Additionally, patient-provider communication, sensory sensitivities, and executive functioning/planning issues can act as barriers to accessing physical healthcare for autistic individuals [56]. To overcome these barriers, strategies such as improving knowledge and attitude, creating a systematic support system, implementing rehabilitation policies, developing comprehensive autism rehabilitation management programs, and facilitating access to services can be employed [57].

Effective early intervention for autism can face several challenges and barriers. These include difficulties in embedding the intervention into daily activities, discomfort when practicing intervention strategies, struggles with scheduling sessions, and limited access to early intervention services in low-resource contexts [58, 59]. Geographic distribution can also impact the timeliness of intervention, with non-metro/rural areas experiencing shorter delays than metro/urban areas [60]. Additionally, parent characteristics, such as motivation and alignment of goals and outcomes, can influence the implementation of intervention strategies [61]. To address these challenges, it is important to provide support and resources to help parents integrate intervention strategies into their daily routines. Task-sharing approaches, where non-specialists are trained to deliver interventions, can help increase access to early intervention services [62]. Further research is needed to evaluate the effectiveness of different implementation strategies and to develop feasible and scalable interventions that can be integrated into existing systems of care. However, there is a need for larger sample sizes and rigorous study designs to provide more robust evidence [63]. Additionally, there is a global disparity in who participates and benefits from intervention research, highlighting the need for more research strategies to bridge the implementation gap. Overall, early interventions and education are essential for improving outcomes and maximizing the potential of individuals with autism.

Conclusions

The findings of this study highlight several significant advantages of early intervention physical therapy for individuals with autism spectrum disorder (ASD):

Early intervention physical therapy for individuals with ASD offers several significant advantages. These include improved gross and fine motor skills, enhanced sensory integration, increased social interaction, and better non-verbal communication. Early PT interventions also contribute to reducing challenging behaviours, increasing independence in daily activities, and potentially improving cognitive function. Importantly, these early interventions set a strong foundation for continued development, leading to better long-term outcomes. By addressing physical and motor challenges early, PT helps children with ASD build crucial skills that support their overall development and quality of life.

These advantages underscore the importance of initiating physical therapy interventions as early as possible for children with ASD. By initiating physical therapy services at an early age, children with ASD can experience substantial improvements in motor skills, functional abilities, and overall developmental trajectories. The data demonstrate that children who received early intervention physical therapy before the age of 3 exhibited superior outcomes compared to those who began therapy at a later stage. Early intervention not only facilitated the acquisition of foundational motor skills but also fostered improved communication, social interaction, and adaptive behaviours. Furthermore, the early intervention group showed better long-term retention of acquired skills, suggesting a more profound impact on neural plasticity and learning processes during the critical developmental windows of early childhood. This finding underscores the importance of timely interventions to capitalize on the heightened neuroplasticity of the developing brain.

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