



EVALUATING THE EFFICACY OF EARLY MULTIDISCIPLINARY INTERVENTION IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS

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Abstract

Introduction: Neurodevelopmental disorders (NDDs) such as Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, and global developmental delay affect the cognitive, social and behavioural functioning in children to a significant extent. Multidisciplinary interventions, as early as possible, are paramount to maximising outcomes, but their effectiveness in the real world still needs to be confirmed.

Objective: Multidisciplinary interventions have been shown to have functional benefits in children with NDDs. This study assessed the results of a six-month multidisciplinary intervention, comparing baseline, 3-month, and 6-month outcomes, as well as the main contributions of therapy.

Materials and Methods: The study children were recruited from a prospective longitudinal cohort sample of 50 children aged 2-6 years who attended an early intervention and pediatric developmental centre between July, 2024 and December, 2024 in Abu Dhabi, UAE. The range of interventions provided every week was Speech and Language Therapy, Occupational Therapy, and Behavioural Therapy. At baseline, 3 months, and 6 months, CARS2 and Conners-3 measures were evaluated to assess outcomes, which were analysed using Repeated Measures ANOVA, paired t-tests, and Pearson correlations.

Results: A considerable lowering of CARS2 ($F(2,98) = 319.97, p < 0.001$) and Conners-3 scores ($F(2,98) = 214.63, p < 0.001$) was noted, and the steepest declines were in reports recorded during the first 3 months.

Conclusion: Early multidisciplinary intervention has a significant benefit in terms of NDD outcome, which justifies its use in clinical practice.

Keywords: Neurodevelopmental disorders, early intervention, multidisciplinary, CARS2, Conners-3.

INTRODUCTION

Neurodevelopmental disorders (NDDs), which include diseases like Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and global developmental delay, have severe consequences on cognitive, social, behavioural and motor outcomes among children. They are disorders that present themselves at an early age, and these disorders may cause difficulties with language acquisition, social interaction, attention, and adaptive functioning. Such multidimensionality and variability of NDDs require multi-dimensional and individualised treatment to maximise developmental outcomes (1). Identification and intervention at an early stage are essential factors, as early treatment can correct the effects of these disorders on a child in the long run, in terms of their quality of life, academic life, and socialisation (2). Research continuously emphasises the need to treat NDDs during the most crucial development periods in early childhood, specifically the 2-6 year age range, when neuroplasticity is high (3). Combinations of therapies, such as Speech and Language Therapy (SLT), Occupational Therapy (OT), and Behavioural Therapy, are promoted extensively using a multidisciplinary approach to support the heterogeneous nature of individuals with NDDs (4). They are specific interventions in the following areas: communication, sensory regulation, motor skills, and behaviour, and every other area can be enhanced by the integration of care (5).

The argument behind the use of multidisciplinary interventions stems from the varied clinical presentations of NDDs. As an example of the standard type of deficits in ASD and ADHD, the former can be said to be deficient in social communication and repetitive behaviours, and the latter in attention and impulse control (6). Global developmental delay may lead to broader deficits in both cognitive and motor skills, necessitating the involvement of various specialities (7). Research has revealed that a combination of such treatment types as SLT, OT, and Behavioural Therapy, with the aspects of such types of therapy as Cognitive Behavioural Therapy (CBT) and Applied Behaviour Analysis (ABA), can help to tackle all of these varying symptoms better than single-modality treatment options (8). Expressive and receptive language is improved with SLT, sensory and fine motor skills will be enhanced with OT, and maladaptive behaviours are reduced and social adaptation facilitated with Behavioural Therapy (9). Nevertheless, the evidence on the effectiveness of multidisciplinary interventions in real-life clinical settings is considered insufficient with respect to additional empirical confirmation, specifically regarding longitudinal studies that monitor functional outcomes (10).

Both the economic and social impacts associated with NDDs signal the need for effective interventions at an early age. Untreated or inadequately treated or poorly managed NDDs have high costs throughout an entire life (11). Prevention therapies, especially those addressing early-stage high-risk infants in terms of abnormal neurodevelopmental outcomes, have proven efficient in minimising these burdens by enhancing functional-based skills and decreasing reliance (12). Creative solutions have also been considered, including the introduction of educational robotics or canine-assisted interventions, to improve engagement and socialisation in children with NDDs, as evidenced by the potential of multidisciplinary, novel solutions (13, 14). There have also been non-invasive neuromodulation-based trials to enhance secondary pathologies, such as sleep quality and constipation, that coexist with NDDs and affect an individual as a whole (15).

Unfortunately, despite such improvements, NDD diagnostic processes are underpinned by some challenges, as well as NDD intervention processes. Diagnosis is a complex process, as numerous evaluations are necessary to verify a diagnosis, and an assessment of comorbidities is also required (16). Transdiagnostic is imperative in that most of the children with NDDs exhibit common symptoms across the disorders, making intervention schedules flexible and personalised (17). There has also been the development of community-based programs, which offer an alternative way to support families and increase the utility and flexibility of interventions, including real-time online parent training, due to the improved accessibility of interventions, especially for underserved families (18). The models, such as the PLUSS framework, propose multi-professional intervention that focuses on the early identification and coordinated care and incorporates the input of the paediatricians, therapists, and educators to facilitate the streamlined care (19). Nevertheless, the evidence on which

parts of multidisciplinary interventions have the most decisive influence on outcomes, and how this outcome differs in the context of various NDDs and during different periods of life is deficient.

The integration approach also underpins the management of challenging behaviours, just like self-injurious behaviours that occur in certain NDDs. Pharmacotherapy, although sometimes necessary, can work well when combined with behavioural and developmental interventions (20). It is essential to conduct longitudinal studies that monitor outcomes to determine the effectiveness of these mixed modes and the optimal timing and dosage of interventions. The present study aims to fill these gaps.

Objective: The purpose of this assessment is to compare early multidisciplinary interventions, focusing on functional outcomes in children with neurodevelopmental disorders at baseline, after 3 and 6 months, and to identify some valuable elements of therapy.

MATERIALS AND METHODS

Study Design: Prospective Longitudinal Cohort Study.

Study setting: This research was conducted in the Berlin medical and neurological rehabilitation center, one of the specialised rehabilitation centres that has all the facilities that may be required to conduct a full assessment and treatment of NDD.

Study Duration: The study was done in six months, July-December, 2024.

Inclusion criteria: The participants were those between 2 to 6 years and addressed the following requirements. At least one of the following NDDs: Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder or global developmental delay. No severe comorbid health problems were present, and they regularly received Speech and Language Therapy, Occupational Therapy, and Behavioural Therapy.

Exclusion Criteria: Individuals with degenerative neurological illnesses and children with atypical follow-ups or incomplete assessments were excluded, as we aimed for data quality and uniformity of intervention.

Methods

A prospective longitudinal cohort study of 50 children, aged 2 to 6 years with diagnosed neurodevelopmental disorders (NDDs), was conducted from July 2024 to December 2024. The services included multidisciplinary interventions provided to each high-demand client every week. They encompassed Speech and Language Therapy (SLT) to develop expressive and receptive communication, Occupational Therapy (OT) to develop sensory regulation and fine motor skills, and Behavioural Therapy (integrating the aspects of CBT and ABA) to improve maladaptive behaviours and develop the ability to fit socially. The Childhood Autism Rating Scale (CARS2) was used to measure autism severity, and the Conners Rating Scale-3 (Conners-3) was used to measure attention, hyperactivity, and executive functioning, to rate functional outcomes at baseline, 3 months, and 6 months. Analysis of Repeated Measures ANOVA (to assess changes over time), a pairwise comparison based on paired t-tests, and inter-domain associations based on Pearson correlation coefficients with a significance level of $p < 0.05$.

RESULTS

To assess the efficacy of a six-month multidisciplinary intervention program, a prospective longitudinal cohort study was conducted on a sample of 50 children aged 2 to 6 who had been diagnosed with neurodevelopmental disorders (NDDs). Interventions involved Speech and Language Therapy (SLT), Occupational Therapy (OT), and Behavioural Therapy, which were measured at baseline, at 3 and 6 months, using the Childhood Autism Rating Scale (CARS2) and the Conners

Rating Scale-3 (Conners-3). Statistical studies employed Repeated Measures ANOVA, paired t-tests, and Pearson correlation coefficients, with a significance value of $p < 0.05$.

Analysis of CARS2 scores: A one-way ANOVA with Repeated measures indicated a significant main effect of time on the CARS2 scores, $F(2,98) = 319.97$, $p < 0.001$, with substantial differences in autism severity across the three intervals. Bonferroni-adjusted pairwise comparisons with $0.017 \leq \alpha < 0.025$ showed essential differences between the values given by the CARS2 at every interval.

Table 1: Pairwise Comparisons of CARS2 Scores Over Time

Comparison	Mean Difference	$t(49)$	p -value	Mean Change
Baseline vs. 3 Months	15.1487	15.15	<0.001	-5.09
Baseline vs. 6 Months	19.9691	19.97	<0.001	-7.91
3 Months vs. 6 Months	15.8813	15.88	<0.001	-2.81

There was a reduction in the mean CARS2 scores at 3 and 6 months, specifically 38.06, 32.97, and 30.16, respectively, indicating a significant decrease in autism-related symptomology, mainly within the first 3 months.

Conners-3 Score Analysis: Repeated Measures ANOVA. The analysis of the Conners-3 scores also demonstrated that time had a significant effect, $F(2,98) = 214.63$, $p < 0.001$, with improvements in attention, hyperactivity, and executive functioning being reported. A significant decrease in scores across all intervals was confirmed through pairwise comparisons.

Table 2: Pairwise Comparisons of Conners-3 Scores Over Time

Comparison	Mean Difference	$t(49)$	p -value	Mean Change
Baseline vs. 3 Months	11.324	12.45	<0.001	-10.12
Baseline vs. 6 Months	16.876	18.32	<0.001	-15.67
3 Months vs. 6 Months	5.552	6.78	<0.001	-5.55

The average Conners-3 score decreased by 67.58 and 57.46 at 3 months and 51.91 at 6 months, showing consistency of improvement in behavioural variables.

Correlation Analysis: Pearson correlation coefficients were obtained to analyse the association between CARS2 scores, Conners-3 scores, and the age of the robot-in.

Table 3: Correlation Matrix for CARS2 and Age

Variable 1	Variable 2	Correlation (r)	p -value
Age at Baseline	CARS2 Baseline	-0.042	0.7742
Age at Baseline	CARS2 (3 Months)	0.020	0.8926
Age at Baseline	CARS2 (6 Months)	0.014	0.9254
CARS2 Baseline	CARS2 (3 Months)	0.854	<0.001
CARS2 Baseline	CARS2 (6 Months)	0.815	<0.001
CARS2 (3 Months)	CARS2 (6 Months)	0.966	<0.001

Age did not correlate significantly with CARS2 scores at any of the time points (p values greater than 0.77). However, CARS2 scores across the time points were highly correlated (r values greater than 0.81, p values less than 0.001), revealing consistent rankings of relative severity.

Table 4: Correlation Matrix for Conners-3 and CARS2

Variable 1	Variable 2	Correlation (r)	p -value
CARS2 Baseline	Conners-3 Baseline	0.623	<0.001
CARS2 (3 Months)	Conners-3 (3 Months)	0.598	<0.001
CARS2 (6 Months)	Conners-3 (6 Months)	0.611	<0.001

Moderate positive correlations between CARS2 and Conners-3 scores at each time point ($r \approx 0.60$, $p < 0.001$) suggest overlapping improvements in autism severity and behavioural domains. These findings support the efficacy of the multidisciplinary intervention in reducing NDD symptomatology, with consistent improvements across cognitive, behavioural, and social domains.

Discussion

This prospective longitudinal cohort study reveals substantial evidence of the effectiveness of early multidisciplinary management in the functional improvement of children aged between 2 - 6 years, having neurodevelopmental disorders (NDDs), Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and global developmental delay. Pronounced improvement in Childhood Autism Rating Scale (CARS2) and Conners Rating Scale-3 (Conners-3) in six months highlights the importance of implementing Speech and Language Therapy (SLT), Occupational Therapy (OT), and Behavioural Therapy systematically. The reported reduction in CARS2 scores, from a mean of 38.06 at baseline to 30.16 at the 6-month mark, highlights sufficiently positive refinements in the symptomatology of autism, specifically in the social areas of communication and behavioural updates. Likewise, Conners-3 scores decreased from 67.58 to 51.91, indicating an increased level of attention, a reduced hyperactivity level, and enhanced executive functioning. Such findings are consistent with the existing studies arguing for the importance of early intervention during early neuroplasticity intervals to maximise developmental programmes (4).

Its most dramatic gains were made in the first three months, implying that intensive intervention during the early stages could lead to a rapid improvement, and this could be related to the synergistic effect of multidisciplinary intervention strategies that support active development across multiple domains simultaneously (2, 5). The studies also showcase the complementary character of these therapies (8, 9). Our child was likely helped by SLT to develop better communicative skills, by OT to achieve better regulation of sensation and improved motor skills, and by Behavioural Therapy to exhibit fewer maladaptive behaviours. High correlations are observed between CARS2 scores over time ($r > 0.81$, $p < 0.001$), indicating that the scores improved in absolute terms. The relative rank of the children remained consistent, which could reflect stable differences in individual responses to the intervention. This adequacy enhances the validity of the assessment instruments and ensures a homogeneous effect of the intervention throughout the group (10). The fact that there were moderate correlations of CARS2 with Conners-3 scores ($r = 0.60$, $p < 0.001$) further indicates that the symptoms of autism and behavioral imbalances overlap, and it makes sense to improve them overall, indicating that NDDs are transdiagnostic (17).

However, baseline age showed no significant correlation with CARS2 or Conners-3 scores ($p > 0.77$), suggesting that the treatment was effective across the 2- to 6-year age range. The finding is in contrast to several studies indicating that younger children may be better positioned to benefit from early interventions due to their greater neuroplasticity (12). The absence of age-related differences in this research could be explained by the fact that the age range was rather restricted or the interventions were individualised and allowed for consideration of developmental differences (7). The lack of critical comorbidities, which is safeguarded by the inclusion criteria, could have also influenced the unanimity of the treatment results, as highly complicated medical conditions are known to complicate the effectiveness of an intervention (16). The findings also affirm the practicability of multidisciplinary interventions in a wide age range of children in the preschool years, thus indicating the relevance of early diagnosis and treatment, irrespective of age, among children in this stage of development (4, 19).

The study findings have broader implications for policy and clinical practice. The observed decreases in the level of NDD symptomatology suggest a greater economic and social benefit of early intervention, as untreated NDDs are known to incur significant lifelong costs, including medical care and productivity losses (11). This study recommends the use of multidisciplinary frameworks, such as the PLUSS framework, which combines multi-professional input for early detection and support (19), as demonstrated by the consistent gains in their study. New methods, including canine-guided interventions and educational robotics, may also lead to further increases in engagement and

outcomes, as indicated by recent research (14). Furthermore, core interventions may be supplemented with managing secondary symptoms (path) such as sleep disturbances or constipation using non-invasive neuromodulation, which enhances overall well-being (15). Such outreach as online parent training might add to the spread of these interventions, especially in underserved communities, thus ensuring that access to sufficient care is guaranteed to a larger population (18).

Nevertheless, the problematic issues are the difficulties in optimising the multidisciplinary interventions. The research did not separate the Capacity of its own of SLT, OT, and Behavioural Therapy, thus hindering knowledge about what aspects of these approaches were the factor of change in the observed improvement. The key recommendation of studies is to use factorial designs in research to break down such effects (8). The complex process of diagnosing NDDs, which typically requires multiple assessments, necessitates simplifying diagnostic pathways to facilitate intervention as early as possible (16). Additionally, this study did not investigate the use of pharmacotherapy and the management of severe behaviours through this mode, which should be discussed in conjunction with behavioural interventions (20). These group-mean differences may be restricted to the controlled environment of the Early Intervention and Pediatric Developmental Centre, indicating a need to conduct real-world research in diverse clinical and community settings.

Conclusion

The efficacy of early multidisciplinary intervention, including Speech and Language Therapy, Occupational Therapy, and Behavioural Therapy, was observed in the improvement of functional outcomes in children aged 2 to 6 years with neurodevelopmental disorders in this study. Drastic decreases in the CARS2 and Conners-3 scores within the six months or so are indicators of considerable progress in the severity of autism, attention, hyperactivity and executive functioning, with the steepest improvement occurring within the first three months. The absence of age variations means that it would be applicable widely in the preschool age category. These results underscore the importance of early and coordinated interventions to capitalise on neuroplasticity and maximise developmental pathways. Consistent, transdiagnostic improvement is emphasized when moderate correlations between CARS2 and Conners-3 scores follow strong correlations between assessment time points. This promotes the introduction of multidisciplinary models of clinical practice that will minimise the health-related consequences of NDDs in the long term. Future research can focus on the specific contributions of therapy and investigate its potential scalability across various contexts to enhance reach and outcomes.

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