Parent-Implemented Early Start Denver Model

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder that can cause difficulties in communication and social interaction. Naturalistic developmental behavioral interventions (NDBIs) have been tested by clinical trials of behavioral treatments. NDBIs integrate developmental and relationship-based approaches with applied behavioral analysis (ABA) strategies and are implemented in the child's day-to-day environment, including in play and routine activities where many learning opportunities can be embedded. Among evidence-based practices, the Early Start Denver Model (ESDM) is a representative approach to NDBIs. In addition, ESDM follows comprehensive NDBI principles, grounded in developmental and behavioral science and neuroscientific evidence.

autism spectrum disorder fidelity parent-implemented Early Start Denver Model

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that can cause difficulties in communication and social interaction. Children with ASD may maintain the presence of restricted interests and repetitive behaviors ^[1]. Furthermore, evidence suggests that reliable diagnosis of children with ASD can be made before the age of 2 years ^[2]. An emphasis on very early intervention in several reviews suggests the importance of effective early intervention which may relate to greater possibility of children's learning and progress ^[3]. Accordingly, early intervention is key and leads to better outcomes in shaping the child's developing brain and is especially crucial for young children with social and developmental disabilities ^{[4][5]}.

Early intervention research for ASD has increased dramatically in the past decade. Naturalistic developmental behavioral interventions (NDBIs) have been tested by clinical trials of behavioral treatments ^{[5][6][7][8][9]}. NDBIs integrate developmental and relationship-based approaches with applied behavioral analysis (ABA) strategies and are implemented in the child's day-to-day environment, including in play and routine activities where many learning opportunities can be embedded ^{[10][11][12]}. In many interventions, natural reinforcement strategies are used which focus on the child's choices and rewards closely related to the learning activities ^[13].

Among evidence-based practices, the Early Start Denver Model (ESDM) is a representative approach to NDBIs. In addition, ESDM follows comprehensive NDBI principles, grounded in developmental and behavioral science ^{[14][15]} and neuroscientific evidence ^[16]. Based on ABA and developmental psychology, ESDM is a comprehensive early intervention that aims to reduce the severity of ASD symptom and emphasize in the development of cognitive, social, emotional, and language abilities ^{[4][17][18]}. The model was designed for use with children aged 18–48 months and features a manualized curriculum divided into four levels ^[19], each of which targets different

developmental areas. Moreover, by emphasizing natural environments and positive relationships to promote children's learning outcomes, ESDM acknowledges that parents are best placed to implement early interventions in the home setting [3][18][20][21].

Grounded in Bronfenbrenner's ^[22] ecological systems theory, the theoretical framework indicates that multiple levels of the child's environment influence child development. The microsystem is the smallest system in which relationships between the child and parent are constructed ^[23]. Parents play a crucial role in the early interventions provided to young children with disabilities, helping foster the child's growth and development ^[24]. Parenting a child with autism can be rewarding but also challenging ^{[25][26][27]}. Furthermore, research underscored that parents of children with ASD consistently reported lower levels of parenting-related anxiety, stress, or depression ^{[5][28]}. Indeed, many studies on NDBIs have focused on evaluating the effects of early intervention when delivered by parents. Recent studies have demonstrated that ESDM intervention strategies can be implemented by parents to maximize learning opportunities in daily activities and bridge service gaps; this intervention is known as parent-implemented ESDM (P-ESDM) ^{[15][28]}. Several studies have revealed that (a) parents can learn to implement the intervention techniques with fidelity and (b) doing so results in a range of improvements in child outcomes ^{[7][8][14]} ^{[29][30]}. Thus, research recommended that parents can plausibly incorporate naturalistic techniques into daily routines in order to accelerate the maintenance and generalizability of treatment gains ^{[31][32]}.

P-ESDM is an evidence-based structured approach that teaches parents ESDM techniques such as gaining the child's attention and motivating them, promoting dyadic engagement and joint activity routines, enhancing verbal and nonverbal communication, and incorporating play skills ^[26]. To determine whether improvements in the child's development result from corresponding changes in the techniques of parent's interaction, one must take parent's use of the intervention strategies into account ^[33]. Treatment fidelity is defined as "the methodological strategies used to monitor and enhance the reliability and validity of behavioural interventions" ^[34] (p. 139). The treatment fidelity is considered acceptable for an adherence of 80% or more ^[35]. However, the role of treatment fidelity relates to child intervention response needs further investigation ^[36]. Thus, measuring treatment fidelity is crucial for clarifying this relationship.

2. Parent-Implemented Early Start Denver Model for Children with Autism Spectrum Disorder

ESDM is an evidence-based intervention integrating ABA principles ^[37]. To address the need for an evidence base that includes research methods evaluating effectiveness, researchers included interventional studies in this entry. All 13 research articles in this entry reported using a quantitative research design, including three that used a multiple-baseline across subjects design ^{[5][38][39]} and one that adopted a single-case nonconcurrent alternating-treatment design ^[40]. Of the group studies, one was a nonrandomized controlled trial ^[12], four were randomized controlled trials ^{[15][28][41][42]}, and three used a quasi-experimental one-group pretest–posttest design ^{[3][16][17]}.

Table 1 provide a summary of each study's (a) child characteristics, (b) intervention intensity and duration, (c) child outcome measures, and (d) parent-related outcome measures and results on parent fidelity.

Table 1. Summary of child characteristics, type of study design, outcome measures, and results of parent fidelity of the included studies.

	Title 2				Intervention	Outcom	e Measures	Parent	
Study N		Age (MOS)	Diagnosis	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest)	
Abouzeid et al. (2020) [17]	10	18– 45	Clinical diagnosis of ASD	Quasi- experimental one-group pretest- posttest	3 h/wk for 13 wk	No information	 Satisfied or highly satisfied Positive perceptions of the relationship between the coach and their family 	53% → 61%	
Estes et al. (2014) ^[28]	49 (int.) 49 (TAU)	12– 24	At risk of ASD	Randomized controlled trial	1 h/wk for 12 wk	No information	 P-ESDM group reported no increase in parenting stress whereas community group increased. P-ESDM did not differ in their sense of competence compared to the community group 	No scores but were analyzed using videotape	
Hernandez- Ruiz (2018) [<u>18</u>]	3	30– 36	At risk/clinical diagnosis of ASD	Quasi- experimental one-group pretest- posttest	0.5 h/wk for 10 wk	No information	Two of the mothers seemed to feel more competent	No information	

	Title 2				Intervention	Outcom	e Measures	Parent	
Study	Ν	Age (MOS)	Diagnosis	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest)	
							 Parent's perception of their child's social skills modified 		
							 Decreasing from moderate distress to no distress 		
							 The intervention was culturally and developmentally appropriate, enjoyable, and promoted interaction 		
Hernandez- Ruiz (2020) [<u>40</u>]	1	48	Clinical diagnosis of ASD	Single-case, nonconcurrent alternating- treatment design	1 h/wk for 12 wk	Improvement in nonverbal responsiveness and initiation of joint attention	Parents seemed capable and found value in learning strategies from professionals that they could implement at home.	52–58% → 80% (linear)	
Malucelli et al. (2021) [43]	9 (int.) 9 (TAU)	29– 42	Clinical diagnosis of ASD	Randomized controlled trial	2 h/wk for 12 wk	Learning rate in different areas (except imitation) showed significant differences between two groups	Descriptive information was provided by the researchers regarding the high agreement of observation in 10- min videos of parent-child interaction	No information	
Rogers et al. (2012) [<u>15</u>]	49 (int.)	12– 24	At risk of ASD	Randomized controlled trial	1 h/wk for 12 wk	Improvement in both groups; no significant	 P-ESDM group did not exhibit 	P-ESDM group had large effect size (0.57) compared	

	Title 2				Intervention	Outcome	Parent	
Study	Ν	Age (MOS)	Diagnosis	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest)
	49 (TAU)					differences related to group assignment were noted	significantly higher P-ESDM fidelity scores than the community treatment group. • Parents receiving ESDM coaching exhibited stronger working relationships with their primary therapist than parents receiving community intervention	with the community intervention group's moderate effect size (0.37)
Rogers et al. (2019) (41)	45	12– 30	At risk/clinical diagnosis of ASD	Randomized controlled trial	1.5 h/wk for 12 wk	Significant developmental acceleration; child outcomes did not differ by group	 P-ESDM++ group exhibited significantly increased sensitivity and skill compared with the parents in the P-ESDM group Parents in the enhanced group exhibited 	3.4 → 3.8 (maximum of 5.0)

	Title 2				Intervention Outcom		e Measures	Parent	
Study	Ν	Age (MOS)	Diagnosis	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest)	
							significantly greater improvement in interaction skills than parents in the control group • Parents were extremely satisfied with the intervention		
Vismara et al. (2012) 381	9	16– 38	Clinical diagnosis of ASD	Single-subject multiple- baseline design	1 h/wk for 12 wk	Children's social- communicative behaviors increased significantly, as indicated by three independent data sources	 Parental responsivity, affect, and achievement- oriented behaviors increased during intervention Parents gave positive ratings on a feasibility and acceptability questionnaire 	2.62 → 4.29 (maximum of 5.0)	
Vismara et al. (2013) 39	8	18– 45	Clinical diagnosis of ASD	Single-subject multiple- baseline design	1.5 h/wk for 12 wk	Use of functional verbal utterances, joint attention initiations(eye gaze alternation, i.e.,	 Parent engagement increased during intervention and follow-up 	6 of 8 parents achieved fidelity (80%) on the ESDM fidelity scale during intervention and 7 of 8 parents during follow-up.	

N (MOS	e S) Diagnosis	Study Design	and Duration	Child giving, showing, or pointing), and receptive and expressive language increased during intervention and follow-up	Parent Parents gave positive ratings on a satisfaction survey • Posttreatment,	Fidelity (Pretest → Posttest
	[<u>12]</u>			giving, showing, or pointing), and receptive and expressive language increased during intervention and follow-up	 Parents gave positive ratings on a satisfaction survey Posttreatment, 	[<u>17]</u>
	[<u>12</u>]				• Posttreatment,	[<u>17</u>]
14 (int.) 18– 10 48 TAU)	Clinical diagnosis of ASD [<u>1</u>	[<u>28]</u> [<u>5</u>] Randomized controlled trial	1.5 h/wk for 12 <u>火</u> 約 [<u>46</u>]	[12][15][No treatment effect for children's social communication behaviors	36% of parents in the P-ESDM group compared with 20% of parents 17][28][38][39][41][42] in the commun[44] treated group achieved fidelity • Parents in the P-ESDM group used the website more often and with higher satisfaction][43] 0% → 36% of P- ESDM parents achieved fidelity [3]
4 18– 48	- fragile X syndrome	Single-subject multiple- baseline	1.5 h/wk for 12 wk	Standardized composite scores increased for all but one child	 Parent fidelity increased Three out of four parents rated the intervention and coaching 	below 4.00 → above 4.00 (maximum of 5.0)
: (ii T	14 nt.) 18– 10 48 AU) [47] 4 18– 48	14 Clinical diagnosis 10 48 of ASD [1] AU) of ASD [1] [47] fragile X 4 18– fragile X 48 syndrome 900 01 the fragile X 48 syndrome	14 18- Clinical diagnosis controlled trial of ASD controlled trial of ASD [1][45] 10 48 of ASD [1][45] [47] 4 18- fragile X single-subject multiple-baseline 4 18- fragile X single-subject multiple-baseline	14 18- Clinical diagnosis of ASD controlled trial of ASD [1][45] 1.5 h/wk for 12 v/k for 12 v/k for 12 v/k [47] [46] 4 18- fragile X single-subject multiple- baseline 1.5 h/wk for 12 wk 900 01 100 1.5 h/wk for 12 v/k for 12 wk	14 nt.) 18- 48 Clinical diagnosis of ASD Randomized controlled trial 1.5 h/wk for 12 wk (a6] effect for children's social communication behaviors [47] 4 18- 48 fragile X syndrome Single-subject multiple- baseline 1.5 h/wk for 12 wk for 12 wk Standardized composite scores increased for all but one child	 Clinical diagnosis of ASD (1)(45) AU) AU) AU) Clinical diagnosis of ASD (1)(45) Controlled trial of ASD (1)(45) Controlled trial (46) Clinical diagnosis of ASD (1)(45) Controlled trial (46) Controlled trial (46) Controlled trial (46) Parents in the P-ESDM group used the website more often and with higher satisfaction Fragile X syndrome Single-subject multiple-baseline Single-subject multiple-baseline Standardized composite scores increased for all but one child Three out of four parents rated the intervention and coaching Controlled the intervention and coaching

outcomes, were analyzed.

Six research articles reported measures for child behavioral functioning and development ^{[5][12][15][38][39][41]}. These measures were assessed using a variety of instruments, including the MCDI ^[48]; MSEL ^[49]; Vineland Adaptive Behavior Scales ^[50]; PATH CC ^[51]; Griffiths Development Scales, Chinese version ^{[52][53]}; and Child Behavior Rating Scale ^[54]. All six research articles reported significant improvements over time after the P-ESDM intervention. However, two of the three group studies ^{[12][38][43]} reported no differences in child outcomes between groups.

		Title 2			Intervention	Outcom	e Measures	Parent	[<u>3][5][12][15]</u>
[<u>18] Study</u> [40][42]] N	Age (MOS)	Diagnosis	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest	jiveness,
							experience		research
							positively		ig group
[<u>15</u>]	[<u>42</u>]						Parents also reported		ocial and
				[4	<u>43]</u>		improvement of		er Model
							children's		
							and usage of		
			[<u>12][15][41</u>]				communicative		DOS ^{[<u>44</u>].}
							gestures and		
							words		
							All five mothers		
							gave the		varanting
							intervention		arenting
							positive ratings		yzed.
							Treatment		
		[<u>3][12][15][17][</u>	<u>18][39][40][41][42]</u>		All mothers	Acceptability		tisfied or
			At	Quasi-		mentioned	Rating Scale-	No information	naires or
et al.	5	23– 59	risk/clinical diagnosis	experimental one-group	1 h/wk for 12 wk	improvements in spoken	Revised.	(only reported four of the mothers	eptability
(20200)			of ASD	posttest		nonverbal	Four mothers	improved)	shington,
	[<u>41</u>]					communication	commented on		
							the positive		
							personal		<u>s [28][42]</u>
							qualities and		ov Short
[56]						[57]	the trainer.	[2][[1]7]	ex-Short
<u>00</u>]						[<u>37</u>]			positive
Zhou et al	23	18_	Clinical	Nonrandomized	1.5 h/wk	Neither group	Parents in the P-	[5][38][39] No information	positive
(2018) ^[12]	(int.) [5] ²⁰ (TAU)	30	diagnosis of ASD	controlled trial	for 26 wk	exhibited significant change in ASD severity, but	ESDM group experienced decreased parenting stress,	No momutor	1 by the
						the P-ESDM group exhibited	but those in the [5][5][15][17][28][38][3] intervention group	<u>9][40][41][42]</u>	neasures

included the ESDM Fidelity Rating System ^[19] and the P-ESDM Fidelity Tool ^[56]. All these research articles reported improvements in interaction skills over the 12-week period of the P-ESDM. However, most of the parents in only 50% of the studies ^{[3][38][39][40][42]} achieved the standard benchmark (at least 80% at posttest) for acceptable fidelity using the ESDM.

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Study		Title 2		Intervention Outcom		e Measures	Parent	an
	Ν	Age (MOS) ^{Diagnosis}	Study Design	and Duration	Child	Parent	Fidelity (Pretest → Posttest))
					improvement in social affect	exhibited an opposite trend.		

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