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Effectiveness of An Early Intervention Model for Children with Autism and Family Outcomes: A Repeated Measurement Study

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Abstract: The study examined evaluated the effects of an early intervention model based on the principles of Naturalistic Developmental Behavioral Intervention (NDBI) on young children with autism spectrum disorder (autism) and family outcomes in China. The sample (n = 60) mean age was 4.8 years old (SD = 1.1) in the study. Children in the treatment group received the culturally adapted intervention 3 hours per day, 15 hours per week. Children in the control group received publicly funded intervention services for 3 hours per day, 15 hours per week, for a total of 8 weeks. Findings showed a decrease in autism symptoms and improved severity categorization for children in the intervention group. Also, there were positive changes in the treatment group's parental stress and anxiety levels. Discussion and implications for culturally responsive early intervention are discussed.

Keywords: Autism; Early intervention; Culturally responsive

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1. Introduction

Autism Spectrum Disorder (autism) is a neurodevelopmental condition characterized by challenges in social communication, repetitive behaviors, and restricted interests (American Psychiatric Association, 2013). Recent prevalence estimates indicate that one in 36 children might get a diagnosis in the United States. Given the large population of China, there are a great number of Chinese children with neurodevelopmental disorders [1]. Early intervention improves outcomes for children with autism, in areas such as language development, social skills, and adaptive behavior [2,3]. However, evaluating the long-term effectiveness of these interventions presents unique challenges. Below, we highlight the necessity of repeated measurements in intervention research by examining existing studies on autism interventions and their impact over time.

1.1. Early intervention in China

In China, many intervention service providers adopt the traditional Applied Behavior Analysis (ABA) approach and claim to be delivering interventions with scientific rigor [4]. Recently, naturalistic developmental and behavioral interventions have been widely investigated and have been widely investigated and reported with promising outcomes in areas such as social communication, language, play, adaptive skills, and cognitive skills [5]. The teaching opportunities occur in a child's natural environment, daily routines, or during other motivating interactions to promote the generalization and maintenance of new skills in natural settings.

While the reviews have predominantly reported positive findings in the research on NDBIs, few studies have investigated how these interventions can be culturally adapted while maintaining impacts on child and family outcomes. Due to constraints in qualified personnel and families' capacity to pay for intensive intervention services in China, there is an urgent demand to adapt evidence-based practices like NDBIs to the cultural context [6,7]. Treatment interventions must be efficient, minimizing training and professional effort, be affordable for society and families, and maximize intervention effects [8]. In this context, it is necessary to develop and investigate a culturally responsive early intervention program based on the principles of NDBI to maximize the acquisition, maintenance, and generalization of meaningful skills across settings.

Recent efforts have been made in developing intervention programs that are inspired by the NDBI programs. For example, Xu and her colleagues conducted a pilot study to evaluate a culturally adapted intervention program influenced by the Early Start Denver Model (ESDM), a specific type of NDBI program [8]. While these pilot studies demonstrated a decrease in autism symptoms and improved severity categorization in the intervention group, compared with children in the control group, the intervention is only administered 1 hour per day for 5 days and may not be sufficient for children with more severe symptoms. It is important to further explore other intervention options based on the NDBI principles.

1.2. The RICE model

To address these needs, the RICE model was developed based on the NDBI principles, cultural considerations, and strengths and limitations of other programs. The RICE model was developed upon the four fundamental premises:

(1) "R" for relationship-centered, that the intervention goals should primarily target social communication and relationship building;
(2) "I" for individualization, the learning objectives should be individualized based on assessment results and not one-size-fits-all;
(3) "C" for comprehensive, the curriculum should address both the strengths and limitations across the core developmental domains, and integrate comprehensive services and support to meet the needs of individual children;
(4) "E" for engagement, therapists and family members should collaborate as equal members of a team in a child's early intervention program.

1.3. Current study

The RICE module was developed in 2018 and has been implemented in 30 centers serving thousands of young children with autism and their families in China. However, no empirical study has been conducted to evaluate to whether this culturally adapted intervention model could replicate the effects of the NDBI. This study evaluated the efficacy of the RICE model on both child and family outcomes, and here are the research questions:

(1) To what extent was there a mean difference over time (i.e., pre, post, and follow-up) in the severity of autism symptoms of young children with autism, based on the type of early intervention model (NDBI-inspired RICE model vs. traditional ABA approach)?
(2) To what extent was there a mean difference over time in the mental well-being of parents of young children with autism, based on the type of early intervention model?

2. Method

2.1. Research design

This study used a quasi-experimental design with a non-equivalent control group. Participants who received the target intervention for 8 weeks, while the control group received a low-intensity intervention funded by the government. This study was approved by the research ethics committee at a University in Southeastern China.

2.2. Participants

2.2.1. Treatment group

The treatment group participants were recruited from two early intervention centers where the RICE model has been implemented since 2018. The two centers were located in two coastal metropolitan cities in eastern China. Initially, a total of 30 children (26 boys and 4 girls) were recruited, and their parental consent was obtained, but later, 7 children in the treatment group withdrew from the study, leaving 23 children in the post-test.

2.2.2. Control group

The control group participants (n = 30) were recruited from one government-subsidized early intervention service in a suburban city in Northeastern China. The average age of children in the control group was 4.7 years (SD = 1.2), is no statistical difference from the treatment group. The treatment group and control group children were similar in their age of autism diagnosis, gender ratio, and percentage of minority ethnicity, as well as the marital status of the parents.

2.3. Intervention program

Children in the treatment group attended centers where the RICE model was fully installed. In these centers, a child upon enrolment was first assessed with a curriculum-based tool called “Social Ladder Assessment” to identify individualized learning objectives. The child will then participate in the intervention for 3 hours a day, 5 days a week. The eight RICE-trained therapists in the study were native Chinese speakers who received six weeks of intensive RICE training and passed the qualification exam on the eight core NDBI practices. After qualification, these therapists were evaluated and coached weekly throughout the 8 weeks to ensure implementation fidelity. During the intervention phase, four supervisors conducted fidelity checks for 80% of the sessions using a fidelity measure adapted from NDBI-Fi [9]. The measure included a general session that evaluated whether the therapists are using the core NDBI principles (e.g., following the child’s lead and modeling appropriate language). All therapists met the fidelity standard. Meanwhile, parents of children in the treatment group were trained to carry out the generalization component in the RICE model at home and in the community.

Control group participants attended a publicly funded autism intervention center for 3 hours a day, 5 days a week. At this center, children participated in 1:1 traditional APA approach therapy for 30 minutes a day. In the rest of 2.5 hours, children received large group social skill training. The therapists at this publicly funded center received basic training of the ABA approach to intervention and with minimal clinical supervision from the program supervisor. The RICE model has not been introduced to this center, and the center staff have not received any training on NDBI practices.

2.3.1. Measures

Measures included standardized caregiver and clinician-rated tools assessing autism severity, parental stress, and anxiety.

2.3.2. The primary child measures were the ATEC and CARS (CARS)

The CARS is a behavioral rating scale used for the diagnosis of autism and the evaluation of autism symptom severity as well as to distinguish diagnoses between autism and other developmental disabilities and to evaluate the severity of autism [10]. The CARS has shown good psychometric properties in the Chinese population for children more than 2 years old, with a positive rate of 97.7%, a reliability coefficient of .74, and the prediction validity coefficient of .5 with the Chinese version of Autism Behavior Checklist (ABC), and .57 with the Chinese version of Autism Treatment Evaluation Checklist [11].

2.3.3. Zung self-rating anxiety scale (SAS)

The Zung SAS is a self-reported scale with 20 items examining a variety of anxiety symptoms, such as physiological symptoms (e.g., "I get upset easily or feel panicky".) and somatic symptoms (e.g., "I get numbness and tingling in my fingers and toes".) [12]. A four-point scale ranging from 1 as none or rarely to 4 as most or all of the time is used to rate each item. Participants were asked to respond based on their experiences over the last week. Items describing positive experiences (e.g., "I fall asleep easily and get a good night's rest".) were reverse-coded to ensure higher total scores indicate more severe anxiety symptoms. Evidence in the literature indicates satisfactory internal consistency of the SAS with a Cronbach's alpha of .82 and a sensitivity of 89% [13,14]. In the study, Cronbach's α coefficient was .84.

2.3.4. Parenting stress index-short form (PSI)

The PSI is a 36-item measure completed by parents of children 3 months to 10 years of age, designed to assess parental stress. Each item is rated on a 5-point scale (from "Strongly Disagree" = 0 to "Strongly Agree" = 5). The PSI yields a total stress score and subscale scores across three factors: parental distress, parent–child dysfunctional interaction, and difficult child characteristics. Example statements include, "I feel trapped by my responsibilities as a parent", and "I feel that my child is moody and easily upset". The PSI has good test–retest reliability (ICC = 0.77) and internal consistency [15]. This measure was used to differentiate among subtypes of stress, including stress related to child behavior and interactions, as well as stress related to the parents' internal emotional state.

2.4. Data analysis

We first summarized the demographic characteristics of both the intervention and control groups, and then we conducted *t*-tests or chi-square tests to compare the baseline variables between the intervention and control groups, which helped determine if the groups were equivalent before the intervention. Then we conducted the descriptive analysis of the three time points between treatment and control groups.

3. Baseline characteristics

Children's and parents' demographic information and characteristics at entry measured by the four target measures are presented in **Table 1**. As shown in **Table 2**, in the follow-up comparison, differences were observed between the treatment and the control groups for the child outcomes. Specifically, the treatment group showed a greater improvement ([SE] = 0.36[0.11], $t = 32.3$, $p < .001$, d = 0.62) based on the overall ATEC score. Similarly, improvements were noted in specific subscales of the ATEC score between the treatment and control groups: speech/language communication ([SE] = 0.67[0.21], $t = 34.2$, $p < .001$, d = 0.74), sociability ([SE] = 0.55[0.20], $t = 29.2$, $p < .001$, d = 0.64), sensory/ cognitive awareness ([SE] = 0.72[0.30], $t = 35.4$, $p < .001$, d = 0.69), health/physical/behavior of ATEC score ([SE] = 0.38[0.07], $t = 25.7$, $p < .001$, d = 0.38). Similarly, we also observed a difference between the treatment and control group for the CARS measure ([SE] = 0.64[0.05], $t = 0.05$, $p < .001$, d = 0.29).

Table 1. Descriptive analysis of the sample

Variables n (M)		Treatment group		Control group		Whole sample	
		% (SD)	n (M)	% (SD)	n (M)	% (SD)	
Child age (M, SD)		4.9	1.1	4.7	1.2	4.8	1.1
Child gender	Female	4	13.3	3	10.0	7	11.7
	Male	26	86.7	27	90.0	53	88.3
Ethnicity	Minorities	1	3.3	2	6.7	3	5.0
	Han	29	96.7	28	93.3	57	95.0

Table 1 (Continued)

Variables n (M)		Treatment group		Control group		Whole sample	
		% (SD)	n (M)	% (SD)	n (M)	% (SD)	
Age Autism diagnosis (year) (M, SD)	0–2	4	13.3	3	10.0	7	11.7
	2.1–4	24	80.0	25	83.3	49	81.7
	4.1–6	2	6.7	2	6.7	4	6.7
Mother's age (M, SD)		37.9	9.2	35.1	7.0	36.4	8.2
Paternal education	High school	3	20.0	7	23.3	25	41.7
	College	6	20.0	19	63.3	10	16.7
	Graduate or higher	21	70.0	4	13.3	25	41.7
Marital status	Single	2	6.7	3	10.0	5	8.3
	Married	28	93.3	26	86.7	54	90.0
	Prefer not to say	0	0.0	1	3.3	1	1.7
Family income (RMB/year)	250–300K	29	96.7	0	2.2	29	48.3
	200–250K	1	3.3	0	2.2	1	1.7
	150–200K	0	7.1	28	93.3	28	46.7
	100–150K	0	28.6	2	6.7	2	3.3

Table 2. Descriptive comparisons of the outcome variables by treatment and control groups

Outcome variables	Treatment			Control			Baseline, *p*
	Pre test (M, SD)	Post test (M, SD)	Follow up (M, SD)	Pre test (M, SD)	Post test (M, SD)	Follow up (M, SD)	
Child outcome							
ATEC overall	63.3 (10.1)	54.6 (11.4)	53.6 (8.4)	66.2 (11.1)	67.6 (11.2)	68.6 (9.1)	< .001
ATEC speech/ language/ communication	18.9 (5.7)	14.0 (5.9)	13.5 (5.5)	18.1 (5.2)	19.4 (5.1)	20.2 (3.1)	.501
ATEC sociability	16.2 (2.5)	13.2 (2.8)	13.0 (2.4)	16.8 (2.6)	15.2 (2.3)	16.1 (1.4)	.392
ATEC sensory/ cognitive awarness	15.1 (2.1)	12.5 (2.7)	12.5 (2.2)	17.1 (2.1)	16.1 (2.4)	15.8 (1.3)	< .001
ATEC health/physical/behavior	14.7 (1.6)	13.3 (1.6)	13.8 (1.9)	15.7 (1.6)	16.7 (1.2)	17.2 (1.8)	< .001
CARS overall	35.6 (6.4)	30.8 (6.7)	31.6 (6.9)	38.6 (5.4)	36.8 (6.2)	39.8 (5.8)	< .001
Parental outcomes							
SAS_Overall	53.4 (6.1)	46.6 (5.7)	45.6 (5.8)	55.4 (6.4)	52.6 (5.5)	54.6 (4.6)	< .001
PSI__Overall	101.1 (11.7)	95.4 (9.1)	94.2 (8.5)	105.1 (8.7)	106.8 (8.1)	106.8 (7.9)	< .001

Note. ATEC = Autism Treatment Evaluation Checklist; CARS = Childhood Autism Rating Scale; SAS = Self-Rating Anxiety Scale; PSI = Parent Stress Index.

This study also identified improvement for the parent outcome measures (**Table 3**). In the pre-post comparison, there was an improvement in the treatment group ([SE] = 0.16[0.05], t = 9.5, p = .002, d = 0.73) for the SAS overall score. The largest effect was seen in the PSI overall score, where the treatment group showed a coefficient of 1.62 (SE = 0.12, t = 17.3, p = .001, d = 0.49). In the follow-up comparison, there was an improvement in the treatment group ([SE] = 0.21[0.04], t = 12.3, p < .001, d = 0.78) for the SAS overall score. The largest effect was seen in the PSI overall score, where the treatment group showed a coefficient of 1.95 (SE = 0.21, t = 13.4, p < .001, d = 0.51).

Table 3. Results for repeated measures of child and family outcomes

Outcomes	Pre-post comparison					Pre-follow up comparison				
	b	SE	*t*-value	p	d	b	SE	t-value	p	d
Child outcomes										
ATEC_overall	0.31	0.05	36.3	< .001	0.65	0.36	0.11	32.3	< .001	0.62
ATEC_speech/language/communication	0.65	0.11	36.2	< .001	0.71	0.67	0.21	34.2	< .001	0.74
ATEC_sociability	0.51	0.1	28.6	< .001	0.61	0.55	0.20	29.2	< .001	0.64
ATEC_sensory/cognitive awareness	0.64	0.1	40.8	< .001	0.67	0.72	0.30	35.4	< .001	0.69
ATEC_health/physical/behavior	0.34	0.07	25.7	< .001	0.33	0.38	0.07	25.7	< .001	0.38
CARS_overall	0.83	0.05	2.87	.011	0.37	0.64	0.05	2.77	< .001	0.29
Parental outcomes										
SAS_overall	0.16	0.05	9.5	.002	0.73	0.21	0.04	12.3	< .001	0.78
PSI__overall	1.62	0.12	17.3	.001	0.49	1.95	0.21	13.4	< .001	0.51

Note. ATEC = Autism Treatment Evaluation Checklist; CARS = Childhood Autism Rating Scale; SAS = Self-Rating Anxiety Scale; PSI = Parent Stress Index. SE= Standard Error. All the models used the following control variables: child age, gender, minority status, parent education, marital status, and family incomes, and the baseline assessment of the target measures.

4. Discussion

This study examined the use of repeat measurements to evaluate the effect of a culturally adapted NDBI intervention, the RICE model, for young children with autism in China. The gains in subscales such as speech/language communication, sociability, and sensory/cognitive awareness imply that early interventions can be effective in improving communication and social skills, key areas that children with autism often struggle This shows early therapeutic strategies can target specific developmental challenges. Findings are supported by Rogers and Dawson, who noted that early interventions such as the ESDM lead to improvements in communication and social engagement in young children [16]. Moreover, Yoder et al. highlighted that early language interventions, such as focused play-based therapy, can significantly enhance communication skills in toddlers with autism. The current study's results confirm that early, targeted interventions can address these specific developmental challenges, further emphasizing the importance of customized therapy approaches.

The fact that differences between treatment and control groups were also observed in follow-up comparisons implies that the benefits of early intervention are sustained over time. This has long-term implications for how early therapy might reduce the need for more intensive support as children age, possibly reducing the severity of autism symptoms in the future. Prior studies have shown that early therapy's benefits extend into later childhood. For example, a meta-analysis by Peters-Scheffer et al. found that children who received early behavioral interventions maintained developmental gains over time, reinforcing the idea that early intervention has lasting effects.

Significant improvements in parent outcome measures indicate that early interventions not only benefit the child but also improve parental mental health and reduce stress. This is critical, as the well-being of parents can influence the overall family dynamics and the child's long-term progress. Moreover, studies such as those by Bonis suggest that early intervention positively impacts not just the child but also the family's overall well-being by alleviating the emotional and psychological burden on parents. These findings align with this literature, highlighting that early autism interventions benefit not only the child but also the entire family unit.

The findings have substantial policy implications, advocating for widespread early screening and intervention access. Studies such as those by Johnson and Myers emphasize the importance of early autism screening, which can lead to earlier

diagnosis and quicker access to services. The study's results could contribute to refining existing autism intervention models by demonstrating that early, intensive, and targeted interventions yield substantial developmental gains.

In conclusion, this study contributes to the growing body of evidence that early intervention is critical for improving outcomes in young children with autism. The improvements observed in communication, sociability, and sensory awareness, along with the sustained long-term benefits and positive impacts on parental stress, underscore the importance of early, targeted interventions. This study reinforces the need for accessible intervention programs and refined therapeutic models that address the specific needs of children with autism.

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