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Effectiveness of a home-based, post-discharge early intervention program for very preterm infants in reducing parental stress: a randomized controlled trial

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Abstract

Background This study aims to evaluate the impact of a home-based, post-discharge early intervention (EI) program on reducing parental stress levels in families with preterm infants born between 28^{+0} and 31^{+6} weeks gestational age.

Methods A randomized controlled trial was conducted, with families randomly allocated to either the EI or standard care (SC) group. A term reference group was also recruited for comparison. The Parental Stress Index-Short Form was used to assess parental stress levels, yielding a total stress score and three subdomain scores. Assessment was performed at baseline, at the 60-day mark of the study, and when the infants reached six corrected months of age. Parents in the reference group were assessed only at six months of corrected age for infants. The intervention comprised three sections: intellectual, physical, and social training, which was administered to the infants in the EI group immediately after discharge and to those in the SC group after 60 days of enrollment.

Results Seventy-three families were enrolled in this study, with 37 allocated to the EI group, and 36 to the SC group. Prior to intervention, higher stress levels were reported by mothers in both groups than fathers, with no difference observed between the EI and SC groups. Re-assessment performed at 60 days of the study showed that mothers and fathers in the EI group had significantly lower total stress score than those in the SC group (82.00 ± 5.64 vs. 94.26 ± 7.99, $p < 0.001$; 80.74 ± 7.14 vs. 89.94 ± 9.17, $p < 0.001$, respectively), which was predominantly due to the lower scores in parental distress and parental-child dysfunction interaction subdomains in the EI group (both had $p < 0.001$). Mothers in the EI group exhibited a more pronounced reduction in total stress score after intervention when compared to fathers (13.15 ± 4.68 vs. 8.26 ± 4.03, $p < 0.001$). At six months of infant age, the total stress score and subdomain scores of parents in the EI and SC groups were similar, but significantly higher than those of the reference group.

Conclusion The home-based, post-discharge EI program demonstrated significant effectiveness in reducing parental stress levels among the parents of very preterm infants.

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Trial registration This study was registered in the Chinese Clinical Trial Registry (registration number: CTR1900028330). Registration date: December 19, 2019.

Keywords Early preterm infants, Early intervention, Parental stress, Follow-up

Introduction

The birth of a newborn often brings about a significant amount of stress for new parents, encompassing the transition to parenthood and the responsibilities that come with it. However, if the newborn is born very prematurely and requires intensive care, it can furtherly heighten this stress due to the added uncertainty of the infant's clinical condition, potential for longer hospital stays, and increased risk of neurosensory complications or behavioral problems [1, 2]. Studies have indicated that parents of preterm infants in the intensive care unit (NICU) are more likely to report greater levels of stress. A systemic review showed that a prevalence of stress in the parents with babies admitted to NICU was 39.9%, and it remained as high as 27.1% even one year after birth [3].

Parental stress is an established clinical predictor of poor children's development. Stressed parents may exhibit reduced positive emotions and responsiveness towards their infants, negatively affecting parenting behavior and ultimately hindering the children's neurodevelopment [4]. Moreover, parental stress influences the infant's gut microbiome, adversely affecting their neurodevelopment through the gut-brain axis [5]. Postpartum parental stress has been shown to significantly impact infant motor and socio-emotional development at one-year-old [6]. While the majority of previous studies on parental stress have focused on mothers, there is limited evidence to suggest that fathers exhibit lower levels of stress than mothers [7, 8]. However, the stress experienced by fathers of preterm infants may negatively impact the mother-child interaction and the language development of the preterm infants [9]. In addition to affecting the children's neurodevelopment, parental stress also negatively impacts the well-being of parents themselves. One study reported that more than 40% of parents with very preterm infants (VPIs) experienced depression, and almost 50% of them experienced anxiety symptoms soon after the preterm birth [10]. These findings emphasize the need for appropriate intervention to reduce parental stress experienced by both mothers and fathers.

Numerous studies have explored various approaches to reduce parental stress levels. Of them, early intervention (EI) is commonly recommended for preterm infants due to their high risk of neurodevelopment impairment, which often focuses on supporting physical, cognitive, behavioral, and social and emotional development to the infants. Literature has demonstrated that EI not only promotes the neurodevelopment of infants but also effectively reduces the parental stress level [11]. Nowadays, most EI programs are carried out in medical settings, such as hospitals, follow-up clinics, or community-based facilities, and are typically performed by medical professionals. However, limitations in time and resources often restrict the implementation of clinical-setting-based EI, hampering their accessibility in regions with limited medical resources. To address this issue, the Chinese Eugenics Association developed a home-based, post-discharge EI program in 2018. Our previous study has demonstrated the feasibility of implementing this program at home, and found that it could significantly enhance motor development and physical growth of VPIs 120 days after discharge [12].

To date, there has been limited investigation into the impact of this innovative EI program for VPIs on reducing parental stress. In order to address this gap, we conducted a randomized, controlled trial of this EI program, which involved parents of VPIs carrying out the early intervention at home and focusing on parent-infant interaction. Our study aimed to test whether this EI program could reduce levels of parental stress in both mothers and fathers following a preterm birth.

Patients and methods

Study design

This study is part of a randomized, non-blinded, controlled trial that primarily evaluated the impact of this EI program on neurodevelopment and physical growth of VPIs. Ethical approval was obtained from the Institutional Review Board of the Children's Hospital of Chongqing Medical University (No.2019–216). This trial was registered in the Chinese Clinical Trial Registry (ChiCTR1900028330). Parents of VPIs were informed of this trial and provided written consent to participate.

VPI families were randomly assigned to either an EI or standard care (SC) group. Randomization was performed before the infants were discharged, using a computed permuted block randomization sequence (block-size 4, 1:1 allocation). Infants in the EI group had a 30-day EI exposure superimposed with post-discharge standard care, while those in the SC group only received standard care. After 60 days of enrollment, VPIs in the SC group were allowed to receive the 30-day EI exposure.

Participants

As previously mentioned, VPIs with a gestational age of 28^{+0} to 31^{+6} weeks admitted to the Children's Hospital of Chongqing Medical University from December 1, 2019,

through June 30, 2020, were enrolled in this study. The inclusion criteria were as follows: (i) postmenstrual age of $36^{+0} \sim 39^{+6}$weeks; (ii) stable vital signs with a respiratory rate < 60 breaths/min, a heart rate of 100 to 160 beats/min, and an axillary temperature of 36.5℃ to 37.4℃ in an open crib; (iii) did not require oxygen; (iv) achieved an average weight gain of 15 to 30 g/d; (v) either of the parents being able to take round-the-clock care for the infants at home.

Infants were excluded from the study if they met any of the following criteria: (i) small for gestational age; (ii) diagnosed with presumed brain injury, including intraventricular hemorrhage ≥ grade II, various degrees of periventricular leukomalacia, and neonatal seizure; (iii) diagnosed with congenital or acquired sensory deficits; (iv) presence of major dysmorphic features or laboratory-confirmed chromosomal abnormality; (v) simultaneously receiving various specialist interventions such as occupational therapy, physiotherapy, and speech therapy. (vi) born into a single family or born to parents with language barriers, neurodevelopment disorders, or other disabilities expected to hinder the implementation of EI.

To enhance comparability, a group of parents with full-term infants hospitalized due to uncomplicated hyperbilirubinemia were conveniently selected from the follow-up clinics to serve as a reference group. Relevant clinical information was extracted from the hospital follow-up dataset.

Intervention

Implementation of EI

One week before the planned discharge, all enrolled parents attended a didactic lecture and workshop where a comprehensive introduction to the EI program was presented, including theories related to the interventions and how to perform the EI. This home-based, post-discharge EI program comprised three sections: intellectual, physical, and social training. The intellectual section included hearing-induced training and vision-induced training; the physical section involved whole-body massage; the social section included kangaroo care and hearing-vision integrated training (see supplementary file for more information about the EI program). A researcher with a rehabilitation background led the workshop and ensured that the parents were competent in independently performing the EI program.

Once the infants were discharged home, the researcher assessed the safety and suitability of the family environment to perform the EI program based on the videos obtained from the parents. Additionally, parents were required to write an information card daily, reporting the timing and duration of the EI, the person performing the EI, and the infant's response to researchers.

Standard care

Both groups of infants in this study received the SC and post-discharge follow-up. The scope of the SC intervention encompassed a range of essential areas, including feeding education, strategies for preventing injuries and illnesses, fostering parent-infant bonding, scheduling of immunizations, and providing readily accessible medical services when required. A brochure with the above content will be given to the parents at the infant's first post-discharge follow-up.

A bimonthly clinical follow-up was scheduled for all EPIs after discharge. During each follow-up visit, fundamental anthropometric measurements, such as weight, length, and head circumference, were taken. Given that EPIs are at a high risk for neurodevelopmental impairment, all subjects received comprehensive neurological assessments. The follow-up information was stored in a hospital follow-up dataset. Parents were advised to inform the researchers of clinical visits due to the infant being unwell, so that relevant medical information could be recorded.

Outcomes

Assessment of parental stress was carried out using the instrument of Parental Stress Index-Short Form (PSI-SF). Parents of the VPIs were assessed three times throughout the study: just prior to discharge (T0), at the 60-day mark of the study (T1), and at six months of corrected age for VPIs (T2). In contrast, parents of the term control group only received PSI-SF assessment when the infants reached six months of age.

Instruments

PSI-SF is derived directly from the Parental Stress Index Full-Length test [13, 14], which has three domains with 12 items for each: parental distress (PD), parent-child dysfunctional interaction (P-CDI), and difficult child (DC). PD reflects the level of distress that parents experience in exerting their roles and how the requirement of the child may restrict their lives; P-CDI reflects the parents' dissatisfaction with their child and their interaction with them; DC measures the parents' feeling that their child is difficult to take care of. By combining all three domains, a total stress score is computed and presented as a raw score. A higher score denotes an increased level of parental stress. The Chinese version of PSI-SF has been validated for use in the Chinese population, regardless of gender [15, 16].

Power calculation

This study is part of an intervention study with long-term follow-up of VPIs, where the sample size was already calculated based on the differences in motor performance of VPIs between the EI group and SC group at T1. Based

on the assumption of a follow-up rate of 90%, 31 infants were required for each group [12]. With this sample size, there was an 80% chance of detecting a difference of 0.73 standard deviations in the total PSI-SF scores between the groups, with a significance level of 0.05.

Statistics

Clinical data were inputted using Epidata 3.1 and analyzed using SPSS 27, with a p-value <0.05 considered statistically significant. For normally distributed quantitative data (Shapiro-Wilk test), the mean ± standard deviation was used to describe the data, while median and interquartile range were used if the data was not normally distributed. One-way ANOVA was used to compare the total stress score and each domain score between groups, with the Bonferroni test applied for post hoc multiple comparisons. Cohen's d was calculated to measure the effect size of the intervention. Paired t-tests were used to test differences between mothers and fathers at T2. Categorical data was expressed as percentages and analyzed using chi-square or Fisher's exact test between groups. Finally, a multiple linear regression analysis was conducted to identify predictors of the delta changes in the total stress scores reported separately by mothers and fathers in the EI group. Prior to this, a Pearson's correlation test was performed to identify variables significantly associated with the delta changes in total stress scores at the univariate analysis level. For a variable to be considered statistically significant, the p-value had to be less than 0.1. The multiple linear regression analysis was conducted using the "enter" method.

Results

Out of the 138 eligible families, 65 were excluded based on the predetermined criteria, leaving a final enrollment of 73 families. The study randomized 37 families into the EI group, with three families experiencing loss to follow-up at T1. Thirty-six families were assigned to the SC group, with five families lost to follow-up. Additionally, 30 mother-father dyads with full-term infants were recruited as the reference group and assessed at T2 (Fig. 1). There were no significant differences in the baseline characteristics of parents and infants, except for the reference group having a larger gestational age and birth weight (Table 1). At baseline assessment (T0), the total stress score was 94.91 for mothers and 89.43 for fathers. No significant differences were observed between the EI and SC groups for total stress score or each domain score for either mothers or mothers (all $p>0.05$, Table 2).

Assessment at T1

At T1, parents in the EI group had significantly lower levels of total stress and PD, P-CDI domains than those in the standard care group, while no significant difference was observed in the DC domain (Table 2). The effect size of the intervention was most significant in the PD domain, with a Cohen's d value of 1.95 in the mothers and 0.79 in the fathers, respectively.

Assessment at T2

From T1 to T2, nine families in the EI group and three in the SC groups were lost to follow-up, respectively. At the endpoint of T2, the EI and SC groups had similar total stress scores and PD and P-CDI domain scores, significantly higher than those observed in the reference group by post-hoc analysis (Table 3).

Differences between mothers and fathers

At baseline assessment, mothers in both the EI and SC groups had significantly higher total stress scores and PD domain scores than fathers ($p<0.05$); however, there was no significant difference observed in the P-CDI and DC domain scores (all $p>0.05$). In terms of the delta changes from T0 to T1 within the EI group, mothers exhibited more pronounced changes than fathers (Table 4). By the end of T2, mothers in the reference group had significantly higher total PSI-SF and PD domain scores than the fathers ($p<0.05$, Table 3).

Predictors of the delta changes in the total parental stress score

Pearson correlation test showed that variables significantly associated with the delta changes in the total parental stress score: postmenstrual age at discharge, and time of EI performance. Multiple linear regression analysis indicated that the time of EI performance was the sole predictor affecting the delta changes in the total stress scores from T0 to T1 for both mothers and fathers (estimated coefficients of 1.316 in mothers and 1.172 in fathers, respectively, $p<0.05$). Moreover, there was a significant difference in the time of EI performance between mothers and fathers, with mothers performing 30.35 ± 3.228 h of EI compared to fathers who performed only 10.18 ± 2.865 ($p<0.05$).

Discussion

This study revealed that both mothers and fathers of VPIs experienced elevated levels of stress, with a mean total stress score of 94.91 and 89.43, respectively, which are significantly higher than those observed in other reports [17–19]. This discrepancy could be partially attributed to restricted visiting policies for parents in our NICU. Most NICUs in China do not allow parental visits to their infants before they achieve clinical stabilization. The separation between parents and their infants can impede parental role transition and impact the development of the parent-infant relationship in the early postpartum period, which was considered the predominant

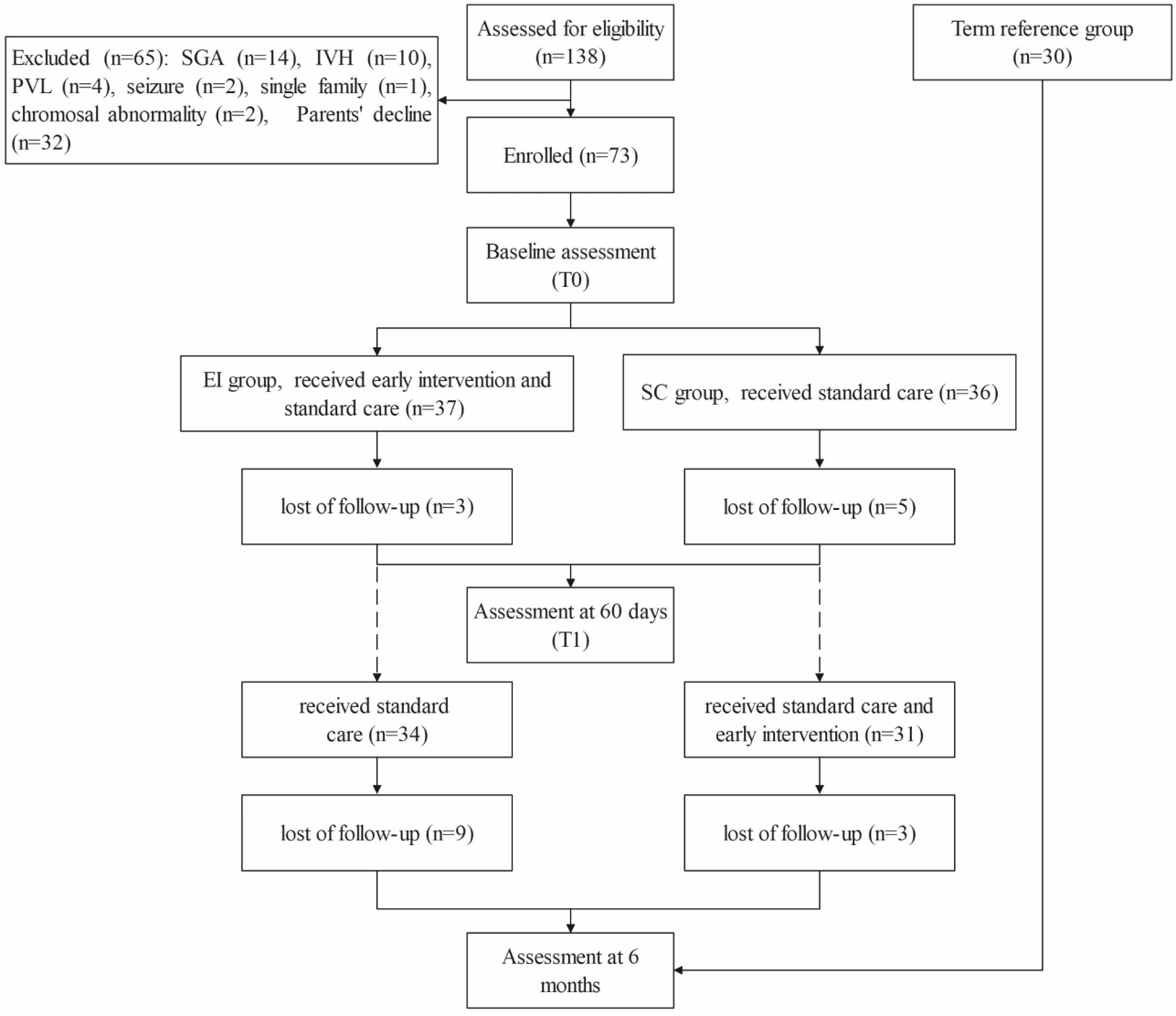

Fig. 1 Patient flow and follow-up. SGA, small for gestational age; IVH, intraventricular hemorrhage; PVL, periventricular leukomalacia; EI group, early-intervention group; SC group, standard-care group

source of stress for parents of hospitalized VPIs [20]. Hospital-based neonatal care policy should be modified to supply positive support and necessary strategies for parents of preterm infants to facilitate their parental role transition and strengthen the parent-infant bonding. Room-in services to the NICU are becoming more prevalent in China and are a great step towards achieving this goal. Another possible explanation for the higher level of stress reported by the parents in this study was due to the inclusion of preterm infants with smaller gestational weeks. Immature infants are commonly at higher risk for adverse short and long-term outcomes, and Pisoni et al. reported that parents with higher-risk infants experienced higher levels of stress [21].

Previous studies have suggested that the EI program for VPIs is an effective method of reducing parental stress [22–25]. However, some factors, such as transportation inconvenience and economic hardship, could prevent some families from accessing a traditional, clinical-setting-performed EI program for their preterm infants. Our study showed that a home-based EI program could effectively reduce parental stress. In this study, parents actively participated in the EI program, allowing them to directly witness significant improvements in the neurodevelopment and physical growth of their infants compared to those in the SC group, as demonstrated by our previous report [12]. It further improved parental adherence to the EI program and strengthened its effectiveness, forming a positive reinforcement cycle [26]. Throughout the EI program, parents and their infants engaged in interactions such as whole-body massage and kangaroo care, enhancing maternal sensitivity and

Table 1 Characteristics of parents and infants

	EI group (experimental) *n* = 34	SC group (control) *n* = 31	Term reference group *n* = 30
Gestational age (weeks, mean [SD])	29.47 ± 1.93	30.65 ± 1.47	39.17 ± 1.23
Birth weight (grams, mean [SD])	1417.32 ± 199.47	1499.00 ± 206.27	3616.08 ± 303.92
PMA at enrollment (weeks, mean [SD])	36.82 ± 0.80	36.68 ± 0.95	—
Males (n, %)	21 (61.76%)	17 (54.84%)	16 (53.33%)
Primipara (n, %)	20 (58.82%)	22 (70.97%)	17 (56.67%)
Age of fathers (years, mean [SD])	30.38 ± 2.92	31.65 ± 4.02	31.42 ± 2.94
Educational attainment of fathers			
College or above (n, %)	21 (61.76%)	23 (74.19%)	23 (76.67%)
High school or below (n, %)	13 (38.24%)	8 (25.81%)	7 (23.33%)
Age of mothers (years, mean [SD])	26.53 ± 4.08	27.52 ± 3.18	27.62 ± 3.00
Educational attainment of mothers			
College or above (n, %)	18(52.94%)	15(48.39%)	16(53.33%)
High school or below (n, %)	16(47.06%)	16(51.61%)	14(46.67%)
Monthly family income			
>10,000 CNY	14(41.18%)	12(38.71%)	11(36.67%)
5000 CNY～	14(41.18%)	15(48.39%)	13(43.33%)
<5000 CNY	6(17.65%)	4(12.90%)	6(20.00%)
Residency			
City	13(38.24%)	13(41.94%)	12(40.00%)
Town	16(47.06%)	13(41.94%)	14(46.67%)
Village	5(14.70%)	5(16.13%)	4(13.33%)

PMA, postmenstrual age; CNY, Chinese Yuan

Table 2 PSI-SF assessment at baseline (T0) and at the 60-day mark of the study (T1)

PSI-SF domains	T0			T1				
	EI group (experimental) *n* = 34	SC group (control) *n* = 31	*p*	EI group (experimental) *n* = 34	SC group (control) *n* = 31	*p*	Mean difference (95%CI)	Cohen's *d*
Mothers								
PD (mean [SD])	37.03 ± 4.87	36.65 ± 4.83	0.751	28.97 ± 2.02	36.77 ± 5.39	< 0.001	7.80 (5.82, 9.79)	1.95
P-CDI (mean [SD])	30.44 ± 4.51	30.19 ± 4.52	0.826	27.15 ± 2.68	29.84 ± 4.98	0.008	2.69 (0.67, 4.72)	0.68
DC (mean [SD])	27.68 ± 4.45	27.81 ± 4.48	0.907	25.88 ± 4.80	27.65 ± 4.14	0.119	1.76 (-0.47, 3.99)	0.39
Total scores (mean [SD])	95.15 ± 8.02	94.65 ± 7.51	0.796	82.00 ± 5.64	94.26 ± 7.99	< 0.001	12.26 (8.85, 15.67)	1.79
Fathers								
PD (mean [SD])	32.62 ± 5.64 *	32.45 ± 5.49 *	0.905	27.74 ± 8.86	32.68 ± 5.61 *	0.002	4.94 (1.82, 8.06)	0.79
P-CDI (mean [SD])	28.82 ± 3.99	29.58 ± 4.12	0.449	26.59 ± 4.16	29.13 ± 4.57	0.022	2.54 (0.37, 4.71)	0.58
DC (mean [SD])	27.56 ± 4.36	28.87 ± 3.48	0.188	26.41 ± 4.46	28.13 ± 4.37	0.122	1.72 (-0.47, 3.91)	0.38
Total scores (mean [SD])	89.00 ± 7.17 *	89.90 ± 8.44 *	0.644	80.74 ± 7.14	89.94 ± 9.17	< 0.001	9.20 (5.15, 13.26)	1.13

PSI-SF, Parenting stress index-short form; PD, parental distress; P-CDI, parent-child dysfunctional interaction; DC, difficult child

* denotes the significant difference between mothers and fathers by paired-sample t test

responsiveness towards their infants. Whole-body massage could promote breastfeeding and improve weight gain in preterm infants, addressing parents' concerns on catch-up growth [27]. Kangaroo care also triggers positive neuro-psychological-biological feedback between parents and their infants, significantly increasing oxytocin levels in the parents. A high oxytocin level is associated with a lower level of parental stress [28]. In terms of the PSI-SF subdomains, our results showed that PD decreased significantly more compared to P-CDI, while no changes were observed in the DC, which suggested that promoting the parental role transition through positive adaptation and self-adjustment plays an essential role in overall reduction of parenting stress.

As expected, the parents of VPIs had higher total PSI-SF and subdomain scores than those in the reference groups. However, prior studies on preterm-term parental stress differences are conflicting [19–21]. Some reasons might account for the discrepancy of our results from other studies: Firstly, VPIs generally require more intensive post-discharge care than full-term infants. However, since many parents may have had inadequate

Table 3 PSI-SF assessment at six months of corrected age for infants

PSI-SF domains	EI group (experimental) *n* = 25	SC group (control) *n* = 28	Term reference group *n* = 30	F	*p*
Mothers					
PD (mean [SD])	26.64 ± 3.00[a, b]	28.68 ± 5.10[a]	24.70 ± 4.66[b]	5.931	0.004
P-CDI (mean [SD])	24.80 ± 2.93[a]	24.79 ± 5.88[a]	20.03 ± 3.40[b]	11.777	< 0.001
DC (mean [SD])	23.64 ± 4.70	23.43 ± 4.78	20.87 ± 3.81	3.477	0.036
Total scores (mean [SD])	75.08 ± 7.07[a]	76.89 ± 10.26[a]	65.60 ± 7.08[b]	15.501	< 0.001
Fathers					
PD (mean [SD])	26.28 ± 6.49[a]	27.39 ± 5.83[a]	20.83 ± 5.24[b] *	10.485	< 0.001
P-CDI (mean [SD])	22.84 ± 4.00[a]	22.61 ± 5.44[a]	18.67 ± 3.58[b]	8.114	< 0.001
DC (mean [SD])	22.16 ± 4.27	22.18 ± 4.45	19.70 ± 3.69	3.423	0.037
Total scores (mean [SD])	71.28 ± 6.49[a]	72.18 ± 9.48[a]	59.20 ± 6.32[b] *	26.372	< 0.001

a, b denotes the significant difference by the Bonferroni test

* denotes the significant difference between mothers and fathers by paired-sample t test

Table 4 Comparison of PSI-SF scores changes between mothers and fathers

PSI-SF domains	Mothers	Fathers	*p*
ΔPD (mean [SD])	8.06 ± 2.92	4.88 ± 3.54	< 0.001
ΔP-CDI (mean [SD])	3.29 ± 1.90	2.24 ± 1.59	0.012
ΔDC (mean [SD])	1.79 ± 1.47	1.15 ± 0.93	0.037
ΔTotal scores (mean [SD])	13.15 ± 4.68	8.26 ± 4.03	< 0.001

Δ, delta changes from baseline to the 60-day mark of the study

involvement during their hospital stay, they may lack sufficient knowledge and skills to care for VPIs, resulting in more stressful situations for the parents. Secondly, the vulnerability of the VPIs places a high burden on their parents. In regions with rich medical resources, parents of VPIs receive adequate social, medical, and psychological support as a matter of priority during hospitalization and after discharge. However, such support is currently deficient in China. Finally, the stress that parents experience may be compounded by the lack of sleep, anxiety, and exhaustion that often accompany caring for a preterm infant, which in turn exacerbates the stress of the parents.

Our study also revealed that the level of parental stress had gender-specific differences. Baseline assessments were consistent with prior studies indicating that mothers exhibited a higher level of parental stress than fathers [7, 8]. The predominant dimension of the total stress score in both mothers and fathers was the PD score, and the higher PD score in mothers explains the gender-specific discrepancy in stress levels. Mothers have established a solid attachment to their fetus during pregnancy and often view breastfeeding as a fundamental responsibility in fulfilling their natural role as mothers. Admission of a preterm infant to the NICU may cause mothers to experience difficulties in bonding with their child and feelings of guilt due to the inability to feed the baby, which adds more challenges to the mother in the alteration of the parental role, as compared to the fathers [8]. Moreover, our study found that the reduction in total stress score and each subdomain was more pronounced among mothers than fathers. Logistic regression analysis demonstrated that the time of EI performance was the sole factor impacting the efficacy of the EI program. The mother-father discrepancies presented might be attributed to the increased amount of time the mother spent on the EI program.

The major strength of our study stems from utilizing a randomized controlled design, which generated a high degree of equality in the baseline characteristic and ensured comparability between the preterm groups. Meanwhile, we set a term control group to further enhance the comparability of our results. However, it is important to acknowledge certain limitations that may impact the findings of this study. Firstly, information regarding the pregestational psychological status of parents was not included in this study, which might influence their stress levels during pregnancy and the postpartum period [29]. Secondly, existing research has indicated that parental stress level tends to increase over time, with divergent trends observed between parents of preterm and term infants; a prolonged follow-up might witness a lower stress level in the parents of preterm versus term infants [19, 30]. Therefore, to accurately investigate the long-term efficacy of the EI program, it would be meaningful to conduct an extended follow-up beyond six months. Lastly, some parents may have participated in additional EI or commercially available early education programs, particularly as the latter is widespread in China. It may potentially confound our evaluation of the efficacy of this EI program.

Conclusion

The current study implemented a home-based EI program following hospital discharge. This cost-effective solution is particularly well-suited for regions with limited medical resources. The results of this study

demonstrated that this EI program significantly reduced parental stress levels among the parents of VPIs.

Abbreviations

EI	Early intervention
VPIs	Very preterm infants
SC	Standard care
PSI-SF	Parental Stress Index-Short Form
PD	Parental distress
P-CDI	Parent-child dysfunctional interaction
DC	Difficult child
NICU	Intensive care unit

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-024-19969-7.

Additional file 1 The videos of the implementation of early intervention in early preterm infants.

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Author contributions
J.F. and J.H.W contributed to study conceptualization, data acquisition, and data analysis, drafting the initial manuscript, and revising the manuscript before submission. R.Y.H, S.S.H and M.Y contributed to data acquisition, data analysis. X.J.T, M.Z, and W.H.Y contributed to data analysis, compiling tables and figures. J.H.W contributed to study conceptualization and design, data analysis, reviewing and revising the manuscript. All authors made substantial contributions to the conduct of the study and approved the final manuscript as submitted.

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Data availability
The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Subjects were enrolled in the study after written informed consent was obtained from their parents. This study was approved by the Institutional Review Board of Children's Hospital of Chongqing Medical University.

Consent for publication
A written consent for publication has been obtained from the parents of the infant shown in our supplementary video.

Competing interests
The authors declare no competing interests.

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