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Original Article

The Effect of Tele-Education on The Development of Premature Infants After Discharge During The Corona Pandemic: A Randomized Clinical Trial

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Abstract

Introduction: Premature infants are at risk for neurodevelopmental delays, and parents do not have enough knowledge and information about that. The coronavirus pandemic and the limited presence of parents in the NICU (Neonatal Intensive Care Unit), as well as the risk of rehospitalization after discharge to follow up on the child's condition, increased the need to investigate compensatory solutions to provide services to high-risk children and their parents.

Methods: This randomized clinical trial study was conducted in Tehran from July 2021 to March 2022. A total of 32 preterm infants were randomly assigned to the intervention group (n=16) and the control group (n=16). Tele-education was provided through a 12-week intervention by written content, video, audio, and photos for the treatment group. Infants were matched and randomly assigned to two comparable groups using permuted block randomization before the intervention. The results of the infant's development after the intervention were measured using the ASQ via an online form and the Bayley III scale by the country's Bayley test mentor at 3 months corrected age. This clinical trial was registered in the Iranian Registry of Clinical Trials (IRCT) (Registration No. IRCT20220725055554N1).

Results: The results indicated that tele-education could not produce a statistically significant distinction between participants in the intervention and control groups ($P>0.05$).

Conclusion: Although this study showed that tele-education has no significant positive impact on the development of premature babies at 3 corrected ages, further studies with larger sample sizes are necessary to improve our knowledge about the effects of tele-education at older ages.

Keywords: Parents, Premature, Infant, Coronavirus, Development

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Introduction

Premature birth and its associated complications exert a substantial influence on public health indicators and impose significant societal burdens (1). Premature birth represents the leading contributor to neonatal morbidity and mortality (75%) and long-term physical and neurological disabilities, including cerebral palsy, especially spastic diplegia, mental retardation, sensory-neural hearing loss, and vision loss with retinopathy of prematurity. Therefore, research in this field and the identification of existing methods in dealing with this issue can be important (2). Premature infants experience extra-uterine life during a critical window of brain maturation, typically spanning the late second to early third trimester. During the last trimester of pregnancy, neurodevelopment undergoes rapid acceleration, marked by approximately a fivefold expansion in white matter volume and a fourfold increase in gray matter volume (3). Early intervention is associated with improved developmental trajectories in children, a decreased likelihood of later complications, and the provision of critical support for parents (4). Thus, parent-training after discharge from NICU can be very helpful for infant health (3).

Growth refers to the irreversible and continuous increase

in physical size, whereas development encompasses the progressive enhancement of psychomotor abilities. Development is a lifelong process that begins in the neonatal period and extends through adulthood and has different aspects, such as motor development, psychosocial development, cognitive development, and language (5). Researchers reported that early interventions should begin for high-risk children as soon as possible because it is a critical developmental period for plasticity of developing systems (6).

Family-centered care (FCC) is both a guiding philosophy and a healthcare delivery model that underscores the essential role of the family in supporting individual health and well-being. Within this framework, healthcare institutions and professionals are expected to engage patients and families as active partners in care that is culturally responsive, personalized, and oriented toward strengthening self-care abilities, knowledge, and confidence. With the rapid advancement of mobile technologies, opportunities to engage and support parents have expanded, enhancing the feasibility and accessibility of FCC programs. Given its affordability and ease of access, mobile-based approaches can serve as effective tools to increase parental participation and strengthen family-centered education (7).

Since early December 2019, cases of Coronavirus Disease 2019 (COVID-19) were first reported in China and subsequently disseminated to other countries worldwide (8). The limited presence of mothers in the hospital and NICU due to health protocols increased during the coronavirus epidemic and caused a decrease in the participation of mothers in caring for the baby, and subsequently created some problems in the formation of the maternal role and attachment to the baby (9, 10).

With this point of view, the needs of parent-training regarding the care for their premature children and increasing their knowledge about the importance of milestones and developmental red flags can be managed through accurate and reliable methods, such as distance education. By focusing on meeting the needs of mothers and babies, tele-education can have advantages such as cost-effectiveness, reducing the need for specialized manpower, and preventing the consequences of prematurity (11).

So, this study was designed and performed to determine the effects of tele-education on the infants' development at 3 months corrected age.

Methods

A double-blind, randomized clinical trial was conducted at Imam Hossein and Mahdieh University Hospitals in Tehran, Iran, between February and July 2022. The study population comprised 32 preterm neonates with gestational ages ranging from 30 to 36 weeks, all of whom were admitted to the neonatal intensive care units (NICUs) of the studied hospitals. Eligibility was established based on predefined inclusion criteria: (1) gestational age between 30–36 weeks, (2) birth weight greater than 1500 g, (3) Apgar score ≥ 7 at 5 minutes, (4) absence of major brain abnormalities on ultrasound, such as grade 3 or 4 intraventricular hemorrhage (IVH), (5) parents able to read and write in Persian, (6) parents owning a smartphone and were familiar with social media, and (7) neonates having parental care. Exclusion criteria comprised incurable disease, neonatal death during the study, or parental refusal to participate.

The institutional review board evaluated and approved the study protocol, and ethical approval was obtained from the Ethics Committee of the School of Rehabilitation Sciences, Shahid Beheshti University of Medical Sciences (Ethical code: IR.SBMU.RETECH.REC.1401.569). This study was registered at www.irct.ir (Registration code: IRCT20220725055554N1).

The required sample size was estimated using a specified significance level as the basis for calculation (α) of 0.05 and a statistical power of 80%, taking into account the characteristics of vulnerable populations. According to the preliminary data obtained from the pilot study, the total sample size was determined to be 32. Following enrollment, infants were allocated to the intervention or control group through permuted block randomization (using 8 permuted blocks of four with six possible arrangements). This method allowed us to maintain balanced group sizes while also accounting for key stratification variables such as gestational age and birth weight. This approach helped ensure comparability between groups and minimized selection bias, and finally, the neonates were randomly allocated to the intervention group (n = 16) and the control group (n = 16) (Figure 1).

Following the collection of clinical data, mothers were invited to complete the Ages and Stages Questionnaire (ASQ) online via Google Forms. The ASQ consisted of 30 items encompassing five developmental domains: communication, gross motor, fine motor, problem solving, and personal–social skills, assessed for infants at three months of corrected age. Each item was rated on a three-point Likert scale with response options ranging from "yes" to "not yet"(12).

Infants were also evaluated by mentor of country Bayley test at 3 months corrected age in person. The Bayley Scales of Infant and Toddler Development (BSID) constitute a comprehensive, standardized assessment instrument designed to identify developmental delays during early childhood. Nancy Bayley published the first BSID (Bayley Scales of Infant and Toddler Development) in 1969. Scoring is Dichotomous (1, 0) in BSID III (5).

Neonates in the control group did not receive any supplementary treatment from the research therapist; however, they continued to receive standard interventions and routine clinical services (regular pediatric check-ups and growth monitoring, standard nutritional guidance and breastfeeding support, routine immunizations according to national guidelines, parental education on infant care and safety, monitoring for developmental milestones during scheduled visits), and the tele-education program was provided for the treatment group. The tele-education

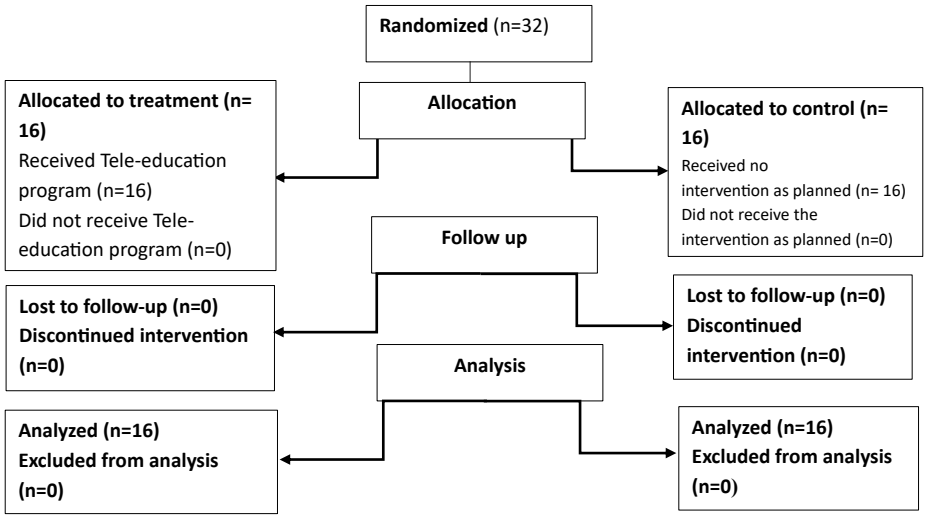

Figure 1. Flow diagram of the participants

program consists of six training sessions over 12 weeks. It was done online and through WhatsApp Messenger asynchronously. In this model, providers and patients are not engaged simultaneously; instead, communication occurs through a "store-and-forward" approach, utilizing data transmission methods such as video recordings, digital images, virtual technologies, and other electronic formats (13).

The main body of training sessions was based on MITP (Mother-infant transaction program) and COPE (Creating Opportunities for Parent Empowerment) and other supplementary training approved in previous articles, such as massage, Kangaroo-Mother Care (KMC), etc.

Saturdays/Sundays: Theoretical content was delivered via video or recorded audio to introduce the week's developmental topics.

Mondays: Practical demonstrations related to the theoretical content were provided through instructional videos to guide parents in applying the techniques.

Tuesdays/Wednesdays: Families engaged in hands-on practice under the remote supervision of the therapist. Parents recorded and submitted videos of their exercises for feedback.

Thursdays: Therapists reviewed the submitted videos and provided individualized feedback. This day also included follow-up guidance tailored to each infant's progress and any challenges encountered.

Following Week: Additional time was dedicated to answering family questions, reinforcing practical skills, and adapting strategies to suit individual developmental needs.

The intervention generally consisted of 6 sessions for a total of 12 weeks (every two weeks). The content of sessions briefly includes:

First session: getting familiar with mothers and knowing their understanding of the baby's appearance, assessments of the home environment, and teaching about home modification and suitable positions for infants.

Second session: Enhancing mothers' knowledge about the reflex system of their baby, teaching innovative games in the visual, auditory, and tactile fields, teaching KMC

Third session: Explaining stages of alertness for mothers and how they can use this opportunity to enhance attention, teaching a special massage for infants.

Fourth session: Teaching about behavioral patterns and individuality of the baby, knowing about posture and muscle tone, and discrimination between jerky and smooth movement.

Fifth session: Reviewing past sessions, preparing mothers for independence in taking care of the baby.

Sixth session: Evaluating the infant's reflex motor system and developmental status, encouraging mothers to follow the baby's development process, and providing suitable activities for the baby's development up to the age of 6 months.

Statistical analyses were conducted using SPSS version 21. Independent t-tests were applied to compare quantitative variables between groups. Nominal categorical data were examined using Chi-square and Fisher's exact tests, while ordinal variables were evaluated with the Mann–Whitney U test. The results are expressed as mean values with standard deviations (SD), and a p-value below 0.05 was considered statistically significant.

Results

The mean gestational age of premature infants was 33.50 weeks (SD = 1.67) in the intervention group and 33.13 weeks (SD = 2.50) in the control group. As presented in Tables 1 and 2, neonates in both groups were comparable across all baseline parameters (i.e., gestational age, birth weight, birth length, head circumference at birth, gender, number days of hospitalization in NICU, mother's level of education, and IVH history), and at study initiation, no statistically significant differences were observed between the intervention and control groups.

A comparative evaluation of ASQ scores between the intervention and control groups is displayed in Table 3. The table includes both the subscales and the total ASQ score. Mean scores for each domain were calculated and compared between groups, and the results indicate the statistical significance of these differences.

Table 4 displays the comparison of Bayley III scores (Bayley subscales) between the two groups. The findings indicated that tele-education failed to yield a statistically significant difference between the intervention and control groups ($P > 0.05$).

Discussion

The results of this study showed no statistically significant difference in neurodevelopmental outcomes between preterm infants who received the Tele-education program and the control group over the three months.

While empirical evidence specifically validating telehealth in neonatal follow-up remains limited, its adoption accelerated during the COVID-19 pandemic as an essential mode of healthcare delivery. In the context of post-discharge care, telehealth can be useful for neonates during post-discharge follow-up. Neonatal follow-up requires strict timeliness, as even minor delays in evaluation or intervention may adversely affect growth, neurodevelopment, and long-term health outcomes. Ensuring prompt post-discharge monitoring is therefore a critical component of neonatal care. In addition to

Table 1. The socio-demographic characteristics of participants at baseline (quantitative variables)

Variable	Treatment group (Mean ± SD)	Control group (Mean ± SD)	*P*-value
Gestational age (week)	33.5 ± 1.67	33.13 ± 2.5	0.622
Birth weight (g)	1998.44 ± 513.996	1935.31 ± 634.58	0.759
Birth length (week)	45.07 ± 3.8	45 ± 4.09	0.962
Head circumference	31.57 ± 1.95	31.4 ± 2.97	0.857
Days of hospitalization	19.67 ± 9.27	25.57 ± 15	0.218

Notes: Mean ± SD: Mean ± Standard Deviation; ***P*-value**: Indicating statistical significance. **Significance Level:** $P < 0.05$ indicates statistical significance. This table compares quantitative variables, including Gestational age, Birth Weight, Birth Length, Head Circumference, and Days of Hospitalization in the treatment and control groups, with the *P*-value.

Table 2. The socio-demographic characteristics of participants at baseline (qualitative variables)

Variable		Treatment group No. (%)	Control group No. (%)	*P*-value
Gender	Female	10 (62.5%)	9 (56.3%)	0.719
	Male	6 (37.5%)	7 (43.8%)	
Mother's education level	Under diploma	3(18.8%)	8(50%)	0.202
	Diploma	5(31.3%)	4(25%)	
	Graduated	8(50%)	4(25%)	
IVH history	Positive	0(0%)	2(25%)	0.164
	Negative	11(100%)	6(75%)	

Notes: Mean ± SD: Mean ± Standard Deviation**; *P*-value:** Indicating statistical significance. **Significance Level:** $P < 0.05$ indicates statistical significance. This table compares qualitative variables, including Gender, Mother's education, and IVH history, in the treatment and control groups, with the *P*-value.

Table 3. Comparative evaluation of the ASQ results after intervention between the study groups

	Treatment group (Mean ± SD)	Control group (Mean ± SD)	*P*-value
ASQ-Communication	46.67 ± 9.037	43.75 ± 10.083	0.582
ASQ- Gross motor	48 ± 10.823	46.56 ± 13.130	0.743
ASQ- Fine motor	42.33 ± 10.668	40.31 ± 14.079	0.657
ASQ-Problem solving	49 ± 10.385	43.75 ± 13.102	0.228
ASQ-Personal-Social	48 ± 10.675	44.38 ± 14.930	0.446
ASQ- Total	233 ± 31.442	219.33 ± 58.060	0.430

Notes: Mean ± SD: Mean ± Standard Deviation**; *P*-value:** Indicating statistical significance. **Significance Level:** $P < 0.05$ indicates statistical significance. This table compares the mean score of ASQ (subscales and total) between the treatment and control groups, with the *P*-value (subscales and total).

Table 4. Comparative evaluation of Bayley III in the treatment and control groups with the Mann-Whitney U test

	Treatment group (Mean Rank)	Control group (Mean Rank)	Mann-Whitney U	*P*-value
Bayley-Cognitive	13.50	17.50	82.50	0.169
Bayley-Rec. language[1]	15	16	105	1
Bayley- Exp. language[2]	15.50	15.50	112.5	1
Bayley-Fine motor	13.50	17.50	82.50	0.169
Bayley-Gross motor	13.37	17.63	80.50	0.131

Notes: Mean ± SD: Mean ± Standard Deviation**; *P*-value:** Indicating statistical significance. **Significance Level:** $P < 0.05$ indicates statistical significance. This table compares the mean Rank of Bayley III between the treatment and control groups with the Mann-Whitney U test, with the *P*-value.
[1]Receptive Language
[2]Expressive Language

the COVID-19 pandemic, there are other barriers to providing in-person services to parents. These barriers are categorized into time, logistics, knowledge, and emotional stress (14, 15). The reports indicated that telehealth facilitated ongoing engagement with infants and children at risk, offering a structured platform for delivering clinical interventions and guidance. It also enabled observation of participants within their home environment, an approach particularly valuable under the restrictive conditions imposed by the COVID-19 pandemic. Overall, this mode of care was perceived as beneficial by both families and healthcare providers (15).

The findings of the present study showed that although the mean average of developmental scores in the treatment group was higher in the ASQ test, training programs for mothers, from a distance and through telehealth, did not have a significant impact on the infant's development ($P > 0.05$). There are several similar studies that have shown a significant impact of early intervention on the developmental skills of young infants. For example, Ghazi et al. investigated the impact of a home visit program centered on continued Kangaroo Mother Care (KMC) on maternal resiliency and the developmental progress of premature infants. Infant development was evaluated at two months of corrected age using the Ages and Stages Questionnaire (ASQ). The findings demonstrated that the home-based KMC program significantly enhanced developmental outcomes in premature infants (16). Also, Melnyk et al. published positive developmental findings from the implementation of the COPE program at 3-month corrected age by the Bayley test (17). It seems that although the therapist made efforts to train parents thoroughly in the intervention program—providing detailed instruction and monitoring their implementation—the absence of the therapist during the actual execution may have contributed to inconsistencies.

It is important to emphasize that this study was conducted over a short duration of around three months only, and therefore may not have been sufficient to detect the full impact of early developmental support. At this early stage, an infant's brain and behavior are undergoing rapid but subtle maturation, and many developmental skills are still emerging. Also, Neurodevelopmental tests conducted within the first three months of life are inherently limited in their sensitivity to detect meaningful changes. Most standardized neurodevelopmental tools are designed to assess gross milestones and domain-specific skills that typically become more observable after 6 months of age.

Although, this study showed that the effect of tele-education on developmental skills in premature infants was not significant, but due to its flexibility, cost-effectiveness, and feasibility after discharging from NICU and also the importance of providing early developmental intervention for premature infants, ongoing research is essential to clarify the impact of early intervention through tele-health in comparison with in-person interventions with a larger sample size and in longer period of time more thoroughly. Longer-term follow-up may reveal significant improvements in cognitive, motor, and socio-emotional development, as neurodevelopment is a gradual and complex process.

Conclusion

Providing early intervention is indispensable and should start as soon as possible. Tele-health and technology can be a facilitator in some conditions, such as the COVID-19 pandemic or other barriers like time, logistics, knowledge, and emotional stress. Thus, the present study emphasizes the need for early intervention and parent-training for parents who have a premature baby after being discharged from the hospital, even in special conditions like the coronavirus pandemic, or for any parents who are far away from health services.

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Authors' Contribution

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Formal analysis: Zahra Amini, Leila Yazdi
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Methodology: Reihaneh Askary Kachoosangy
Project administration: Minoo Kalantari
Software: Zahra Amini
Supervision: Reihaneh Askary Kachoosangy, Minoo Kalantari
Writing–original draft: Reihaneh Askary Kachoosangy, Zahra Amini

Competing Interests

The authors declare that there is no conflict of interest associated with the publication of this study.

Data Availability Statement

Due to privacy considerations and ethical constraints, the data underlying this study are not publicly accessible.

Ethical Approval

The research procedures were approved by the Institutional Review Board, and ethical approval was obtained from the Ethics Committee of the School of Rehabilitation Sciences, Shahid Beheshti University of Medical Sciences (Ethical code: IR.SBMU.RETECH.REC.1401.569). This study was registered at www.irct.ir (Registration code: IRCT20220725055554N1).

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