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Neuromotor and sensory development in preterm infants: prospective study

Yenidoğan preterm bebeklerde nöromotor ve duyusal gelişim: prospektif çalışma

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The known about this topic

Premature infants in Neonatal Intensive Care Unit are exposed to many sensory inputs (high-frequency sounds and lights, medical procedures, etc.) that not experienced in the uterus. This excessive sensory loading in critical period of brain development might affect the physiological responses of infants and cause to negative changes in motor, neurologic and sensory development. A few research was investigated the relationship between motor and sensory development in preterm infants during the first year of life and results were conflicting.

Contribution of the study

This is the first study in the literature that investigated the relationship between gross, fine motor and sensory development in very preterm infants during the first 4 month of their life. It seems that there was a strong relationship between gross and fine motor development and sensory of tactile and proprioception at corrected 1 months old. Based on the sensory development, most of the preterm infants were included in the high-risk group.

Abstract

Aim: To investigate the relationship between motor and sensory development in the first 4 months of life in preterm infants born at 32 gestational weeks and below.

Material and Methods: The study consisted of 56 high-risk infants with a corrected age of 1 month who were born at 32 gestational weeks and stayed in the neonatal intensive care unit for at least 15 days. Neuro Sensory Motor Developmental Assessment and Infant Sensory Profile-2 were used for evaluation. These assessments were applied to preterm infants at the 1st and 4th months. The results of assessments were analyzed using the Wilcoxon test. The relationship between the results of motor and sensory assessments was analyzed using Spearman's correlation test.

Results: The mean gestational age of the infants was 29.58±2.09 weeks, their birth weights were 1233.87±251.22 grams, and their duration of stay in the neonatal intensive care unit was 26.48±9.58 days. There was a statistically significant difference between the Neuro Sensory Motor Developmental Assessment and Infant Sensory Profile-2 scores between the 1st and 4th months ($p<0.05$). It was found that there was a risk in terms of

Öz

Amaç: Bu çalışmanın amacı, 32 hafta ve altında doğan preterm bebeklerde yaşamın ilk 4 ayındaki motor ve duyusal gelişim arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntemler: Çalışmaya, 32 hafta ve altında doğmuş, Yenidoğan Yoğun Bakım Birimi'nde en az 15 gün kalmış, düzeltilmiş yaşı 1 ay olan 56 yüksek riskli bebek alındı. Değerlendirme için Nöro Sensori Motor Değerlendirme Anketi ve Yenidoğan Duyu Profili-2 kullanıldı. Değerlendirme testleri bebeklere düzeltilmiş 1. ay ve 4. ayda uygulandı. Değerlendirme sonuçlarının 1. ve 4. aylar arasındaki farkı Wilcoxon testi kullanılarak çözümlendi. Motor ve duyu değerlendirme sonuçları arasındaki ilişki Spearman korelasyon testi ile çözümlendi.

Bulgular: Bebeklerin ortalama gestasyonel yaşı 29,58±2,09 hafta, doğum ağırlıkları 1233,87±251,22 gram ve Yenidoğan Yoğun Bakım Birimi'nde kalma süreleri 26,48±9,58 gündü. Bebeklerin Nöro Sensori Motor Değerlendirme Anketi ve Yenidoğan Duyu Profili-2 puanları arasında 1. ve 4. aylar arasında istatiksel olarak anlamlı fark olduğu bulundu ($p<0,05$). Preterm bebeklerin 1. ayda %86–%91'i, 4. ayda ise

Cont. ➡

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sensory development in 86–91% of the preterm infants at the 1st month and in 69–85% at the 4th month. There was moderate-strong degree of significant relationship between motor and sensory development.

Conclusion: Considering the findings of our study, preterm infants are at risk for motor and sensory development. There is, therefore, a need for future research to investigate the effect of early sensory-based intervention approaches on preterm infants.

Keywords: Development, gestational age, preterm, sensory processing, very low birth weight

%69–%85'inin duyusal gelişim açısından risk altında olduğu bulundu. Motor ve duyusal gelişim arasında orta-güçlü derece anlamlı ilişki olduğu gösterildi.

Çıkarımlar: Çalışmamızın bulguları ışığında, preterm bebekler motor ve duyusal gelişim açısından risk altındadırlar. Bu nedenle gelecekte duyu temelli erken dönem müdahale programlarının preterm bebeklerde etkisini gösteren çalışmalara gereksinim vardır.

Anahtar sözcükler: Çok düşük doğum ağırlığı, duyusal işlemleme, gelişim, gestasyonel yaş, preterm

Introduction

In extremely preterm infants (≤32 weeks), the rates of motor and neurologic disorders and cognitive and sensory problems continuing in advanced periods of life are higher compared with healthy peers (1–4). In addition, preterm babies are at risk in terms of medical complications (periventricular leukomalacia, severe intraventricular hemorrhage, sepsis, low birth weight, bronchopulmonary dysplasia, postnatal steroid use) because of premature birth (5, 6). Therefore, they may need to stay in the neonatal intensive care unit (NICU) for a long period.

The NICU provides a reduction in neonatal morbidity and mortality rates by supporting vital functions, but the special care applied has a negative influence on the baby's short- and long-term development (7). In NICUs, babies are confronted by many sensory stimuli (e.g. excessive sound, bright light, painful medical applications), which they had not experienced in utero (8, 9). This excessive sensory load, experienced in a critical period of brain development, impairs the baby's physiologic responses and may lead to negative changes in motor, neurologic, and sensory development (10–12). The reason for this is a lack of inhibitory control, which selects, controls, and processes sensory stimuli arising from the preterm baby's brain, which continues to develop (13, 14). Therefore, the relationship between preterm birth and the NICU transforms into a chain of negative events that cause learning difficulty and sensory and motor dysfunction (15, 16).

Sensory integration is a congenital ability that enables the baby to interpret and process sensations and to give the most appropriate response to the environment (14). Inappropriate stimulus processing ability causes sensory processing impairment (14). Sensory processing impairment reflects difficulties in transforming sensory information used to regulate physiologic, motor, sensory or attention responses in organization of behavior (17). This may cause the child to give less response or excessive response to a sensory stimulus (18). Atypical sensory behaviors negatively influence the child's participation in daily life activities (18). Weak participation in daily life activities in turn, may cause delay in the acquisition of developmental abilities (19). Therefore, processing the accurate sensory stimuli is important in the normal neurodevelopmental process (20). In particular, impairment in the stimuli coming from the vestibular, proprioceptive, and tactile sensory systems may lead to problems in the production of adaptive behavior, development of postural control, coordination of movement, and motor development (10). Sensory processing impairment affects 39–52% of preterm babies, and babies born before 32 gestational weeks carry a higher risk (4, 21, 22).

Most studies in the literature emphasized that cognitive development occurred in preterm babies (3, 11, 23–25). A limited number of studies have examined the relationship between motor and sensory development in the first year of life in preterm babies and the results are contradictory (14, 20, 21, 26). Celik et al. (20) found a strong positive correlation between sensory processing and motor development in preterm babies with an adjusted age ranging between 10 and 12 months, whereas Cabral et al. (14) could not show a correlation between motor development and sensory processing in preterm babies aged 4–6 months. These contradictory results may have arisen from the cross-sectional design and non-homogeneous study group. In the literature, there is a considerably limited number of studies related to sensory processing impairment, which is frequently observed in preterm babies, and more attention should be paid to this issue in research studies. In light of the current information, we could not find any studies that examined the relationship between sensory processing and motor development in the first 4 months of life beginning from birth in preterm babies. Therefore, we aimed to investigate the relationship between sensory processing and motor development in the first 4 months of life in preterm babies born at or below 32 gestational weeks in our study.

Material and Methods

Approval for the study was obtained from the ethics committee of the institution where the study was conducted (Approval Date: October 16, 2018; Decision Number: 18/250). Families who participated in the study were informed about the study and necessary approval was obtained by having consent forms signed. The study was conducted in accordance with the Declaration of Helsinki.

Participants

Sixty-three high risk babies with an adjusted age of one month who were born at 32 gestational weeks or before and stayed in the NICU for at least 15 days, were included in the study. Babies of families who did not accept to participate in the study and babies with congenital anomalies, genetic syndromes, and hearing and visual loss were not included in the study. One baby was lost in the neonatal period and six babies did not come for the second assessment visit. Therefore, a total of seven babies were removed from the study.

Method

Assessment was performed while the baby was on a large mattress on the ground or in the sitting position on their mother's lap approximately 2 hours after feeding. While performing the assessment, the babies received no medication that could hinder the assessment. The Neuro-Sensory Motor Development Assessment questionnaire (NSMDA) and Infant Sensory Profile 2 (ISP-2) were used for assessment. Each assessment lasted for approximately 20 minutes. The NSMDA and ISP-2 were applied to the babies at the adjusted age of one month and four months. The NSMDA was applied by a physiotherapist (Ö.K.K) with 10 years' experience in the area of pediatric rehabilitation. The ISP-2 was applied by an ergotherapist (S.S) who had 9 years' experience in the area of pediatric rehabilitation. The evaluators received training and utilization permits for the assessment batteries.

The Neuro-Sensory Motor Assessment Questionnaire

The NSMDA is composed of 6 subchapters that evaluate motor development. These include gross motor abilities appropriate for age, fine motor abilities, tonus, deep tendon reflexes, clonus, tremor, neurologic appearance of involuntary movements, infantile movement patterns, postural reactions, and balance and sensory stimuli for motor responses (tactile, proprioceptive, ocular, vestibular). According to the NSMDA, a score of 5–8 indicates normal motor function, a score of 9–11 indicates minimal motor problem, a score of 12–14 indicates mild motor problem, and a score of 15–30 shows moderate-severe motor dysfunction. The greatest advantage of the NSMDA is in providing differentiation between normal motor function, minimal dysfunction, mild dysfunction, and moderate and severe dysfunction (27, 28).

The Infant Sensory Profile 2

The ISP-2, which is also known as Dunn's sensory profile, is a commonly used scale that evaluates sensory processing abilities of infants from the neonatal period to the age of three years (29, 30). It emphasizes sensory processing difficulties and problems related to daily activities in infancy. The ISP-2, which is used to evaluate babies from the time of birth to the age of 6 months, is composed of a total of 36 items that assess general, auditory, visual, tactile and vestibular processing abilities. Caregivers are asked to give a score for each question according to a 5-point Likert scale by the performances of the babies in order to examine sensory processes. The scoring of the test is as follows: 1 point = Always, 2 points = Frequently, 3 points = Sometimes, 4 points = Rarely, 5 points = Never and 0 point = Inapplicable (29). The ISP-2 subtitles are as follows: general processing (minimum 0–maximum 30), auditory processing (minimum 0–maximum 45), visual processing (minimum 0–maximum 35), tactile processing (minimum 0–maximum 30), vestibular processing (minimum l0–maximum 40). The test paper also includes information about which title each question belongs to, according to sensory system responses and quartiles (sensory seeking, low registration, sensory sensitivity and sensory avoidance). This information makes a great contribution to therapists in terms of providing information about the area in which babies and children have sensory processing problems, as well as about the point of view that should be used in the approach.

Statistical Analysis

Statistical analyses were performed using the SPSS Ver. 21 program (IBM SPSS Statistics; IBM Corporation, Armonk, NY, USA), which was prepared for the Macintosh operating system. The number of individuals was determined to be 30 according to strength analysis in the study (for 80% strength when α=0.05 and β=0.20) (20). Compatibility of the variables to normal distribution was decided using the Kolmogorov-Smirnov test, histograms, and box-line graphs. Descriptive statistics of the data were calculated with mean and standard deviation. The Wilcoxon test was used for the subscales of the NSMDA and for determining the difference between the ISP-2 results in the first and fourth months. Spearman's correlation test was used to analyze the relationship between the NSMDA and ISP-2 results in preterm babies. The relationship was assessed as follows: correlation coefficient 0–0.24: weak, 0.25–0.49: moderate, 0.50–0.74: strong, 0.75–1.00: very strong. A p value of <0.05 was considered statistically significant.

Results

Thirty (53.6%) of 56 babies who were included in the study were twins. Two (3.6%) of the babies had grade 3 intraventricular hemorrhage, five (8.9%) had grade 2 intraventricular hemorrhage, and five (8.9%) had grade 1 intraventricular hemorrhage. The babies' prenatal, natal, and postnatal characteristics are shown in Table 1.

The preterm babies' NSMDA and ISP-2 scores and comparison by months are shown in Table 2. At the adjusted age of 1 month, the NSMDA subdivision scores were found to be lower compared with the normal range scores by the following percentages: gross motor score: 12.73%, fine motor score: 6.9%, postural reactions: 9.92%,

Table 1. Prenatal, natal and postnatal characteristics of the infants

Characteristics (n=56)	Mean±SD
Corrected age (days)	31.48±1.97
Gestational age (weeks)	29.58±2.09
Birth weight (g)	1233.87±251.22
Maternal age (years)	30.5±4.78
Duration of stay in the intensive care unit (days)	26.48±9.58
	n (%)
Sex (male/female)	24 (42.9)/32 (57.1)
Multiple birth	30 (53.6)
Respiratory distress syndrome	11 (19.6)
Bronchopulmonarey dysplasia	1 (1.8)
Necrotizing enterocolitis	0
Intraventricular hemorrhagia 1–3	12 (21.4)

SD: Standard deviation

tactile score: 9.58%, ocular score: 6%, vestibular score: 12.25%, and proprioception: 6.41%. At the adjusted age of four months, the NSMDA subdivision scores were found to be lower compared with the normal range scores by the following percentages: gross motor score: 9.09%, postural reactions: 12.87%, tactile score: 6.25%, ocular score: 4.16%, and proprioception: 2.08%. At the age of 1 month, 8 (14.3%) babies were found to have minimal or mild motor problems, and 4 (7.2%) of these babies were classified as having moderate-severe motor dysfunction at the age of 4 months. A statistically significant difference was found between the babies' NSMDA and ISP-2 scores at the age of 1 month and at the age of 4 months (Table 2).

The ratios of the preterm babies who showed low, normal, and excessive performance according to the ISP-2 subscales, are shown in Table 3. According to the ISP-2 subscales, a problem was found in the area of low registration in 89% of babies at the age of 1 month and in 71% of babies at the age of 4 months, in the area of sensory seeking in 86% of babies at the age of 1 month and in 77% of babies at the age of 4 months, and in the area of sensory avoidance in 91% of babies at the age of 1 month and in 85% of babies at the age of 4 months.

The relationship between gross and fine motor development and sensory process in preterm babies is shown in Table 4. At the adjusted age of 1 month, there was a strong correlation between NSMDA tactile and proprioception subscales and gross motor, fine motor, and functional level. A moderately significant correlation was found between gross motor development scores and ocular scores, and between fine motor development scores and vestibular scores at the age of one month. At the adjusted age of 4 months, a moderately significant correlation was found between gross motor development and functional level and the tactile and proprioception subscale scores. There was a moderately significant correlation between fine motor development and the vestibular and proprioception subscale scores at the age of 4 months.

The ISP-2 showed that there was a moderately significant correlation between gross motor development scores and auditory, visual, tactile and oral-sensory processing. At the adjusted age of 4 months, a significant correlation could not be shown between gross motor development and ISP-2 subscales. Fine motor development was found to have a moderately significant correlation with the ISP-2 subscales of visual and oral-sensory processing at the age of 1 month, and a moderate correlation was found between fine motor development and auditory and movement processing at the age of 4 months. A moderate statistically significant correlation was found between functional level and the ISP-2 subscales general, auditory, visual tactile, and oral-sensory processing. Among the ISP-2 subscales, only the visual processing subscale was found to have a moderate correlation with functional level at the age of four months.

Discussion

This study is the first study to investigate the relationship between gross and fine motor development and sensory development in the first four months in very preterm babies. In our current study, a strong correlation was found between gross and fine motor development and tactile and proprioception senses, especially at the adjusted age of one month. In addition, it was shown that motor and sensory scores in the NSMDA in preterm babies improved significantly with growth at the age of 4 months, though they were below the normal average range. The ISP-2 assessment results showed that the majority of preterm babies carried high risk in terms of sensory development.

Studies in the literature have shown that the rates of neurosensory motor development disorders are higher, especially in preterm babies born at the 32nd gestational week and before, compared with healthy peers (31). Pin et al. (32) stated that facedown and supine motor performances in preterm babies aged 8 months were similar to term babies, whereas a significant difference was found in standing and sitting motor performances between the groups, which are mostly related to the antigravity muscle effect and motor control. In a study in which neurodevelopmental results at the age of one year were investigated in 137 babies born before 30 gestational weeks, Olsen et al. (33) showed that 76.6% of babies had mild-severe functional level according to the NSMDA. In our study,

Table 2. Neuro Sensory Motor Development Assessment Questionnaire and Infant Sensory Profile scores of the preterm infants and their comparison

	1st month Mean±SD (lowest–highest)	4th month Mean±SD (lowest–highest)	Z	p
NSMDA				
Gross motor	**15.71±2.64** (11–22)	**19.3±3.46** (5–24)	-5.58	<0.001[b]
Fine motor	**55.82±7.52** (32–61)	15.23±12.07 (4–60)	-6.44	<0.001[b]
Neurological	53.44±5.52 (27–56)	50.85±3.62 (37–57)	-4.54	<0.001[b]
Postural reactions	**24.32±3.9** (17–39)	**33.98±9.04 (12–39)**	-5.28	<0.001[b]
Tactile	**10.85±2.82** (4–12)	**11.25±2.42 (3–12)**	0.17	0.86
Ocular	**2.82±1.45** (1–12)	**11.5±2.13 (2–12)**	-6.53	<0.001[b]
Vestibular	**10.53±1.68 (6–12)**	12.5±5.27 (8–39)	-3.00	0.003[b]
Proprioception	**11.23±1.54 (8–12)**	**11.75±1.08 (6–12)**	-2.64	0.008[b]
Functional level	6.82±2.57 (5–14)	7.28±3.18 (5–21)	-2.29	0.02[a]
ISP-2				
General processing	12.10±2.78 (10–22)	11.60±2.57 (8–22)	-2.21	0.02[a]
Auditory processing	13.57±4.39 (10–30)	12.57±3.88 (8–30)	-2.53	0.01[a]
Visual processing	13.87±3.61 (10–25)	13.12±12.36 (10–20)	-2.21	0.02[a]
Tactile processing	12.14±3.34 (10–24)	11.64±2.69 (6–23)	-2.02	0.04[a]
Vestibular processing	25.05±3.53 (20–32)	24.14±3.71 (16–30)	-2.21	0.02[a]

Bold: Mean values that are below the normal borderline scores for infants; a: p<0.05; b: p<0.01; NSMDA: Neuro-Sensory Motor Development Assessment; ISP-2: Infant Sensory Profile 2; SD: Standard deviation

gross and fine motor development scores were below the normal range at the first and fourth month, similar to other studies in the literature. However, Olsen et al. (33) dissimilarly classified only 25% of the babies as mild-severe functional level. The accuracy of early neuromotor evaluation is questionable because motor development is fast and extensive and development is influenced by biologic, environmental, and social factors in the first year of life. In a study conducted with children who had cerebral palsy (CP), Burns et al. (28) stated that the best time to evaluate children's developmental status was the eighth month. Therefore, retardation in gross and fine motor development, as well as retardation in growth in risky babies, can be observed more explicitly.

Preterm babies are under risk in terms of sensory development because of exposure to negative sensory stimuli including intubation, heel lance blood sampling, intensive noise, and light, contrary to the safe in utero environment. In a study in which the rates of sensory

Table 3. Sensory responses according to the Infant Sensory Profile

	Low performance (%)	Typical performance (%)	Excessive performance (more than required, %)
Low recording			
1st month	47	11	42
4th month	35	29	36
Sensory quest			
1st month	40	14	46
4th month	36	24	40
Sensory sensitivity			
1st month	42	14	44
4th month	37	23	40
Sensory avoidance			
1st month	45	9	46
4th month	34	15	51

processing disorders were investigated at the age of 4–6 years in children born at the 30th gestational week and before, Ryckman et al. (21) found sensory processing disorder in 50% of the children. Similarly, Chorna et al. (26) found abnormal sensory responses at the age of 12 months in 82% of preterm babies who were born with a birth weight of 1500 g and below. Cabral et al. (14) showed a significant difference, especially in deep pressure sense (tactile) in sensory development in babies aged between 4 and 18 months who were born at the 37th gestational week and before and had stayed in NICU for at least for one day, compared with the term group. Celik et al. (20) found a risk in terms of sensory development in 60% of babies with an adjusted age of 10–12 months who were born before 37 gestational weeks and stayed in the NICU for at least 15 days. In our current study, the sensory development process in the early stage was evaluated in high-risk babies unlike the literature. The risks in terms of sensory responses in preterm babies are classified as low registration, sensory seeking, sensory sensitiveness, and sensory avoidance (29). In accordance with other studies, it was found that the majority of the preterm babies (86–91% at the 1st month, 69–85% at the 4th month) were at risk in terms of sensory development. Proprioception and tactile sense scores in particular were found to be considerably lower compared with the normal range in the babies in our study. Therefore, it is very important to include preterm babies who carry risk in terms of sensory and motor development in appropriate treatment programs by enabling follow-up with neurodevelopmental assessments and detecting developmental disorders in the early stage.

Table 4. Relationship between gross and fine motor development and sensory process in preterm infants

	Gross motor				Fine motor				Functional level			
	1st month		4th month		1st month		4th month		1st month		4th month	
	r	p	r	p	r	p	r	p	r	p	r	p
NSMDA												
Tactile	0.54*	<0.001[b]	0.46	<0.001[b]	0.54*	<0.001[b]	0.11	0.42	0.58*	<0.001[b]	0.43	0.001[b]
Ocular	0.36	0.006[b]	0.25	0.06	0.39	0.03[a]	0.17	0.20	0.22	0.08	0.04	0.74
Vestibular	0.42	0.04[a]	0.20	0.12	0.03	0.81	0.47	<0.001[b]	0.14	0.29	0.23	0.08
Proprioception	0.68*	<0.001[b]	0.37	0.004[b]	0.57*	<0.001[b]	0.47	<0.001[b]	0.62*	<0.001[b]	0.41	0.001[b]
ISP-2												
General processing	0.30	0.02[a]	0.42	0.03[a]	0.13	0.32	0.25	0.04[a]	0.05	0.67	0.18	0.16
Auditory processing	0.27	0.04[a]	0.23	0.27	0.13	0.30	0.09	0.48	0.11	0.38	0.01	0.92
Visual processing	0.30	0.02[a]	0.07	0.56	0.25	0.06	0.26	0.03[a]	0.16	0.23	0.22	0.14
Tactile processing	0.24	0.04[a]	0.39	0.02[a]	0.15	0.24	0.53	0.04[a]	0.14	0.27	0.18	0.17
Vestibular processing	0.30	0.02[a]	0.08	0.52	0.27	0.04[a]	0.55	0.04[a]	0.23	0.08	0.17	0.21

a: p<0.05; b: p<0.01; NSMDA: Neuro-Sensory Motor Development Assessment; ISP-2: Infant sensory Profile 2

In the literature, few studies have examined the relationship between sensory and motor development in preterm babies. Although Cabral et al. (14) found that 53% of preterm babies aged 4–18 months carried a risk in terms of retardation in gross motor development, but they could not find a significant correlation in terms of sensory development. This may be related to the fact that they included babies who were born before 37 gestational weeks and stayed for only one day in the NICU. Chorna et al. (26) showed that preterm babies who had abnormal reactions at the age of 12 months showed worse motor and language development scores at the age of 24 months. Celik et al. (20) proved that there was a strong positive correlation between sensory and motor development in preterm babies at the adjusted age of 10–12 months in a cross-sectional study. In our study, we prospectively investigated the relationship between sensory and motor development in preterm babies at the age of 1 month and 4 months, unlike other studies in the literature. Conclusively, a moderately strong correlation was shown between sensory and motor development. A strong correlation was found between tactile and proprioception senses and gross-fine motor development and functional level, especially at the age of one month. These results indicate that preterm babies should be in close contact with their mothers for accurate tactile and proprioceptive stimuli as soon as they are born.

To the best of our knowledge, no studies in the literature have investigated the relationship between fine motor development and the development of sensory abilities in preterm babies. In our study, a moderate correlation was found between fine motor development and vestibular processing at the age of 1 month and 4 months and a moderate correlation was found between fine motor development and tactile and visual processing responses at the age of 4 months. Chorna et al. (26) found that vestibular processing was influenced with a rate of 21%, tactile processing was influenced with a rate of 49%, and visual processing was influenced with a rate of 33% in preterm babies born before 30 gestational weeks, confirming our results. Similarly, Celik et al. (20) found a moderate correlation between motor development and vestibular and ocular processing responses. In view of these results, it is important to include applications supporting the development of vestibular, ocular, and tactile senses in rehabilitation approaches that aim to support fine motor development in preterm babies.

The lack of long-term results and the absence of a control group are considered among the limitations of our study. More comprehensive studies evaluating motor development and sensory function in the early stage that include a term control group should be conducted.

Considering the results of our study, preterm babies are at risk in terms of motor and sensory development. Therefore, studies demonstrating the effect of early-stage sensory-based intervention programs in preterm babies should be conducted in the future.

Ethics Committee Approval: The study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was obtained from University of Health Sciences, Gulhane Training and Research Hospital local ethics committee (16.10.2018-18/250).

Informed Consent: Written consent was obtained from the parents of all children.

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Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan çocukların ebeveynlerinden alınmıştır.

Hakem Değerlendirmesi: Dış bağımsız.

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