





SENSORY DEVELOPMENT & MULTI-SENSORY PROCESSING

NEUROMOTOR AND SENSORY DEVELOPMENT [24]

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NEUROMOTOR AND SENSORY DEVELOPMENT IN PRETERM INFANTS

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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 sensory development in 88–91% 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.

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 35–62% 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). Gelik 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.

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). Fin 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, 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 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.

In numerous cultures throughout India, Africa and the South Pacific massage is part of regular parenting practices and is handed down from generation to generation. Grandmother teaches mother, mother teaches daughter and baby receives full benefits of this loving tradition.

In New Zealand the Maori mothers provide massage for their babies in the hopes of straightening their legs and improving their nose shape. In Cuba, many mothers rub their baby's tummies with a mixture of oil and garlic to cure their tummy aches.

On the Samoan Islands, it is believed massage with coconut milk, flowers and grass roots may provide the cure for anything from baby's diarrhea or an adult's headache. In New Guinea there is a saying "The baby cries to be closer to the skin of the mother", and in Nepal infants are massaged frequently, often outside in the warm rays of the sunlight. It is common practice to provide massage with mustard seed oil.

In China, techniques of pediatric massage have been practiced by medical professionals. However, the concept of baby massage for health benefits began in China in the mid 1990's, when experts from Beijing, Shanghai and Guangzhou, among other cities, collaborated and introduced this new practice to perinatology. In 1998, baby massage was recommended by the Chinese Nursing Association and the Pediatrics Branch of the Chinese Medical Association

In Indonesia, infant massage has long been practiced as a traditional parenting practice. In Taiwan the number of postnatal care centers is steadily increasing, which presents an excellent opportunity to broaden the benefits of infant massage therapy. Parents are highly motivated to learn about this loving touch, and appear to enjoy more interaction with their infants during the postnatal period.



In Thailand there has been a long history of massage being passed from one generation to the next through education and practice. Clinical interest in the benefits of infant massage has undergone a recent boost in the country, following results from a number of local studies.

In many parts of Europe, the United States, Canada and Australia infant massage has gradually gained in popularity as the large body of touch therapy research lends credibility to the many benefits of the practice of infant massage. Throughout the world infants have received different amounts of honor and respect, which goes in line with the care they receive. In many societies nurturing and close physical contact is the regular standard of care. While in other parts of the world, babies are left in their cradle or crib to cry to sleep. Many of our attitudes around the care and treatment of infants has been influenced by those who have come before us.

Discovered in the 19th century, Marasmus, is the lack of tactile stimulation and interaction. Marasmus comes from a Greek word for "wasting away". It resulted in death among many hospitalized babies. Doctors later discovered that this disease was caused by a lack of touch: babies not touched on a regular basis would literally starve themselves to death. A child with marasmus looks emaciated and body weight may be reduced to less than 80% of the normal weight for that height.

In the early 1900's, Dr. Henry Dwight Chapin, a well known pediatrician, made the case against orphanages and for family foster care. Henry Dwight Chapin began with statistical findings about infant mortality, but also suggested that institutional child care was damaging even for those children lucky enough to survive it. At risk, according to Chapin, was the long-term mental and emotional development of children in orphanages or asylums. In 1915 he had discovered that amongst children in institutions in ten cities, every infant under the age of two had died in all but one institution.

John B. Watson was an American psychologist who established the psychological school of behaviorism, after doing research on animal behavior. He is known for having claimed that he could take any 12 healthy infants and, by applying behavioral techniques, create whatever kind of person he desired.

He is the author of "Psychological Care of Infant and Child" (1928), and believed parents should teach an infant to "Master his schedules" and that parents should keep an emotional distance from the child in order to resist the "animal impulse" to pick up their baby. Watson's advice to treat children with respect, but with relative emotional detachment, has been strongly criticized.

"Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select – doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.

I am going beyond my facts and I admit it, but so have the advocates of the contrary and they have been doing it for many thousands of years."

- John B. Watson

Among the doctors who were confronted with infant mortality daily was Dr. Fritz Talbot of the Children's Clinic in Dusseldorf. Dr. Talbot had uncommon success in dealing with sick children. He introduced the concept of the "Tender Loving Care" approach, after witnessing a grandmotherly caregiver ("Old Anna"), who held, carried and touched the babies. She had success with the infants after all medical interventions were exhausted.

One intern under Dr. Talbot relates, "Many times we would come across a child for whom everything had failed. For some reason the child was hopelessly wasting away. When this would happen, Dr. Talbot would take the child's chart and scrawl some indecipherable prescription - Old Anna. In most of the cases, the magic formula took effect and the child began to prosper. My curiosity was aroused and I wondered if the famous doctor had developed some new type of wonder drug."

"Whenever we have a baby for whom everything we could do had failed, we turn the child over to Old Anna. She has more success than all the doctors and nurses in this institution combined." - Head Nurse, Children's Clinic in Dusseldorf

Dr. Luther Emmett Holt was the president of the American Pediatric Society, the director of Babies' Hospital in New York, a pediatrician to the Rockefellers, and the author of "The Care and Feeding of Children" (1894), (15th edition in 1935). His book greatly influenced America with his teachings of abolishing the cradle/rocking. He believed in strict schedules, for both feeding and sleeping. He said that toilet training could be achieved by the age of three months, "if begun early." He warned mothers against cuddling or playing with their babies; this over stimulated them and gave them germs. Even a crying baby, Holt said, should not be picked up. Crying was necessary for health: "It is the baby's exercise."

Considered "a classic" work by many parents, Dr Spock's Baby and Child Care, originally published in 1946, sold over 50 million copies and was the guidebook to rearing the generation of baby boomers. Spock advocated ideas about parenting that were, at the time, considered out of the mainstream. Over time, his books helped to bring about a major change, if not a reversal, in the opinions of those who considered themselves to be the experts. Previously, experts had told parents that babies needed to learn to sleep on a regular schedule, and that picking them up and holding them whenever they cried would only teach them to cry more and not to sleep through the night (a notion that borrows from behaviorism). They were told to feed their children on a regular schedule, and that they should not pick them up, kiss them, or hug them, because that would not prepare them to be strong and independent individuals in a harsh world. Spock encouraged parents to see their children as individuals, and not to apply a one-size-fits all philosophy to them. The book sharply broke with the authoritarian tone and rigorous instructions found in earlier generations of baby-care books, most of which said to feed infants on a strict schedule and not to pick them up when they cried. In 1968 he revised Baby and Child Care to make his intentions more clear, now cautioning his readers "Don't be afraid that your children will dislike you" if you set those limits and enforce them.

An amazing study completed in the 20th century by touch researcher Ashley Montagu found that children deprived of loving touch suffer the consequences in their bones – small lines of retarded growth, known as Harris lines, appear at the ends of the tibia and the radius.

Along with a team of researchers, Dr. Tiffany Field at The Touch Research Institute at the University of Miami, further confirms the need for touch in early development.

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