

# Prediction of Behavioral Problems Based on Attachment Styles and Sensory Processing in Children with a History of Prematurity at Birth

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## ABSTRACT

**Background:** Despite significant advancements in the care of premature infants, it must be acknowledged that premature infants, especially low birth weight infants, are prone to problems such as sensory, cognitive, neuro-motor, visual, and hearing problems. Their objective future difficulties are behavioral abnormalities, socio-emotional difficulties, and impaired school performance.

**Methods:** This research aimed to predict behavioral problems based on attachment styles and sensory processing in children with a history of prematurity at birth. The research method was a descriptive cross-sectional study. The study population consisted of all 5 to 12-year-old children in Tehran in the year 2022; among them, 154 children aged 5 to 12 years old with a history of prematurity at birth were selected by the convenience sampling methods. Data were collected using the Sensory profile2-child, Kinship Center Attachment Questionnaire, and Strengths and Difficulties Questionnaire. Data were analyzed using the Pearson correlation coefficient and regression analysis.

**Results:** The findings demonstrated a significant negative correlation between adaptive development and children's behavioral problems ( $r=-0.65$ ,  $p<0.05$ ). Moreover, a significant positive relationship was found between attachment styles and emotional reactivity ( $r=0.64$ ,  $p<0.05$ ), negative behaviors, and avoidance of attachment figure support ( $r=0.67$ ,  $p<0.05$ ), as well as sensory processing and behavioral problems in children with a history of prematurity at birth ( $r=0.67$ ,  $p<0.05$ ). Additionally, motor processing ( $\beta=0.22$ ,  $p<0.05$ ), emotional reaction ( $\beta=0.17$ ,  $p<0.05$ ), and avoidance of attachment figure support ( $\beta=0.17$ ,  $p<0.29$ ) were capable of predicting behavioral problems in children with a history of prematurity at birth.

**Conclusion:** It was concluded that as the levels of attachment styles, emotional reactions, negative behaviors, and avoidance of attachment increase in children with a history of prematurity, their behavioral problems increase as well. Conversely, increased positive adaptive development is associated with decreased behavioral problems.

**Keywords:** Attachment disorder, Behavioral problems, Bonding, Premature births, Sensory processing

## Introduction

Every year, 15 million premature infants are born worldwide, constituting more than 10% of all newborns globally (1). The World Health Organization classifies infants born before 37 weeks of gestation as premature, including moderate preterm (32-37 weeks), very preterm

(28-32 weeks), and extremely preterm (less than 28 weeks) infants (2). Iran is also among the regions with a high prevalence of preterm birth, with approximately 5,000 daily births, of which around 10% are preterm and low birth weight (3).

Despite advancements in maternal care and

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technological progress, the rate of preterm birth has not significantly changed in the past 40 years and has even shown an increase in the past two decades (4). Preterm birth is one of the most important causes of neonatal mortality and the second leading cause of child mortality after illness (5). Premature infants play a crucial role in determining community health and well-being. The resulting complications impose significant costs on these families and, consequently, on the entire healthcare system (6).

Despite significant advancements in the care of premature infants, it must be acknowledged that low-birth-weight infants are prone to problems such as sensory-neurological impairments, cerebral palsy, cognitive and speech delays, neuro-motor and visual impairments, hearing loss, behavioral abnormalities, socio-emotional difficulties, and impaired school performance too (7,8).

According to the study by Rodrigues et al. (2022), approximately 20% of children born very prematurely experience behavioral problems, and internalizing problems are much more prevalent in these children compared to externalizing problems (9). Researchers have found a positive and significant relationship between behavioral problems and lower cognition in preterm children during school years (10). Therefore, one of the fundamental issues in preterm infants is their future behavioral problems, which encompass behaviors that are inappropriate for their age, severe and chronic, or persistent, ranging from hyperactive and aggressive behaviors to withdrawn/autistic-like behaviors.

Lack of proper attachment and bonding with the primary caregiver not only makes the infant emotionally vulnerable but also sets the stage for future emotional disorders (11).

Attachment is the emotional bond between an infant and its parent figure or caregiver; it is developed as a step in establishing a feeling of security and demonstrated by calmness while in the parent's or caregiver's presence (11). Furthermore, bonding can be defined as: "...a maternal-driven process that occurs primarily throughout the first year of an infant's life but may continue throughout a child's life. It is an affective state of the mother; maternal feelings and emotions towards the infant are the primary indicators of maternal-infant bonding (9).

Premature infants also demonstrate a high level of co-occurring atypical sensory processing and behavioral problems (12). Studies have shown that children born preterm exhibit

different sensory responses and may display variations in sensory processing (13).

Studies conducted on children with a history of prematurity have shown that prematurity impacts behavioral problems. However, limited research exists on the relationship between attachment styles, sensory processing, and behavioral problems in children with a history of prematurity at birth. Therefore, considering the points mentioned above, the main objective of this study was to predict behavioral problems in children with a history of prematurity at birth based on attachment styles and sensory processing.

## Methods

This study was an analytical cross-sectional study with a multiple regression analysis.

### Participants

In 2022, an online call was made to invite all 5 to 12-year-old children in Tehran who had a history of being born before 37 weeks of gestation to participate in this study.

### Sampling and Non-Probability Sampling

In this study, participants were selected using the convenience sampling method in 2023, from May 22 to August 21; the samples were collected from 5 regions of Tehran (North, South, Center, East, and West) and on the virtual space platform. The sample size was calculated using the Tabachnick and Fidell formula ( $n > 50 + 8M$ ). The formula  $N$  represents the sample size, and  $M$  represents the number of independent variables (sensory processing subscales (9) and dimensions of attachment style (4)), so the sample size achieved 154 ( $n > 50 + 8(9+4) = 154$ ).

### Procedure

To conduct the research, the questionnaires were distributed online through links in messaging applications such as Telegram, WhatsApp, Eltaa, and Soroush among parents of children with a history of being born before 37 weeks of gestation. It should be noted that the third researcher of the study is one of the nurses working in the NICU. By communicating with other nurses and presenting the code of ethics to the relevant hospitals, he got access to the files of neonates with a history of prematurity, the children's details, and their parents' contact numbers. In the meantime, explanations were provided about the importance and objectives of the research, and parents were assured that the results would be used solely for research

purposes and that their information would remain confidential by telephone. If the parents agreed, the information was sent to them on the platform's virtual networks. Out of 306 contacts, 186 parents agreed to cooperate in this study. After removing incomplete questionnaires (23) and receiving dissent from some parents for data analysis (9), 154 data sets were collected for analysis.

### **Data Collection Tools**

In this study, the data were collected using questionnaires, including the Sensory Profile – Child Form, the Middle Childhood Attachment Interview, and the Child Behavior Checklist for assessing abilities and behavioral problems in children.

### **Sensory profile2-child**

It is a standardized measurement tool for assessing sensory processing abilities in children at home and in the community. Dunn designed it in 2014 and applies for the age range of 3 to 14 years. The questionnaire consists of 86 items. Parents rate each item on a Likert-style scale with six degrees (almost always, frequently, sometimes, rarely, almost never, and does not apply). The different sections of the questionnaire (sensory seeker, sensory avoider, sensory sensitivity, sensory registration, auditory processing, visual processing, tactile processing, movement processing, body awareness, oral sensory processing, behavioral responses, emotional-social responses, and cognitive responses) are measured using a five-point cutoff scale, which includes much less than others, somewhat less than others, similar to others, somewhat more than others, and much more than others. Each section has its cutoff points. The validity and reliability of the Sensory Profile Questionnaire-Child Form 2 have been examined in Iran by Shahbazi et al. (2021). The Cronbach's alpha coefficient for all sections ranges from 0.45 to 0.97 in Iran. The completion time for the questionnaire by the child's caregiver is 15 to 20 minutes, and the scoring time for the specialist is 30 minutes (14).

### **Kinship Center Attachment Questionnaire (KCAQ)**

This questionnaire was designed by Halpern and Cappenberg (2006). It consists of 20 questions and aims to measure attachment relationships in middle childhood (pre-school and elementary school) (ages 3 to 12) from different

dimensions (positive adaptive development, emotional response, negative behaviors, avoidance of attachment figure/support, and approach to attachment figure/support). Parents rate each item on a five-point Likert scale (never, rarely, sometimes, often, and always). The final scores are summed, with a minimum possible score of 20 and a maximum of 100. Scores between 20 and 40 indicate low attachment, scores between 40 and 60 indicate moderate attachment, and scores above 60 indicate high attachment. Soleimani et al. (2014) examined this questionnaire's validity and reliability in their research. The factor analysis results showed that the KMO test was 0.73, indicating an acceptable level. The test-retest reliability of this questionnaire was reported as ICC=0.79 (15).

### **Strengths and Difficulties Questionnaire (SDQ)**

This behavioral screening questionnaire is for children aged 3 to 16, based on the diagnostic criteria ICD-10, developed by British psychiatrist Robert Goodman (1997). The Strengths and Difficulties Questionnaire (SDQ) has several versions to meet the needs of researchers, physicians, and educational specialists, including a parent version, a teacher version, and a self-report version. In this study, the parent version was used. The SDQ measures approximately 25 positive and negative behavioral attributes of the child. These 25 items are divided into five scales: Emotional Problems, Conduct Problems, Hyperactivity/Inattention, Peer Relationship Problems, and Prosocial Behavior. The questions are scored on a 3-point Likert scale, ranging from "Not true" to "Somewhat true" to "Certainly true," with scores ranging from 0 to 2. The score of each subscale is calculated by summing the scores of the corresponding questions—the scores of each behavioral scale range from 0 to 20 for internalizing and externalizing behaviors. The internal consistency of the Persian version of the questionnaire has been reported by Ghanizadeh et al. (2007) as 0.73 using Cronbach's alpha (16).

### **Data Analysis**

This study analyzed the data using descriptive and inferential statistics. Descriptive statistics include frequency, percentage, mean, and standard deviation, while inferential statistics include Pearson correlation and multiple regression analysis using the simultaneous method. The data analysis was performed using SPSS 26 software.

### Ethical approval

All parents gave informed consent before participating in the study. The ethical committee of Shahid Beheshti University of Medical Sciences approved this research study (Ethical code: IR.SBMU.RETECH.REC.1402.218).

### Results

In this study, 84 girls (54.5%) and 70 boys (45.5%) participated, with 26% of them (n=40) being 5 to 6 years old, 32.5% (n=50) being 7 to 8 years old, 21.4% (n=33) being 9 to 10 years old, and 20.1% (n=31) being 11 to 12 years old, with a mean±sd age of (8.03±2.74). The highest frequency was related to the age group of 7-8 with 50 participants (32.5%), and the lowest frequency was related to the age group of 11-12 with 31 participants (20.1%). In this study, 78.6% of children (n=121) were born between weeks 33 and 37 of pregnancy, 19.5% (n=30) were born between weeks 28 and 32 of pregnancy, and 1.9% (n=3) were born before 28 weeks of pregnancy. The highest frequency was related to the weeks 33-37 group with 121 participants (78.6%), and the lowest frequency was related to the before 28 weeks group with 3 participants (1.9%). In this study, 133 mothers (86.4%) and 21 fathers (13.6%) completed the questionnaires.

We calculated the mean and standard deviation of the research variables (Table 1) to provide a clearer visual representation of the variables examined in this study.

As shown in Table 1, the mean and SD of the total score of sensory processing were 77.80±19.185; adaptive development was 5.30±0.792; emotional reaction was 3.45±0.571; negative behaviors were 5.30±0.513, avoidance of attachment face/support was 4.40±0.389, and behavioral problems were 6.53±0.382, respectively.

We used the Kolmogorov-Smirnov test to evaluate the normality of the sample distributions, and the results indicated that the variables were normally distributed ( $p > 0.05$ ). Therefore, Pearson's correlation coefficient was used to examine the relationship between attachment styles and behavioral problems, as well as sensory processing and behavioral problems in children with a history of prematurity at birth.

To explore the prediction of behavioral problems based on attachment styles and sensory processing in children with a history of prematurity at birth, it was necessary first to examine the relationship between attachment styles and behavioral problems and sensory processing and behavioral problems in children with a history of prematurity at birth.

As observed in Table 2, Pearson's correlation coefficient results indicated a significant negative correlation between secure attachment ( $r=0.65$ ,  $p < 0.05$ ) and behavioral problems in children with a history of prematurity at birth. Moreover, there is a significant positive correlation between emotional reaction ( $r=0.64$ ,  $p < 0.05$ ), negative behaviors ( $r=0.67$ ,  $p < 0.05$ ), and avoidance of attachment face/caregiver ( $r=0.73$ ,  $p < 0.05$ ) with behavioral problems in children with a history of prematurity at birth.

Furthermore, the results showed a significant positive correlation between sensory processing ( $r=0.67$ ,  $p < 0.05$ ) and its components, including auditory processing ( $r=0.44$ ,  $p < 0.05$ ), visual processing ( $r=0.49$ ,  $p < 0.05$ ), tactile processing ( $r=0.54$ ,  $p < 0.05$ ), motor processing ( $r=0.55$ ,  $p < 0.05$ ), proprioceptive processing ( $r=0.54$ ,  $p < 0.05$ ), oral processing ( $r=0.53$ ,  $p < 0.05$ ), sensory processing-related behavioral responses ( $r=0.69$ ,  $p < 0.05$ ), social-emotional responses related to sensory processing ( $r=0.64$ ,  $p < 0.05$ ), and cognitive responses related to sensory processing

**Table 1.** Descriptive statistics of sensory processing characteristics of children (n=154)

Variable	Mean	Standard Deviation (SD)
Auditory processing	19.69	7.11
Visual processing	15.45	6.32
Touch processing	18.88	11.25
Motion processing	16.15	8.54
Posture processing	15.23	10.64
Oral processing	22.69	11.45
Behavioral responses related to sensory processing	20.48	10.07
Social emotional responses related to sensory processing	34.73	15.44
Mental responses related to sensory processing	21.89	11.11
Sensory processing total score	185.19	77.80
Positive adaptive evolution	20.79	5.30
Emotional reaction	11.57	3.45
Negative behaviors	13.05	5.30
Avoiding the support of an attachment figure/caregiver	9.38	4.40
behavioral problems	21.38	6.53

**Table 2.** Results of Pearson's correlation coefficient between sensory processing and behavioral problems in children (n=154)

predictor variables	Criterion variable	The correlation coefficient (r)	P value
Positive adaptive evolution	behavioral problems	-.65**	0.0001
Emotional reaction		.64**	0.0001
Negative behaviors		.67**	0.0001
Avoiding the support of an attachment figure/caregiver		.73**	0.0001
Auditory processing		.44**	0.0001
Visual processing		.49**	0.0001
Touch processing		.54**	0.0001
Motion processing		.55**	0.0001
Posture processing		.54**	0.0001
Oral processing		.53**	0.0001
Behavioral responses of sensory processing		.69**	0.0001
Social emotional responses, sensory processing		.64**	0.0001
Mental responses of sensory processing		.61**	0.0001
Sensory processing total score		.67**	0.0001

\*\* : P value <00.01

(r=0.61, p < 0.05) with behavioral problems in children with a history of prematurity at birth.

In this study, the multiple correlation coefficients between attachment styles and sensory processing with behavioral problems in children were obtained as 0.85 (R). The adjusted coefficient of determination was 0.70 (R<sup>2</sup>), indicating that approximately 70% of the variance in children's behavioral problems can be explained by the predictor variables (attachment styles and sensory processing). Additionally, according to Table 3, the value of the Durbin-Watson statistic falls between 1.5 and 2.2, indicating the absence of autocorrelation among errors and lack of correlation between errors. This statistic demonstrates the validity of using the regression model.

Multiple correlation was used to predict behavioral problems in children based on attachment styles and sensory processing.

The analysis of variance (ANOVA) test results were utilized to examine the regression model. Based on the results presented in Table 4, the obtained F-value is 28.49, which is significant at a level less than 0.01. This indicates the adequacy of the proposed regression model. The results of the multiple regression analysis showed that

attachment styles and sensory processing significantly predicted behavioral problems in children.

The regression coefficients of the variables in the regression analysis are shown in Table 5. Results indicated that the statistical significance level of the t-statistic is less than 0.05 for the components of motor processing, emotional reaction, and avoidance of attachment face/caregiver, indicating their significance. Therefore, it can be concluded that motor processing, emotional reaction, and avoidance of attachment face/caregiver are capable of predicting behavioral problems in children with a history of prematurity at birth. Considering the beta weights (regression coefficients), the equation for the effect of attachment styles and sensory processing on children's behavioral problems is as follows: Behavioral problems = 9.25 + Motor processing (0.22) + Emotional reaction (0.17) + Avoidance of attachment face/caregiver (0.29). The positive values of β for motor processing, emotional reaction, and avoidance of attachment face/caregiver indicate that with each unit increase in these three dimensions, behavioral problems in children increase by 0.22, 0.17, and 0.29 units, respectively.

**Table 3.** Validity assessment of the regression model

Multiple correlation coefficient	Squared multiple correlation	Adjusted squared multiple correlation	Watson's statistic
0.85	0.72	0.70	1.91

**Table 4.** Results of the analysis of variance (ANOVA)

Source of changes	sum squares	DF	Mean squares	F	P value
Regression	4739.16	13	364.55	28.49	0.0001
Residual	1791.23	140	12.79		
Total	6530.39	153			

**Table 5.** Regression analysis of the variables

predictor variables	B	Std. Error	Beta	T	P value
Constant	9.25	3.17		2.91	.004
Auditory processing	.084	.063	.091	1.33	.18
Visual processing	-.064	.077	-.062	-.82	.41
Touch processing	-.049	.051	-.085	-.96	.33
Motor processing	.17	.061	.22	2.82	.005
Posture processing	.097	.052	.15	1.87	.06
Oral processing	-.02	.04	-.03	-.45	.65
Behavioral responses to sensory processing	.080	.064	.12	1.26	.21
Emotional responses of social sensory processing	.025	.040	.059	.62	.53
Subjective responses of sensory processing	.092	.054	.15	1.71	.08
Positive adaptive transformation	-.16	.094	-.13	-1.75	.08
Emotional reaction	.33	.11	.17	3.00	.003
Negative behaviors	.19	.099	.15	1.94	.054
Avoiding the support of an attachment/caring face	.43	.12	.29	3.40	.001

## Discussion

The results of the present study indicated a significant negative correlation between positive adaptive development and behavioral problems in children. There was also a significant positive association between emotional reaction, negative behaviors, and avoidance of attachment face/caregiver with behavioral problems in children with a history of prematurity at birth. These findings demonstrate that as the levels of attachment styles, emotional reactions, negative behaviors, and avoidance of attachment face/caregiver increase in children with a history of prematurity, their behavioral problems increase as well. Conversely, increased positive adaptive development is associated with decreased behavioral problems.

These findings are consistent with the results of studies conducted by Dagan et al. (2021) (17) and Esmaeili et al. (2021) (18), which have provided similar results regarding the relationship between attachment styles and behavioral problems in children. Regarding the explanation of attachment styles, it can be stated that attachment experiences are fundamental for healthy social and emotional development. Secure attachment effects include trust, the formation of mutually loving and intimate relationships, positive self-esteem, autonomy, and future self-management skills in dealing with impulses and emotions. According to Bowlby's theory, secure attachment provides a solid foundation for coping skills, including the ability to regulate emotional behaviors in children. Attachment disorders have significant effects on social disconnection and problems related to emotional regulation (19). According to attachment theory, the initial interaction between the child and the primary caregiver is

internalized and encoded into beliefs, expectations, emotions, defenses, and relational behaviors. These developmental stages influence the person's expectations, emotions, defenses, and relational behaviors. Furthermore, the effects of childhood attachment extend into adulthood in terms of emotional, cognitive, and close relationship schemas (20).

A healthy initial bond between parent and child leads to secure attachment, which facilitates the development of social and behavioral skills in future years (21).

Anxiety and feelings of insecurity in the mother can be transmitted to the child through the creation of an unhealthy emotional upbringing environment, abnormal interactive relationships between the mother and child, and a decrease in maternal sensitivity (22). Full-term and healthy babies bond with their mothers immediately after birth by being hugged. However, this bonding is delayed for premature babies, especially babies who have a history of hospitalization in the neonatal intensive care unit. It provides insecure and anxious attachments for the baby in the future (23).

The results of the present study demonstrated a significant positive relationship between sensory processing and behavioral problems in children with a history of prematurity at birth. This finding indicated that the more inappropriate the sensory processing of children with a history of prematurity at birth, the more severe their behavioral problems, and conversely, the more appropriate their sensory processing, the fewer behavioral problems they exhibit. This finding is consistent with the results of studies by Chen et al. (2021) (12) and Shafaghatian et al. (2022) (3), which have

provided similar findings regarding the relationship between sensory processing and behavioral problems in children and support the findings of this study. In the study of Shafaghatian et al. (2022), most preterm infants have sensory processing disorders, which leads to neurodevelopmental delays (3).

Although the precise mechanisms of the relationship between sensory processing problems and behavioral difficulties are not yet clear, one hypothesis is that sensory processing problems may lead to difficulties in emotion regulation and behavior. This can result in children with sensory processing problems having fewer opportunities for positive interactions with peers, potentially leading to limited development of social-emotional skills (Dunn, 2007) (24).

A child with sensory processing disorders may react unpredictably or seemingly without reason to their caregiver or the environment. Difficulty in organizing sensory information such as tactile, olfactory, visual, auditory, movement, or body position leads to various patterns of sensory responsiveness that can negatively affect an individual's ability to adapt to daily situations, interact with the environment, participate in social skills, and engage in school activities (25). Consequently, caregivers of these children often feel inadequate and experience significant stress compared to caregivers of children without sensory processing disorders (26).

According to the study by Garcia Quiroga et al. (2016), sensory processing patterns, as part of everyday life events, significantly impact human experience and behavior (27). Thus, sensory processing is an important and unique component of personality that potentially contributes to genetic susceptibility to various psychopathological conditions, especially neurotic disorders (28).

The results also indicated that 70.0% of the variance in behavioral problems in children is explained by the predictive variables (attachment styles and sensory processing), as well as the components of motor processing, emotional reactivity, and avoidance of attachment/facial support. This finding is consistent with the results of studies by Chen et al. (2021) (12) and Duggan et al. (2021) (17).

Children and adolescents with insecure attachment feel constant restlessness, are unable to trust others, and sometimes experience extreme feelings of detachment and

isolation. They seek someone or something that can provide them with a sense of security, and regardless of other personal and social characteristics, they engage in any action upon receiving the smallest positive signal. This can lead to externalizing behavioral problems in these children (29).

Based on the findings, it can be said that prematurity can lead to sensory processing disorders, and not having good bonding because of environmental barriers (hospitalization in NICU) leads to a bad attachment style between infant and mother that both lead to behavioral problems in the future. So, it is suggested that the healthcare system should intervene in a timely manner to improve sensory processing and foster good bonding.

### **Limitation**

The most important limitation of the study mentioned was that the parents completed the questionnaires online, which was done due to the inability to reach the parents in person. Another limitation of the current study is the study method (cross-sectional study), which reduces the generalizability of the data, and caution should be taken to generalize the results.

### **Conclusion**

This study concluded that a significant positive relationship was found between attachment styles and emotional reactivity, negative behaviors, and avoidance of attachment figure support, as well as sensory processing and behavioral problems in children with a history of prematurity at birth. Additionally, motor processing, emotional reactivity, and avoidance of attachment figure support were capable of predicting behavioral problems in children with a history of prematurity at birth.

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### **Conflicts of interest**

The authors declare that they have no conflicts of interest.

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