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Association between the motor optimality score-revised and clinical variables of preterm infants

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Abstract

Background The goals of this study were to examine the motor repertoire and Motor Optimality Score-Revised (MOS-R) scores among the premature groups (very, moderate, and late preterm) and ascertain the connection between these metrics and the clinical variables of infants.

Methods This study was a retrospective cohort study. Sixty-eight preterm infants, who were followed-up in a reference university hospital, were included. Prechtl's General Movement Assessment (GMA), including the MOS-R, was used as an assessment tool. Clinical variables, such as preterm birth, birthweight, length of hospitalization, admission at neonatal intensive care unit, use of invasive mechanical ventilation, duration of oxygen therapy were collected. Infants were videoed at least single time for 2–3 min between the age of 10–16 weeks corrected age.

Results The median MOS-R score was 21 in the very preterm group, 23 and 24 in the moderate and late preterm groups, respectively. Early preterm infants had lower MOS-R (p:0.003) and motor repertoire scores (p:0.007) compared to moderate-late preterm groups. MOS-R scores of the infants were associated with gestational age, bronchopulmonary dysplasia, neonatal intensive care (NICU) stay, ventilation and oxygen duration ($p < 0.05$). The same results were obtained for the motor repertoire score, except for gender ($p < 0.05$).

Conclusion We think that it is important to closely monitor infants who have been hospitalised for a long time, who have a lower gestational age, history of bronchopulmonary dysplasia and prolonged ventilation or oxygen intake and who are in the high-risk group and to start early intervention when necessary.

Keywords Early preterm birth, Moderate-late preterm birth, Motor optimality score, General movement assessment

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Introduction

Preterm births, defined as occurring before 37 weeks of gestation, represent 11.5% of all live births [1]. The advent of scientific and clinical advances, including assisted ventilation, steroid therapy during pregnancy, and the administration of exogenous surfactant, has contributed to a notable increase in the survival of these infants [2]. The preterm infants are at risk of delays and impairments in neurodevelopment due to a number of factors [3, 4]. The term "risk factor" is used to describe a series of biological or environmental conditions that have been identified as increasing the probability of deficits in a child's development [5]. These factors include but not limit a shorter gestation length, low birth weight, or longer periods of hospitalization in an intensive care unit (ICU), and male gender [6]. A meta-analysis demonstrated that the prevalence of mild to moderate motor impairment in children born preterm was 41% and 19% [7]. The early years of a child's life are considered essential for building a strong foundation for lifelong development. Therefore, impaired early motor development can affect an individual's health, resulting in cognitive impairment, learning disabilities, speech and language problems, and behavioural and speech disorders [8].

Motor development is one of the key indicators used to assess infant well-being and growth, and it is a crucial factor in clinical decision-making regarding the initiation of early intervention [3, 9]. The ability to distinguish gross motor development may prove beneficial in a number of ways. Such knowledge may inform clinical decision-making, influence the design of early interventions, and assist in setting realistic expectations for parents [10]. The General Movements Analyses (GMs) is a widely utilized tool for the assessment of predictive validity in cases of motor and cognitive delays [11]. Fidgety movements, which are characterized by constant, small-amplitude movements of moderate velocity, are one type of spontaneous movement pattern. From 9 to 20 weeks of corrected age, an awake infant's complete body can usually be identified by these movements [12]. Fidgety movements (FMs) can be classified as normal, aberrant (exaggerated with higher amplitude), sporadic (seen only occasionally), or absent (not detected at all). The extension of the GMs semi-quantitative measure, designated the Motor Optimality Score (MOS), has been developed and revised in 2019 as the Motor Optimality Score-Revised (MOS-R) [13]. An infant's motor movements and patterns between 9 and 20 weeks of corrected age (CA) are optimally scored by the MOS-R. The MOS-R may facilitate a more reliable correlation with subsequent developmental outcomes or serve as an indicator of motor severity [14]. The utilization of MOS-R for the screening of motor outcomes presents a number of advantages. These include the possibility of conducting the screening without the involvement of an assessor, the ability to analyse parent-provided video recordings in a home setting [15], and the potential for future automated computer vision analyses [16]. In contrast to performance-based tests such as AIMS and Bayley, which assess whether infants can perform a specific skill, MOS-R evaluates the quality, variety, and symmetry of their spontaneous movements [13].

A number of studies have sought to establish a link between the early and long-term developmental outcomes of premature infants [17, 18]. However, there is a paucity of research examining the relationship between biological factors and the early motor repertoire of these infants [19]. The majority of studies have concentrated on the long-term outcomes of children born extremely or very preterm (i.e., < 28 or 28–32 weeks, respectively). However, it is important to note that children born moderately or late preterm (i.e., 32–33 or 34–36 weeks, respectively) account for approximately 80% of all children born preterm [20]. Therefore, this study's objectives were to compare the MOS-R and motor repertoire scores between the premature groups (very, moderate, late preterm) and determine the relationship between MOS-R, motor repertoire scores and clinical characteristics of infants. The primary aim was to compare MOS-R, motor repertoire scores among the premature groups (very, moderate, late preterm). The secondary aim was to investigate the associations between the clinical variables with the MOS-R, and motor repertoire scores?

Methods

Ethics committee approval

This is a retrospective cohort study approved by the Human Research Ethics Committee at the Karadeniz Technical University of Health Science Faculty. All procedures performed involving human participants followed the Declaration of Helsinki. A signed informed consent form was obtained from the parents of the infants since the study involves video recording.

Participants

The preterm infants were recruited from the risky infant follow-up unit of the Department of Paediatric Neurology at Karadeniz Technical University, Farabi Hospital, Trabzon, Turkey. Trabzon is situated in the eastern and northern regions of the country. This state research hospital serves as the national reference service for risky infants in the Eastern Black Sea region with a population of approximately 2,566,840. Data collection occurred in between January 2022 and June 2024. All infants' medical files were kept regularly between these dates and were reviewed and analyzed retrospectively.

Within the scope of this study, premature infants whose parents submitted videos and whose videos were eligible were included. Exclusion criteria were a diagnosis of

genetic or metabolic syndrome. In addition, babies who cried, were restless, or had a pacifier in their mouth during the video recording were not included in the study (Fig. 1).

Data collection

When the infants were admitted to the risky infant follow-up unit, demographic information and hospital medical information forms were recorded. Afterwards, the families were asked to come for a follow-up visit at the corrected 10–16 weeks of age. During this interval, videos were taken and recorded by the families or by the clinician. It was also planned to follow up the infants at regular intervals. The infants were recorded in a quiet, calm state (without a dummy), dressed in a body with short sleeves and legs, or wearing nothing but a nappy in the supine position either in the clinic by an expert or at home by the parents. Video recordings made between 10 and 16 gestational weeks. Video was recorded for 2 to 3 min while infants were actively moving. When families submitted multiple videos for evaluation, the video with the higher MOS-R score was analyzed. Video recordings were evaluated by a Prechtl GMs certified assessors (two paediatric physiotherapists with GM Trust advanced course certificate). One of the assessors (T.A.) was blinded to clinical history. The final joint decision of the assessors was recorded. The inter-rater agreement had an intraclass correlation coefficient (ICC) of 0.849 for raters. All infants included in this study are followed up with a routine programme because they were born prematurely. Motor development is followed up regularly with the Alberta Infant Motor Scale and language and cognitive development is followed up with the Bayley Scales of Infant and Toddler Development-III (Bayley-III). In addition, MRI is routinely requested between 12 and 24 months in high-risk infants and cerebral palsy (CP) is

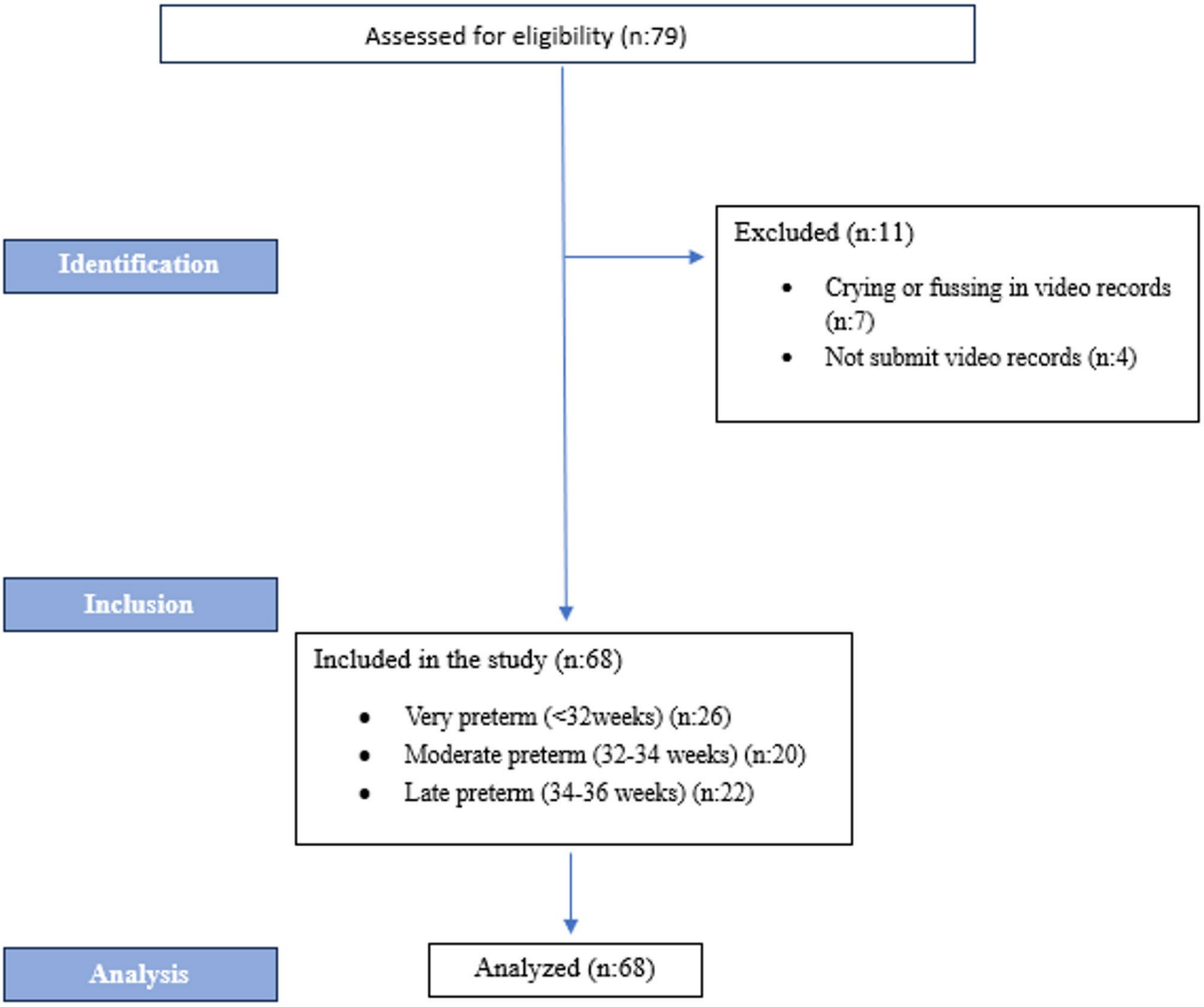


Fig. 1 STROBE flow chart. STROBE, The strengthening the reporting of observational studies in epidemiology

diagnosed by a paediatric neurologist according to physical examination and MRI findings. Infants identified to be at high risk of CP in the early period were referred for early intervention.

General movement assessment

We used the MOS-R to classify FMs at 10–16 weeks gestation and also comprehensively evaluate other behaviours in the infant's motor repertoire, such as movement patterns, posture, and movement quality. Previous studies have demonstrated that the MOS-R is a highly reliable instrument, between 0.86 and 0.98 for intraclass correlation coefficients [19, 21]. The appearance of FMs, described as minor, multidirectional motions of the neck, shoulders, wrists, knees and hips, is a promising indicator of typical infant development. Conversely, the lack of FMs is highly indicative of CP, with a sensitivity of 95%. The MOS-R represents a modification of the original MOS [13]. Five subcategories comprise the MOS-R: a) temporal organization of fidgety movements (maximum 12 points) (b) observed movement patterns (other than fidgety movements; maximum four points); (c) age-appropriate movement repertoire (maximum four points); (d) observed postural patterns (maximum four points); (e) movement character (maximum four points). The evaluation is summed up in a MOS-R with a minimum of five points and a maximum of 28 (best performance). The ideal MOS-R range is 25–28, the slightly decreased range is 20–24, the substantially reduced range is 9–19, and the severely reduced range is 5–8 [13]. For the determination of high-risk infants in this study, previously developed a binary score that is either "lower-risk" (scoring 20–28) or "higher-risk" (score 5–19) was used [22]. As stated previously [22, 23], to create a motor repertoire score, we deducted the fidgety movement score (up to 12 points) from the MOS-R, which varied from 4 to 16. In this way, we obtained the motor repertoire score.

Statistical analysis

Data were analysed using SPSS version 26.0 (IBM SPSS Statistics, Chicago, IL, USA). Both analytical techniques, such as the Shapiro-Wilk test, and visual methods, such as histograms, were used to assess normality. Descriptive statistics are reported as mean and standard deviation for normally distributed data and as median and interquartile range for non-normally distributed data. Descriptive statistics for qualitative variables are presented as percentages and frequencies. Comparisons between the three groups were made using the Kruskal-Wallis test. The Mann-Whitney test was used for pairwise comparisons and post hoc analysis. The p-value was corrected in post-hoc comparisons. Chi-squared tests were used to compare differences between categorical groups. The Spearman rank correlation test was used for correlation analysis. Spearman's rank correlation interpreted as 0.10–0.39 weak, 0.40–0.69 moderate, and 0.70 + strong [24]. To examine potential associations between the MOS-R and motor repertoire scores and infant demographic characteristics, two multivariate linear regression models were constructed. Initially, univariate linear regression analyses were conducted to identify individual characteristics significantly associated with either outcome. Variables demonstrating significant associations were subsequently included in the multivariate models. To assess potential multicollinearity among predictors, the Variance Inflation Factor (VIF) was calculated for each model. Statistical significance value was accepted as $p < 0.05$.

Results

Between the study dates, 79 preterm infants were assessed in the risky infant follow-up unit. Seven infants were excluded from the study due to crying or fussing during video recording. Four families did not submit their video recordings. Therefore, 68 preterm infants were included in the study.

The median gestational age of the infants included in the study was 33 weeks, median birth weight was 1785 g and NICU stay was 27 days. The median duration of NICU stay was 27 days, the median duration of ventilation support was 2 days and the median duration of oxygen support was 10 days. Thirty-five (51.5%) of the babies were male and 33 (48.5%) were female. Other demographic characteristics of infants was shown in Table 1.

It was observed that there was a difference between the MOS-R total scores of the infants according to gestational age classification ($p < 0.05$). Similarly, there were differences between the gestational age groups in the MOS-R domains of fidgety movements, observed movement patterns and movement character ($p < 0.05$). There was no difference between the gestational age groups in the domains on observed postural patterns and age-appropriate movement repertoire ($p > 0.05$). According to the pairwise comparison results, it was observed that the very preterm group had a lower score than the moderate and late preterm groups in terms of MOS-R total score ($p < 0.017$). In the fidgety movements, observed movement patterns and movement character domains, the very preterm group scored lower than the late preterm group ($p < 0.017$). Similarly, motor repertoire score was lower in very preterm infants compared to late preterm infants (p:0.003) (Table 2).

It was observed that there was a difference in MOS-R score in terms of gender (p:0.038). In terms of birth weight, very low birth weight infants had significantly lower MOS-R and motor repertoire scores compared to low birth weight and normal birth weight infants ($p < 0.017$). A difference was observed between MOS-R

Table 1 Demographic characteristics of infants

Demographic characteristics ***n*: 68**		**Median (IQR)**	
Gestational age (week)		33 (30–34)	
Birth weight (gr)		1785 (1365–2358)	
Duration of NICU stay (days)		27 (10–56)	
Ventilation (days)		2 (0–7)	
Oxygen support (days)		10 (5–30)	
Demographic characteristics n: 68		**N: (%)**	
Gender	Male	35	51.5
	Female	33	48.5
Type of birth	Normal	62	91.2
	Caesarean section	6	8.8
Gestational age classification	Very preterm (< 32weeks)	26	38.2
	Moderate preterm (32–34 weeks)	20	29.4
	Late preterm (34–36 weeks)	22	32.4
Birth weight classification	Very low birth weight (< 1500 gr)	24	35.3
	Low birth weight (1500–2500 gr)	31	45.6
	Normal range (> 2500)	13	19.1
Duration of NICU	≤ 30 days	35	51.5
	> 30 days	33	48.5

NICU: Neonatal Intensive Care Unit

and motor repertoire scores according to the duration of NICU (p:0.001, p:0.002). Duration of ventilation and oxygen support had a significant moderate negative correlation with MOS-R and motor repertoire score (Table 3).

To identify which infant characteristics were predictive of the MOS-R, we conducted a series of univariate analyses. Several factors were found to be significantly associated with MOS-R scores, including gestational age, bronchopulmonary dysplasia (BPD), duration of NICU, ventilation days and oxygen support. However, when these variables were included in a multivariate model, only BPD, gestational age and ventilation days remained independently associated with MOS-R scores. These findings suggest that multiple clinical factors may independently contribute to lower MOS-R scores within the 28-point scale (Table 4).

In the motor repertoire score model, univariate analyses identified like MOS-R, the same predictors significantly associated with the motor repertoire score. Consistent with findings from our previous model, gestational age, BPD, and ventilation days was a significant predictor in the multivariate analysis (Table 4).

When the risky infants were analysed, it was observed that 4 infants without fidgety movements were diagnosed with CP. Exaggerated fidgety movements were observed in one infant and delayed motor development was observed in this infant. This infant was still not able to walk at 18 months of age. The developmental status of the other infant who did not have fidgety movements was not known because he did not attend the controls in the long-term follow-up. One of the two infants with low motor repertoire score who had fidgety movements

Table 2 Motor optimality Score-Revised and motor repertoire scores according to gestational age classification (n:68)

MOS-*R* and domains	**Very preterm (< 32weeks) *n*:26**	**Moderate preterm (32–34 weeks) *n*:20**	**Late preterm (34–36 weeks) *n*:22**	***p* value**
Total MOS-R Median (IQR)	21 (19–24)$^{*+}$	23 (22–24)	24 (23–24)	**0.003**
Fidgety movements, Median (IQR)	12 (12–12)$^{+}$	12 (12–12)	12 (12–12)	**0.005**
Observed movement patterns, Median (IQR)	4 (2–4)$^{+}$	4 (4–4)	4 (4–4)	**0.008**
Age adequate movement repertoire Median (IQR)	1 (1–2)	2 (1–2)	2 (2–2)	0.091
Observed postural patterns, Median (IQR)	2 (1–4)	4 (2–4)	4 (2–4)	0.161
Movement character, Median (IQR)	2 (2–2)$^{+}$	2 (2–2)	2 (2–4)	**0.024**
Motor Repertoire score Median (IQR)	9 (8–12)$^{+}$	11 (10–12)	12 (11–12)	**0.007**
Optimal MOS-R (25–28), n (%)	1(3,8)	0(0)	4 (18,2)	**0.018**[a]
Mildly reduced MOS-R (20–24), n (%)	18 (69,3)	19(95)	18 (81,8)	
Moderately reduced MOS-R (9–19), n (%)	4 (15,4)	1 (5)	0(0)	
Severely reduced (5–8), n (%)	3 (11,5)	0(0)	0(0)	

MOS-R: Motor Optimality Score-Revised, p: Kruskal-Wallis test, *pairwise comparison (Very preterm vs. Moderate preterm) Mann-Whitney test $p < 0.017$, $^{+}$ pairwise comparison (Very preterm vs. Late preterm) Mann-Whitney test $p < 0.017$, [a]:Chi-Squared tests

Table 3 Association between motor optimality Score-Revised, motor repertoire scores and clinical variables of infants

Clinical variables		**Total MOS-*R* Median (IQR)**	***P* value**	**Motor Repertoire score Median (IQR)**	***P* value**
Gender	Male	22 (20–24)	**0.038**	11 (9–12)	0.051
	Female	23 (23–24)		11 (11–12)	
Birth weight	Very low birth weight (< 1500 gr)	21 (15–24)*+	**0.014**	9.5 (8–12)*+	**0.028**
	Low birth weight (1500–2500 gr)	23 (22–24)		11 (10–12)	
	Normal range (> 2500)	23 (23–24)		11 (11–12)	
Duration of NICU	≤ 30 days	24 (23–24)	**0.001**	12 (11–12)	**0.002**
	> 30 days	22 (20–24)		10 (8–12)	
Clinical variables	**Spearman rank correlation**	Total MOS-R		Motor Repertoire score	
Ventilation (days)		**p: 0.001 rho: -0.409**		**p: 0.002 rho: -0.375**	
Oxygen support (days)		**p: 0.001 rho: -0.404**		**p: 0.001 rho: -0.380**	

MOS-R: Motor Optimality Score-Revised, p: Mann-Whitney test or Kruskal-Wallis test, *pairwise comparison (Very low birth weight vs. Low birth weight) Mann-Whitney test $p < 0.017$, + pairwise comparison (Very low birth weight vs. Normal range) Mann-Whitney test $p < 0.017$

Table 4 Independent predictors of MOS-R and motor repertoire scores among all sample

MOS-*R* (maximum score of 28 points)			
Predictor	Score change	Standard error	P value
Gestational age	0.92	0.14	**< 0.001**
History of BPD	-2	0.5	**< 0.001**
Duration of NICU (days)	-0.1	0.01	**< 0.001**
Ventilation (days)	-0.3	0.04	**< 0.001**
Oxygen support (days)	-0.16	0.02	**< 0.001**
Motor Repertoire score (maximum score of 16 points)			
Gestational age	0.37	0.07	**< 0.001**
History of BPD	-0.5	0.01	**< 0.001**
Duration of NICU (days)	-0.04	0.007	**< 0.001**
Ventilation (days)	-0.1	0.02	**< 0.001**
Oxygen support (days)	-0.06	0.01	**< 0.001**

MOS-R: Motor Optimality Score-Revised, BPD: Bronchopulmonary Dysplasia, NICU: Neonatal Intensive Care Unit

showed normal development, whereas the other one showed developmental delay in motor and language areas (Table 5).

Discussion

Using MOS-R and motor repertoire scores, we evaluated very preterm, moderate preterm, and late preterm infants admitted to a referral university hospital. This allowed us to confirm the correlation between the movement quality of these infants and clinical variables. In this retrospective cohort study, we demonstrated that infants born very preterm had lower MOS-R and motor repertoire scores than children born moderately to late preterm. MOS-R scores of the infants were associated with gestational age, BPD, NICU stay, ventilation, and oxygen duration. Similarly, motor repertoire scores were associated with gestational age, BPD, NICU stay, ventilation, and oxygen duration. The MOS-R and motor repertoire scores were

Table 5 Detailed characteristics of the infants with high risk according to MOS-R scores is ≤ 19

Infants	**Sex**	**MOS-*R***	**Motor Repertoire score**	**Gestational age (weeks)**	**Birth weight (grams)**	**Age at assessment (PoC - weeks)**	**NICU stay (days)**	**Ventilation (days)**	**Oxygen support (days)**	**Mother age**	**Diagnosis (if applicable)**
1	F	19	7	30	1685	52	46	0	26	31	Motor and language development delay, not CP
2	M	6	5	28	1160	50	90	35	75	30	Bilateral CP
3	M	12	8	28	1115	55	45	7	32	29	Motor development delay, not CP
4	M	6	5	25	945	52	108	45	72	31	Bilateral CP
5	F	9	8	27	930	56	85	10	50	25	Bilateral CP
6	M	12	11	29	1200	56	40	11	30	38	Not known, lost contact
7	M	18	6	33	1420	52	54	0	7	36	Motor development delay, not CP
8	M	7	6	25	938	54	103	20	62	27	Bilateral CP

M: male, F: female, MOS-R: Motor Optimality Score-Revised, PoC: postconceptional, NICU: Neonatal Intensive Care Unit, CP: Cerebral Palsy

lower for children in the high-risk group, and they were more likely to exhibit abnormal fidgety behaviors.

Various non-CP neurodevelopmental problems are better predicted by the original MOS and MOS-R [15, 18, 25]. GMA's ability to measure FMs is quite sensitive to the prediction of CP [26]. There are plenty of studies of MOS-R scores in populations of infants born extremely preterm [17, 18, 27], very low birth weight, and extremely low birth weight [15–17]. To our knowledge, MOS-R and motor repertoire score outcomes have not yet been reported in a cohort comprising very, moderate, and late preterm infants. In our study, the median MOS-R scores were similar to those of Peyton et al. and a considerable number of healthy full-term infants [15, 22]. The median MOS-R scores in the very preterm group were similar in some studies [15, 28] and higher in other [17]. In our study, it was observed that MOS-R scores were mildly reduced in higher percentage of middle and late preterm infants. We think that especially infants in this group should be followed up regularly for possible neurodevelopmental problems that may be experienced in the future. In populations of children born moderate to late preterm, long-term follow-up is required to determine the relationship between the MOS-R score at 3–5 months and outcomes in toddlerhood and school age. Compared to the group of infants born moderate to late preterm infants, our very preterm group's MOS-R scores were noticeably lower. We think that low MOS-R score may provide important information in terms of neurodevelopmental outcomes in the future, especially because high-risk infants are in this group. In our study, future neurodevelopmental outcomes were not primarily investigated. However, it was observed that four of 8 high-risk infants were diagnosed with CP in the later period and 2 of them had developmental delay. Therefore, we believe that especially infants with MOS-R score of 19 points or less should be followed up closely and supported with evidence-based early intervention approaches [29, 30].

Our secondary aim was to investigate the correlation between MOS-R and clinical variables of infants. We found that MOS-R and motor repertoire scores of the infants were associated with gestational age, bronchopulmonary dysplasia (BPD), NICU stay, ventilation and oxygen duration. Additionally, MOS-R score was found to be lower in the male gender. BPD was associated with lower performance on both the Motor Optimality Score–Revised (MOS-R) and the Motor Repertoire Score. In a separate prospective cohort of very preterm infants, we previously reported a similar association between BPD and reduced Motor Repertoire Scores [23], further supporting the hypothesis that BPD may adversely affect early motor function and contribute to atypical neurodevelopment. BPD has been independently linked to an increased risk of CP and a range of developmental delays [31], including deficits in motor, language, cognitive, and executive functioning domains, as well as poorer academic achievement in later childhood [31]. The chronic hypoxia and inflammation characteristic of BPD provide a plausible biological mechanism for delayed brain maturation and subsequent neurodevelopmental impairment, which may be reflected in the diminished motor performance observed on both the MOS-R and motor repertoire score in early infancy.

A few studies were found in the literature examining the clinical characteristics of infants with MOS-R. Kahraman et al. also found that gestational age and gender correlated with MOS-R [32]. In a study examining the motor repertoire of infants with Down syndrome (gestational age 29–41 weeks), Herrero et al. found no association between birth weight and gestational age and MOS [33]. In a study of children born extremely preterm (EPT) (mean gestational age 26.6 SD 1.8 weeks), Fjørtoft et al. came to the same conclusion [27]. A wider variety of gestational ages (25–36 weeks) are included in our study. In addition, chromosomal anomalies such as Down syndrome which may affect the MOS-R score were not included in our study. Because of this, our findings could differ from those of these two earlier investigations. In one study, preterm infants with low birth weight, long hospital stay (> 30 days) and receiving invasive mechanical ventilation were found to be significantly associated with early GMs outcomes [34]. Similarly, in our study, MOS-R score was significantly associated with prolonged NICU stay, ventilation and oxygen support. In this respect, we think that infants with a history of long-term intensive care unit stay and long-term ventilation or oxygen therapy should be followed up closely and for a long time.

Our study has some limitations. Since our study had a retrospective design, we did not have access to neuroimaging results such as cranial ultrasound and MRI in every child. In our country, MRI is performed between 12 and 24 months for babies with high risk factors or marked developmental delay in order to make a diagnosis. Most of our sample consisted of infants with low risk factors. Therefore, we did not have the MRI results of all the children. In this respect, we think that more studies on the relationship of neuroimaging results with MOS-R and motor repertoire score are needed in future studies. Because our information was only available for three months, we were unable to make inferences regarding the relationship between our group's early repertoire and future neurodevelopmental results. Only infants who were at risk according to MOS-R scores below 19 were eligible to have their subsequent neurodevelopmental outcomes examined. We wish to continue following this group's developmental trajectory in order to ascertain the

connection between MOS-R, motor repertoire scores, and longer-term neurodevelopmental outcomes.

Conclusion

Early preterm infants had significantly lower MOS-R and motor repertoire scores than infants born moderate to late preterm. Infants' MOS-R and motor repertoire scores were associated with gestational age, BPD, birth weight, NICU stay, ventilation and oxygen duration. Understanding the results of this group and MOS-R cut-off scores in future study will help determine clinically meaningful criteria for early intervention. It may be necessary to follow up infants born moderately to late preterm, as more than 73% of them had mildly reduced MOS-R scores. Long-term monitoring is needed to determine the relationship between early spontaneous motor activity and the developmental trajectories of neonates with various risk factors.

Abbreviations

Bayley-III	Bayley Scales of Infant and Toddler Development-III
BPD	Bronchopulmonary Dysplasia
CA	Corrected Age
CP	Cerebral Palsy
EPT	Extremely Preterm
FMs	Fidgety Movements
GMA	General Movement Assessment
GMs	General Movements
ICC	Intraclass Correlation Coefficient
ICU	Intensive Care Unit
MRI	Magnetic Resonance Imaging
MOS	Motor Optimality Score
MOS-R	Motor Optimality Score-Revised
NICU	Neonatal Intensive Care Unit
VIF	Variance Inflation Factor

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Author contributions

Umut Apaydın: Conceptualization, Methodology, Investigation, Writing– original draft, Data collection Turgay Altunalan: Methotology, Critical editing of the manuscript, Formal analysis, Writing– original draf analysis, Conceptualization.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethics committee approval was obtained from Karadeniz Technical University Health Sciences Scientific Research Ethics Committee for this study (Number: E13562490-050.01.04-584237). A signed informed consent form was obtained from the parents of the infants. All procedures performed involving human participants followed the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

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