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RESEARCH ARTICLE

Characteristics of preterm infants in pediatric rehabilitation at a referral hospital in Peru

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Abstract

Background: *Prematurity is associated with a higher risk of disability. However, no studies on this population in rehabilitation settings in Peru have been found. This study aims to describe the characteristics of preterm infants at the Pediatric Rehabilitation Service of Hospital Nacional Edgardo Rebagliati Martins (SRP-HNERM).* **Method:** *A cross-sectional descriptive study was conducted. Medical records of preterm infants at SRP-HNERM from September 2023 to February 2024 were reviewed. The Hammersmith Infant Neurological Examination (HINE), General Movements Assessment (GMA), and other outcome measures were used for evaluation.* **Results:** *A total of 158 preterm infants were evaluated. During hospitalization, 51.3% were evaluated by a physiatrist, 47.5% received physical therapy, and 51.3% had feeding and swallowing disorders (FSD). After discharge, all patients were evaluated by a physiatrist at SRP-HNERM. Among infants with ≥ 44 weeks of corrected gestational age (CGA), 48.1% showed some degree of developmental delay, with global delay present in 34%. Of those with ≥ 48 weeks of CGA, 54.9% had an optimal HINE score. Normal GMA was observed in 51.2% of infants with ≤ 5 months of CGA. A higher frequency of global developmental delay was found in infants who had FSD during hospitalization and a lower frequency in those who had neonatal jaundice.* **Conclusions:** *Slightly more than half of the preterm infants were evaluated by a physiatrist, had FSD during hospitalization, had an optimal HINE score at ≥ 48 weeks of CGA, and had a normal GMA at ≤ 5 months of CGA. The presence of FSD during hospitalization should alert clinicians to a higher risk of global developmental delay in this population.*

Keywords: *Premature. Newborn. Infant. Physical medicine and rehabilitation. Peru.*

Características de lactantes prematuros en rehabilitación pediátrica de un hospital de referencia en Perú

Resumen

Introducción: *La prematuridad está asociada con mayor riesgo de discapacidad. Sin embargo, no encontramos estudios sobre esta población en entornos de rehabilitación en el Perú. Este estudio tiene como objetivo describir las características de lactantes prematuros en el Servicio de Rehabilitación Pediátrica del Hospital Nacional Edgardo Rebagliati Martins*

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(SRP-HNERM). **Método:** *Estudio descriptivo transversal. Se revisaron historias clínicas de lactantes prematuros en el SRP-HNERM desde septiembre 2023 hasta febrero 2024. Para la evaluación, se utilizaron el Hammersmith Examination (HINE), el General Movements Assessment (GMA) y otras medidas de resultado.* **Resultados:** *Se evaluaron 158 lactantes prematuros. Durante la hospitalización, 51.3% fue evaluado por un fisiatra, 47.5% recibió terapia física, y 51.3% presentó trastornos de la succión-deglución (TSD). Posterior al alta, todos fueron evaluados por un fisiatra en el SRP-HNERM. 48.1% de aquellos con ≥ 44 semanas de edad gestacional corregida (EGC) presentó algún grado de retraso del desarrollo, con retraso global presente en el 34%. 54.9% de aquellos con ≥ 48 semanas de EGC tuvo una puntuación HINE óptima. 51.2% de aquellos con ≤ 5 meses de EGC tuvo una GMA normal. Se encontró mayor retraso global del desarrollo en aquellos que tuvieron TSD en hospitalización, y menor en los que tuvieron ictericia neonatal.* **Conclusiones:** *Poco más de la mitad fue evaluado por un fisiatra, tuvo TSD en hospitalización, tuvo una puntuación HINE óptima a ≥ 48 semanas de EGC y tuvo una GMA normal a ≤ 5 meses de EGC. La presencia de TSD en hospitalización debería alertar sobre un mayor riesgo de retraso global del desarrollo en esta población.*

Palabras clave: *Prematuro. Recién nacido. Lactante. Medicina física y rehabilitación. Perú.*

Introduction

Prematurity is defined as birth before 37 weeks of gestational age and is one of the leading causes of neonatal and infant morbidity and mortality[1]. Long-term complications of prematurity can affect the pulmonary, renal, cardiac, neurological, and endocrine systems, among others[2]. According to a 2022 study, global prematurity rates range from 5% to 18%, with high rates observed in industrialized and developing countries[3]. In Peru, the incidence of prematurity varies depending on the source of information: 23% according to the 2020 Demographic and Family Health Survey (ENDES), 8.8% according to the World Health Organization (WHO), and 7% according to the Ministry of Health (MINSA)[4].

Prematurity is associated with a higher risk of disability, particularly motor and intellectual disabilities, making survival without disability an important outcome measure for this population[5]. Current data indicate that approximately 80% of preterm infants born between 22 and 32 weeks survive without any form of disability[5]. However, infants born very preterm (between 28 and 32 weeks) or with very low birth weight (≤ 1500 g) are at higher risk of having a lower health-related quality of life in early adulthood[6]. Children with a history of prematurity are at higher risk of developmental delays, poor academic performance, and lower intelligence quotients (IQ)[7-9].

There are highly predictive tests for motor and cognitive impairments in preterm infants, such as the Hammersmith Infant Neurological Examination (HINE) and Prechtl's General Movements Assessment (GMA)[10]. The HINE has the highest predictive accuracy for severe motor delay, whereas the GMA is most accurate for mild-to-moderate motor and cognitive delays[11]. Early developmental assessment in school-aged children with a history of prematurity shows good specificity and negative predictive value for cognitive impairments[12]. In Peru, screening tests such as the *Test Peruano de Evaluación del Desarrollo del Niño* (TPED) and the *Perfil de Evaluación del Desarrollo Infantil del Hospital Rebagliati* (REBA-PED) are used for child development assessment[13].

Predicting disability associated with prematurity is crucial for initiating early rehabilitation that can reduce the progression of motor impairments, prevent complications, and improve long-term independence[14]. Early rehabilitation in preterm infants is significant due to increased brain plasticity during the first months of life and the absence of fixed pathological movement patterns[15]. Previous studies suggest that early rehabilitation in preterm infants can reduce the incidence of motor delays and improve bone mineralization[16,17]. Oral-motor rehabilitation interventions have proven effective in improving oral feeding in preterm infants, who frequently experience feeding and swallowing disorders (FSD)[18,19].

Investigating the characteristics of preterm infants is essential due to their increased risk of long-term disabilities and health complications, as this enables early identification of developmental delays and timely interventions that can improve outcomes and quality of life[3,5,14]. These characteristics have been studied in various countries in Latin America and around the world[10,16-17,19]. However, no studies conducted in Physical Medicine and Rehabilitation (PM&R) settings in Peru have been found. Therefore, this study aims to describe the characteristics of preterm infants in the Pediatric Rehabilitation Service of *Hospital Nacional Edgardo Rebagliati Martins* (SRP-HNERM).

Method

Design and study population

A cross-sectional descriptive study was conducted using data from electronic medical records of preterm infants (born before 37 weeks of gestation) treated at SRP-HNERM over 6 months (September 1, 2023, to February 29, 2024). This timeframe was selected because the study variables were first recorded in SRP-HNERM medical records beginning in September 2023. All patients who met the selection criteria during this period were included.

Context

HNERM, located in Peru's capital, is one of the most important national referral centers for Social Health Insurance (EsSalud) due to its high level of specialization and problem-solving capacity[20]. All patients at SRP-HNERM were referred either from less complex EsSalud health-care facilities (outside Lima or from the Rebagliati Care Network) or through inter-consultation from other HNERM services.

Between September 2023 and February 2024, SRP-HNERM's staff included four physiatrists, 15 physical therapists, one occupational therapist, five speech and language therapists, and two psychologists. Of these, one physiatrist, five physical therapists, one occupational therapist, two speech and language therapists, and one psychologist were part of the Perinatal and Chromosomal Pathology Unit (also known as the "High-Risk Unit") of SRP-HNERM. This team provided both inpatient and outpatient care to preterm infants and their parents and/or responsible family members.

The Neonatology Service of HNERM includes neonatal intensive care units (NICU) and neonatal intermediate care units (NIMCU). In 2003, the perinatal mortality rate was estimated at 10.5/1,000 live births, and in 2018, the survival rate for NICU admissions was reported at approximately 75%.

Preterm infants hospitalized in the Neonatology Service of HNERM receive care from the SRP-HNERM multidisciplinary team, primarily consisting of physical therapy (PT) and speech and language therapy (SLT) interventions. During hospitalization, parents or responsible family members receive emotional support from the psychology team. Upon discharge, patients are referred to SRP-HNERM for outpatient care according to HNERM's technical guide for the follow-up of high-risk children.

During the initial outpatient medical consultation at SRP-HNERM, the physiatrist prescribes 10 PT sessions for all preterm infants. The prescription for SLT depends on the presence of FSD. When signs of possible neurological damage are observed during the consultation, patients are referred to Pediatric Neurology (part of the Pediatric Clinical Specialties Service at HNERM) at the physiatrist's choice.

SLT interventions for both hospitalized patients with FSD and outpatients include therapeutic techniques such as orofacial massage for tone normalization, extraoral massage to stimulate the rooting reflex, intraoral massage for non-nutritive sucking, orofacial and full-body stimulation to normalize altered sensitivity, and initiation of taste stimulation, among others.

Procedures

Following ethics committee approval, a list of all preterm infants seen in medical consultations between September 2023 and February 2024 was obtained from SRP-HNERM. Subsequently, 158 electronic medical records were manually reviewed to extract relevant information using a custom collection form, which was then imported into a Microsoft Excel database.

Preterm infants seen in medical consultations at SRP-HNERM were included because this facility has standardized the evaluation of all patients through a pediatric rehabilitation protocol[21], enabling better characterization of this group.

Variables

Based on a literature review, variables collected included demographic, anthropometric, comorbidity-related, hospitalization care, outpatient medical consultation care, and clinical evaluation data.

For FSD diagnosis (a disorder of nutritive sucking leading to feeding difficulties) during hospitalization, the Premature Oral Feeding Readiness Assessment Scale (POFRAS) was used[19]. This instrument comprises 18 items evaluating five variables with separate scoring: corrected gestational age (CGA), behavioral organization (state of consciousness, overall posture, and overall tone), oral posture (lips and tongue), oral reflexes (rooting, sucking, biting, and gag reflexes), and non-nutritive sucking (tongue movement, tongue grooving, jaw movement, sucking strength, maintenance of rhythm, maintenance of alertness, and signs of stress)[22]. Each item receives 0 to 1 or 2 points, with a

maximum total score of 35 points; a total score below 28 indicates FSD[22].

Child development was assessed using REBA-PED, an instrument evaluating five developmental areas and identifying warning signs in patients aged 1-72 months[13]. Developmental delay is classified as mild if > 0% but < 25% (equivalent to 2 standard deviations in similar instruments) in one or more areas, significant if ≥ 25% in one area, and global if ≥ 25% in two or more areas[20]. Previous studies detail the methodology for creating and applying REBA-PED[13,20].

HINE consists of 26 items assessing five neurological aspects in patients aged 2-24 months: cranial nerves (0-15), posture (0-18), movements (0-6), muscle tone (0-24), and reflexes and postural reactions (0-15), totaling a maximum of 78 points[23]. Items score 3 points if matching ≥ 75% of the typical development population, 2 points if matching 10-25%, and 1 or 0 points if matching ≤ 10%[23]. Optimal scores are ≥ 73 at 9 and 12 months and ≥ 67 and ≥ 70 at 3 and 6 months, respectively[10,23].

The GMA was used to assess general movements. This test evaluates the complex motor patterns generated by the fetal and neonatal nervous system, which include variable sequences in the neck, arms, trunk, and legs that fluctuate in intensity, speed, and range of motion[24]. These movements are called writhing movements from term age and gradually disappear at 46-49 weeks of CGA when fidgety movements (FM) begin to appear[24]. Abnormal movements can be classified as poor repertoire, cramped-synchronized, chaotic, absent FM, or abnormal FM. If FM is only sporadically present or absent at 3-5 months of CGA, severe neurological deficits such as cerebral palsy (CP) are likely to develop[24]. The patient must be awake, calm, and alert to perform the GMA[25]. The GMA is considered normal if the patient exhibits writhing movements during the first period (before 46-49 weeks of CGA) and/or FM during the second period (up to 5 months of CGA)[10,24].

The *Escala de Evaluación de la Succión Nutricia* was used to diagnose FSD in outpatient medical consultations. This instrument consists of seven questions: "Does the infant form and maintain a seal with the lips around the nipple?" "Does the infant maintain the sucking motion, lip, and jaw movement during feeding?" "Does the infant spit out or reject the nipple or bottle nipple?" "Does the infant have milk or vomit spill from the corners of the mouth?" "Does the infant have coughing episodes?" "Does the infant show signs of choking, gagging, or nausea?" and "Does the infant show signs of fatigue?"[26] Each item is scored from 1 to 4 points, with a minimum and maximum total score of 7 and 28 points, respectively; a total score of < 25 is considered indicative of FSD[26].

Statistical analysis

The data collected from the Excel spreadsheet were imported into Stata v17 software. Numerical variables were presented as means and standard deviations or medians and interquartile ranges (IQR), depending on the data distribution in normality tests. Categorical variables were presented with absolute and relative frequencies. To assess the factors associated with global developmental delay, crude (RR) and adjusted relative risks (aRR) and their respective 95% confidence intervals (95% CI) were calculated using Poisson regression with robust variance. The adjusted model included variables with a $p < 0.05$ in the crude analysis.

Results

A total of 158 preterm infants were evaluated at SRP-HNERM between September 2023 and February 2024. The median CGA was 52 weeks (IQR 40-72), and the median GA was 33 weeks (IQR 31-35). Most infants were moderately premature (43%), male (53.2%), from Lima (81.7%), new patients (74.4%), and had low birth weight (63.9%). Twins accounted for 25.9% of the sample. The most common comorbidities were neonatal jaundice (59.5%), congenital heart disease (33.5%), and retinopathy of prematurity (ROP) (21.5%). The median length of hospital stay was 19 days (IQR 6-33). Among the infants, 51.3% were evaluated by a physiatrist during hospitalization, and 47.5% received PT while hospitalized. FSD was present in 51.3% during hospitalization, and 85.2% received SLT for this reason. Parents and/or relatives of 36.1% of infants received emotional support during hospitalization (Table 1).

After hospital discharge, all patients were evaluated by the physiatrist at SRP-HNERM, with a median time of 1 month from discharge to the first outpatient medical consultation. All continuing patients received outpatient PT after the first outpatient medical consultation, and the median time from birth to the first session was 2 months (IQR 1-4). Only 5% of the continuing patients received outpatient SLT for FSD, with a median time of 1 month from birth to the first session (Table 1).

Among the infants, 4.4% had macrocephaly, 3.8% had microcephaly, and 9.5% had some form of positional cranial deformity. Asymmetrical skin folds were

Table 1. Demographic, anthropometric, comorbidity-related, and hospitalization care characteristics of preterm infants (n = 158)

Characteristics	n (%)
CGA (in months)*	3 (0-8)
CGA (in weeks)*	52 (40-72)
GA (in weeks)*	33 (31-35)
Classification	
Late preterm	48 (30.4)
Moderate preterm	68 (43.0)
Very preterm	37 (23.4)
Extremely preterm	5 (3.2)
Male sex	84 (53.2)
From Lima	129 (81.7)
New patient	118 (74.4)
Birth weight	
Normal	26 (16.5)
Low weight	101 (63.9)
Very low weight	23 (14.6)
Extremely low weight	8 (5.1)
Twin	41 (25.9)
Comorbidities	
Neonatal jaundice	94 (59.5)
Congenital heart disease	53 (33.5)
Retinopathy of prematurity	34 (21.5)
Congenital hypotonia	12 (7.6)
Bronchopulmonary dysplasia	11 (7.0)
Intraventricular hemorrhage	8 (5.1)
Down syndrome	6 (3.8)
Congenital hypertonia	6 (3.8)
Metabolic bone disease	6 (3.8)
History of abdominal surgery	5 (3.2)
Hypothyroidism	4 (2.5)
Days of hospitalization*	19 (6-33)
Evaluated by the physiatrist during hospitalization	81 (51.3)
Received physical therapy during hospitalization	75 (47.5)
FSD during hospitalization	81 (51.3)
Received speech and language therapy during hospitalization for FSD	69 (85.2)
Emotional support to parents and/or family members during hospitalization	57 (36.1)
Received outpatient physical therapy (continuing patient) (n = 40)	40 (100)
Months elapsed from birth to the first session of outpatient physical therapy for those who received it*	2 (1-4)
Received outpatient speech and language therapy for FSD (continuing patient) (n = 40)	2 (5)

*Median (p25-p75).
CGA: corrected gestational age; GA: gestational age; FSD: feeding and swallowing disorder.

present in 15.8% of cases, whereas no patients exhibited orthopedic deformities. FSD was present in 12.7% of patients at the outpatient medical consultation. Among patients with 44 weeks or more of CGA, 48.1% exhibited some degree of developmental delay, with global delay present in 34%. Greater delays were observed in the gross motor (17.9%), hearing and language (17.9%), and fine motor (13.2%) areas (Table 2).

Among patients with 48 weeks or more of CGA, 54.9% had an optimal HINE score, with a median of 71 (IQR 64-76). Most patients had low HINE scores in muscle tone (80.5%), posture (70.7%), and reflexes and postural reactions (54.9%). In patients aged 5 months or less, 51.2% had a normal GMA. Among those showing abnormal movements, poor repertoire movements were the most common (11.9%). The GMA was deferred in 30.9% of these patients because they were not awake, calm, and alert during the assessment. A referral to Pediatric Neurology was made for 38% of patients (Table 2).

In the analysis of associated factors, a higher frequency of global developmental delay was found in patients with 80 weeks or more of CGA compared to those with less than 60 weeks of CGA (aRR: 1.83, 95% CI: 1.04-3.21), as well as in those who had FSD during hospitalization (aRR: 2.13, 95% CI: 1.17-3.88). In addition, a lower frequency of global delay was found in patients with neonatal jaundice (aRR: 0.47, 95% CI: 0.28-0.78) (Table 3).

Discussion

Most infants in this study were male. A national cohort study from 2016 in the Netherlands reported that male sex was a significant risk factor for spontaneous preterm birth, with a higher risk of neonatal morbidity[27]. However, a 2018 study in the UK involving high-risk pregnant women for preterm birth did not observe a significant increase in the risk of spontaneous or iatrogenic preterm birth when the fetus was male, which contradicts reports in low-risk pregnancies[28]. Regarding the potential implications of prematurity on child development, a systematic review from 2023 found that preterm males did not have greater impairment compared to females[29].

The most frequent comorbidities were neonatal jaundice, congenital heart disease, and ROP. A systematic review from 2021 reported that neonatal morbidities were important risk factors associated with lower IQ in young adults born very preterm or with very low birth weight[9]. Neonatal jaundice is a neurological risk factor

Table 2. Characteristics of preterm infants in outpatient medical consultation (n = 158)

Characteristics	n (%)
Developmental delay in those with ≥ 44 weeks of CGA (n = 106)	51 (48.1)
Delay in gross motor development	19 (17.9)
Delay in hearing and language development	16 (15.1)
Delay in fine motor development	14 (13.2)
Delay in personal-social development	8 (7.6)
Delay in intelligence and learning development	6 (5.7)
Global developmental delay in those with ≥ 44 weeks of CGA (n = 106)	36 (34.0)
Macrocephaly	7 (4.4)
Microcephaly	6 (3.8)
Positional cranial deformation	15 (9.5)
Brachycephaly	5 (3.2)
Dolichocephaly	4 (2.5)
Plagiocephaly	4 (2.5)
Scaphocephaly	2 (1.3)
Asymmetric skin folds	25 (15.8)
Orthopedic deformity	0 (0)
FSD	20 (12.7)
HINE score in those with ≥ 48 weeks of CGA (n = 82)*	71 (64-76)
Low score in muscle tone	66 (80.5)
Low score in posture	58 (70.7)
Low score in reflexes and postural reactions	45 (54.9)
Low score in cranial nerves	24 (29.3)
Low score in movements	12 (14.6)
Optimal HINE score in those with ≥ 48 weeks of CGA (n = 82)	45 (54.9)
GMA in those with ≤ 5 months of CGA (n = 84)	
Normal	43 (51.2)
Poor repertoire	10 (11.9)
Cramped-synchronized	4 (4.8)
Abnormal Fidgety movements	1 (1.2)
Deferred	26 (30.9)
Referral to pediatric neurology	60 (38.0)

*Median (p25-p75).
CGA: corrected gestational age; FSD: feeding and swallowing disorder; HINE: hammersmith infant neurological examination; GMA: prechtl's general movements assessment.

in neonates, associated with hearing, visual, and intellectual disabilities, as well as conditions such as autism spectrum disorder and attention-deficit/hyperactivity disorder[30]. A systematic review from 2024 found that 26% and 19% of preterm infants with congenital heart disease exhibited cognitive impairment and intellectual disability, respectively[31]. A systematic review from 2023 concluded that in preterm infants, ROP was associated with a higher risk of intellectual disability, cerebral palsy, behavioral problems, and developmental delay[32].

Just over half of the infants were evaluated by the physiatrist during hospitalization. The physiatrist typically is part of the multidisciplinary team that examines preterm infants during hospitalization and provides care in outpatient consultations[20,33]. Preterm infants hospitalized in the Neonatology Service of HNERM should be evaluated by the physiatrist at least once. However, many preterm infants were not evaluated, possibly due to a short hospitalization time (median of 19 days), compared to what was reported by studies from 2022 in Brazil (median of 39 days) and Malaysia (medians of 26 and 44 days for each group), and by a 2018 study across various European countries (medians of 52.4 and 76.5 days depending on the region)[34-36].

Just under half of the infants received PT during hospitalization. This could be related to the lack of evaluation of preterm infants by the physiatrist, who is the first in the multidisciplinary team to examine these patients and lead rehabilitation interventions. PT is often necessary for most preterm infants due to psychomotor delays caused by biological immaturity[16]. A systematic review from 2020 suggests that PT during hospitalization could have a significant effect on the mental and motor development of preterm infants, especially during the 1st year of life[37].

Just over half of the infants had FSD during hospitalization, which is higher than reported by a systematic review from 2021 (prevalence of 27%)[19]. A systematic review from 2022 concluded that oral feeding within 72 h after birth in preterm infants and low birth weight infants possibly reduces the risk of mortality, length of hospital stay, risk of sepsis, and weight loss at discharge[38]. A systematic review from 2021 revealed that oral-motor therapy interventions in preterm infants could reduce the time to transition to full oral feeding and the length of hospital stay, as well as increase feeding efficiency and weight gain[18]. More than 85% of infants received SLT during hospitalization for FSD; those who did not receive therapy likely missed it due to a short hospitalization time or because they were not in a condition to receive it.

After hospital discharge, all preterm infants were evaluated by the physiatrist at the SRP-HNERM, and the median time from discharge to the first outpatient medical consultation was 1 month. A consensus from 2023 among physiatrists in South Korea recommended outpatient medical evaluations for preterm infants within the 1st month after hospital discharge if there was at least one high-risk antecedent: brain injury, periventricular leukomalacia, grade 3 or 4 intraventricular hemorrhage, hypoxic-ischemic encephalopathy,

Table 3. Factors associated with global developmental delay in preterm infants with 44 weeks or more of corrected gestational age (n = 106)

Factors	Global developmental delay		
	No	Yes	RR (95% CI)
Sex			
Female	32 (61.5)	20 (38.5)	Ref
Male	38 (70.4)	16 (29.6)	0.77 (0.45-1.32)
CGA (in weeks), in tertiles			
44-59	28 (70.0)	12 (30.0)	Ref
60-79	27 (81.8)	6 (18.2)	0.61 (0.25-1.45)
80-132	15 (45.5)	18 (54.5)	1.82 (1.03-3.21)
GA (in weeks), in tertiles			
24-32	30 (66.7)	15 (33.3)	Ref
33-34	16 (59.3)	11 (40.7)	1.22 (0.66-2.27)
35-36	24 (70.6)	10 (29.4)	0.88 (0.45-1.72)
Birth weight			
Normal	12 (66.7)	6 (33.3)	Ref
Low weight	48 (69.6)	21 (30.4)	0.91 (0.43-1.93)
Very or extremely low weight	10 (52.6)	9 (47.4)	1.42 (0.63-3.20)
Days of hospitalization, in tertiles			
0-9	27 (64.3)	15 (35.7)	Ref
10-28	23 (76.7)	7 (23.3)	0.65 (0.30-1.41)
29-210	20 (58.8)	14 (41.2)	1.15 (0.65-2.05)
Optimal HINE score			
No	37 (60.7)	24 (39.3)	Ref
Yes	33 (73.3)	12 (26.7)	0.68 (0.38-1.21)
FSD during hospitalization			
No	65 (69.1)	29 (30.9)	Ref
Yes	5 (41.7)	7 (58.3)	1.89 (1.07-3.34)
Congenital heart disease			
No	45 (65.2)	24 (34.8)	Ref
Yes	25 (67.6)	12 (32.4)	0.93 (0.53-1.65)
Twin			
No	55 (65.5)	29 (34.5)	Ref
Yes	15 (68.2)	7 (31.8)	0.92 (0.47-1.82)
Neonatal jaundice			
No	22 (52.4)	20 (47.6)	Ref
Yes	48 (75.0)	16 (25.0)	0.53 (0.31-0.89)
Retinopathy of prematurity			
No	56 (65.1)	30 (34.9)	Ref
Yes	14 (70.0)	6 (30.0)	0.86 (0.41-1.79)

CGA: corrected gestational age; GA: gestational age; HINE: hammersmith infant neurological examination; FSD: feeding and swallowing disorder.

meningitis, encephalitis, ventriculomegaly, feeding disorders associated with malnutrition, neonatal sepsis, bronchopulmonary dysplasia with mechanical ventilation up to 36 weeks of CGA, neonatal jaundice, confirmed congenital or neuromuscular disorder, extreme prematurity, extremely low birth weight, high social risk, hypertonia, hypotonia, infantile spasms, or epilepsy[39].

Just under half of the infants with 44 weeks or more of CGA exhibited some degree of developmental delay, with greater delays in gross motor, hearing and language, and fine motor areas. This is consistent with findings from a 2023 study of children under 5 years old treated at the SRP-HNERM, who more frequently exhibited delays in hearing and language, and gross motor areas[20]. A systematic review from 2023 reported that moderate preterm infants had a higher risk of developmental delay compared to term-born infants[7]. The effect of prematurity on child development persists into school

age and beyond[40]. Systematic reviews from 2018 and 2020 concluded that preterm infants had lower scores in cognitive ability tests, as well as in motor skills, behavior, reading, mathematics, and spelling[8,40].

Just over half of the infants with 48 weeks or more of CGA had an optimal HINE score (median of 71). This percentage was lower than that found in a 2023 study of preterm infants in Norway (79.5% with optimal HINE at 3 months of CGA, median of 61.8) but higher than reported in a 2018 study of late preterm infants in Greece (25.4% with optimal HINE at 6 months of CGA, median of 59)[41,42]. The median HINE score was higher than reported by these studies and also higher than that of another study from 2022 in preterm infants in Italy (55.6 at 3 months of CGA)[10].

Just over half of the infants with 5 months or less of CGA exhibited a normal GMA. This percentage was lower than that found in a 2022 study of preterm infants in Italy, where 68.1% had normal FM[10]; in a 2023 study of preterm infants in India with 32 weeks or less of gestational age, where 54.9% and 94.4% had normal general movements and FM, respectively[43]; and in a 2023 study of very preterm infants in Germany, where 93.9% had normal FM[44].

A higher frequency of global developmental delay was found in infants with FSD during hospitalization. In preterm infants, having FSD at 40 weeks of CGA may be a clinically useful and simple marker of developmental delay risk[45]. Extreme preterm infants with FSD should be identified as high risk for motor delay at 4-5 years, compared to those without FSD[46]. Preterm infants with FSD are more likely to present language delays at 18 months of CGA[47].

A lower frequency of global developmental delay was found in infants with neonatal jaundice. A systematic review from 2023 concluded that neonatal jaundice has not been demonstrated to be a unique risk factor for developmental alterations in preterm infants, unlike in term newborns, where it is associated with hearing, neurological, and motor developmental alterations, particularly during the 1st year of life[30]. Therefore, more studies are needed in preterm infants with neonatal jaundice to determine its impact on child development[30].

Limitations and strengths

This study has limitations that should be considered to properly interpret its results: (1) as a retrospective study based on the review of electronic medical records, it is possible that the physiatrists in charge of the outpatient consultations at the SRP-HNERM incorrectly recorded some data. (2) Other relevant variables could not be collected as they were not systematically recorded in the medical records (such as the degree of neonatal jaundice or the receipt of phototherapy during hospitalization). (3) The study was conducted in a referral hospital in Lima, Peru, so the results may not be representative of other facilities. (4) Preterm infants not seen at the SRP-HNERM due to transportation, geographical, or other barriers were not included. (5) In addition, there may be a survival bias since preterm infants who died early were not included in the study.

However, to our knowledge, this is the first study to thoroughly evaluate the characteristics of preterm infants in a PM&R setting in Peru. It provides relevant information to understand the needs of this population and formulate improvement proposals.

Conclusions and recommendations

Slightly more than half of the preterm infants at the SRP-HNERM were evaluated by the physiatrist and had FSD during hospitalization. Slightly less than half received PT during hospitalization. Slightly more than half of infants with 48 weeks or more of CGA had an optimal HINE score. Slightly more than half of those with 5 months or less of CGA had normal GMA. A higher frequency of global developmental delay was found in infants who had FSD during hospitalization and a lower frequency in those who had neonatal jaundice.

These findings highlight the importance of adopting strategies to increase the number of preterm infants evaluated by the physiatrist and those who receive PT and SLT during hospitalization. After hospital discharge, it is necessary to strengthen outpatient care in PM&R for preterm infants, as a significant number showed poor outcomes in the predictive tests used in outpatient medical consultations. Finally, it is essential to recognize and address FSD early, both during hospitalization and on an outpatient basis, due to its association with global developmental delay.

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Conflicts of interest

Roger De la Cerna-Luna and Ana Igei-Chiney work at Hospital Nacional Edgardo Rebagliati Martins. The other authors do not report any potential conflicts of interest related to this study.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. This study was approved by the Institutional Ethics Committee for Research of HNERM (Ethical Qualification Certificate AUT No. 082-CE-GHNERM-GRPRESSALUD-2024). All collected information remained strictly confidential and was used exclusively for the study.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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