Journal of Pediatric Nursing 62 (2022) e125–e130

Contents lists available at ScienceDirect

Journal of Pediatric Nursing

journal homepage: www.pediatricnursing.org

Sociodemographic impact of variables on cognitive, language and motor development in very preterm infants

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ARTICLE INFO

Article history:
Received 29 December 2020
Revised 11 August 2021
Accepted 18 August 2021

Keywords:
Very preterm infants
Development
Parental education level
Parental age
Bayley-III
Preschool

ABSTRACT

Background: In the last decades, the birth of premature babies has increased, it is important to know the impact of certain variables, especially in the most vulnerable groups.
Purpose: To analyse the relationship of gestational age (GA), weight and sex of the children, as well as the educational level and age of the parents with the cognitive, motor and language development of a group of very preterm births, assessed at 36 months.
Design and methods: The research followed a descriptive, observational and cross-sectional design. Children's development was measured using the Bayley-III Scale. Descriptive analysis, bivariate and linear regression models were carried out.
Results: Although the cognitive, motor and language development is within average levels, worse results are evidenced in the group of extreme premature, as opposed to the very premature. Boys score lower than girls, with these differences being more pronounced in the motor area. It also shows how the education level of both parents is related to the levels of development at 3 years of age of children born very prematurely, especially in language.
Conclusions: Lower GA, male sex and lower parental educational level are associated with higher risk of developmental difficulties.
Practice implications: The findings of this study are relevant to clinical practice because they suggest to develop protocols of evaluation and the follow up of all premature children beyond 36 months, as well as developing specific intervention programmes for the most vulnerable of the premature groups.

Background

Premature births (under 37 gestation week) have increased in the last two decades progressively in almost all countries (Gasparini et al., 2017; World Health Organization, 2019), classified according to their GA in extremely preterm (<28 weeks), very preterm (28 < 32 weeks), and moderate and late preterm (32 < 37 weeks) (World Health Organization, 2019). Although advances in treatment and the quality of care perinatal has made it possible a higher survival of these minors, there are still many doubts about factors that enhancing or impeding from the initial stages of their development (Caravale et al., 2012; Schonhaut et al., 2015).

In relation to aftermath associated with prematurity, Rogers and Hintz (2016) indicate that the incidence of neurodevelopmental impairment and other disorders, has not changed over the last decades. This population of risk can present from relevant neurological disabilities to mild neurodevelopmental difficulties, including low cognitive functioning, attention decreased and/or behavior problems (Esteban et al., 2019; Farkas & Corthorn, 2012; Pereira-Cerroa et al., 2020; Saigal & Doyle, 2008; Voigt et al., 2012). These difficulties can a higher proportion when we talk about extremely premature. De Groote et al. (2007) evaluated children aged three years born with <26 gestation week with the Bayley II scale and found that more than half of these children had delays in the Mental Development Index, and 70% presented delays in the Psychomotor Development Index. Some lags can be detected in the early years, but others arise throughout childhood and adolescence,

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https://doi.org/10.1016/j.pedn.2021.08.016

may persist sometimes in adulthood (Nguyen et al., 2019; Stoinska & Gadzinowski, 2011).

On the other hand, modulating role to sociodemographic factors about the later development of preterm infants has not been studied in depth. Different authors found that the male sex has a greater incidence of births below week 37 and a higher risk for neurological development (Drevenstedt et al., 2008; Macedo & Cardoso, 2019; Romeo et al., 2015; Skiöld et al., 2014). Additionally, maternal age, advanced or too early, is associated with greater complications in pregnancy and in the child. Early motherhood (≤19 years old) is associated with an increased risk of preterm birth, intrauterine growth restriction, infant mortality and malnutrition (Gibbs et al., 2012). It is also more frequent in these ages that the educational level and socioeconomic is lower (Santos et al., 2008). Maternal age advanced (≥35 years old) is associated with an increase in infant death, preterm births, intrauterine growth restriction and chromosomal abnormalities (Blencowe et al., 2013; Stein & Susser, 2008).

Attending to the paternal age, found higher rates of premature birth in children of fathers with an advanced paternal age (>45 years old), and in young fathers (<24 years old) more frequently small-for-GA births and low birth weight (Alio et al., 2012). More recently, fathers' age and developmental level of children have also been associated (Khandwala et al., 2017). In a sample of full-term births where the level of development or intelligence was assessed at 8 months, 4 and 7 years, advanced fathers' age was found to be associated with lower scores on all neurocognitive measures, and in the motor area (Wiener-Megnazi et al., 2012).

According to education level, Potharst et al. (2011) found that a high level of education in both parents decreased differences in cognitive and behavioral outcomes among children born at <30 weeks evaluated at age 5, when compared with born at term. At the low educational level these differences increased. Sidhu et al. (2010) found that a low parental education level was a risk factor for cognitive and language development in children assessed at 2 to 35 months. On the other hand, other authors found that higher maternal education level was associated with better language and motor outcomes in preterm infants (Dall'oglio et al., 2010; Janssen et al., 2011; Ko et al., 2013; Patra et al., 2016), and that mothers' interactions were associated with their educational level as well as the father's educational level (Hall et al., 2015).

Advances in Neonatal Care Have Increased Survival of Preterm Babies (Fellman et al., 2010). Also an increased risk of suffering some kind of deficit (Rogers & Hintz, 2016). This increases the need for short-, medium-, and long-term developmental assessments of these children, especially in those with extreme prematurity, and identify early on those variables that may have a negative influence in order to minimise them and provide treatment guidelines and advice to parents (Gasparini et al., 2017). For this reason, the choice of developmental assessment protocols, appropriate and adapted to the needs of each child and their family, are essential for the detection of gaps in this population.

So far, there are few studies that take into account the role that parents' socio-demographic variables (such as age and educational level) play in the development of children born very prematurely. Taking into account these previous findings, we asked if some clinical variables, such as gestational age and weight, together with other sociodemographic variables, could be related to the cognitive, motor and language development of premature babies at 36 months, considering the factors that can affect the development of very premature infants in the pre-school stage. Understanding the relationships between these factors can help us create specific intervention programmes aimed at the most vulnerable premature and families with the greatest difficulties. It also optimizes resources to better follow up these children and their families in the medium and long term.

Design and methods

Participants

This is a descriptive, observational, cross-sectional study. Data were collected from the clinical history of preterm newborns who met the inclusion criteria: birth at less than 32 weeks' gestation and reaching the age of 36 months during the assessment period, and who received the standard follow-up due to their prematurity in the hospital maturation unit. The follow-up consisted of pediatric check-ups at 40 weeks and at 3, 6, 12, 18, 24 and 36 months of corrected age, following the protocol established in our context (Patronato & Discapacidad, 2005; Torres Valdivieso et al., 2008). Each check-up included a brief screening of infant development, as well as relevant referrals to other specialized services and early childhood care centers. Families were contacted and informed of the investigation. Those families who decided to participate were given an appointment. A psychologist obtained informed consent, collected socio-demographic data via a structured interview, and assessed the children.

The recruitment process was carried out from March 2017 to May 2018. Of the premature children born from March 2014 to July 2015, 592 were excluded because we did not have access to them or they did not want to participate. The study initially included 49 children, although 5 were excluded because they had been born after the 32nd week of gestation, and 11 because no sociodemographic data of the parents were collected, because it was not possible to contact with them or they had moved out of town for work. In addition, a family of twins refused to participate, making a total of 31 subjects in the sample (18 boys and 13 girls), belonging to 25 families, classified according to the prematurity criteria (World Health Organization, 2019) as extremely premature (<28 weeks) and very premature (28 < 32 weeks), who were evaluated at 36 months of age (Fig. 1).

Instruments

Their development was assessed using the Bayley-III Scale, translated and adapted into Spanish (Bayley, 2015), which includes the main development areas: Cognition, Language (receptive and expressive) and Motor (fine and gross), in children from 0 to 42 months. The duration of the application ranges between 30 and 90 min, and the average score ranges is between 80 and 119 (Bayley, 2015). The instrument has good psychometric properties, and represents one of the most used assessment tools to identify possible imbalances in prematurely born babies (Greene et al., 2012).

Two qualified psychologists performed the assessment in the presence of the mother, father, or both. The time ranged from 75 to 115 min.

Statistical analysis

A descriptive analysis of the sociodemographic data of the child (sex, GA and birth weight) and parents (age and educational level) was carried out, as well as the results in Cognition, Language and Motor areas. The Shapiro-Wilk test was used to check for normality in the distribution of the data. The correlations off cognitive, motor, and language development with birth weight, GA, and parental age were analysed using Pearson's or Spearman's correlation coefficients, depending on the normality of the distribution. Differences between the degree of prematurity, sex and the educational level of the parents were evaluated with the Student's *t*-test when the continuous variable followed a normal distribution, and with the Mann-Whitney *U* test when the distribution was not normal. In order to know the influence of the educational level of the parents in the three development areas, Student's t-test and Mann-Whitney U test were performed in pairs (high vs. medium; high vs. low; medium vs. low). Cohen's d was used to calculate the effect

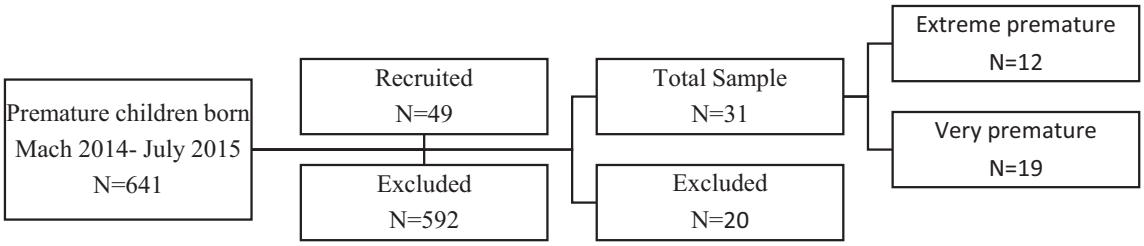

Fig. 1. Flowchart.

size within the parametric tests, with the following classification criteria: <0.20 is considered as null effect; 0.20 to 0.50, small; 0.50 to 0.80, medium; and >0.80, big effect (Cohen, 1988). For the non-parametric cases, Rosenthal r were calculated, being the criteria: null <0.10, small 0.10 to 0.30, medium 0.30 to 0.50, large 0.50 to 0.70, or very large >0.70 (Ellis, 2009; Rosenthal, 1996).

Three linear regression models were performed to analyse the factors associated with the level of development (dependent variables). In these models, the independent variables that were tested were: sex, GA and birth weight in children, as well as age and educational level in parents. To select the covariates included in the models, clinical and statistical criteria were used (Wald test in stepwise regression).

Ethical considerations

The Ethics Evaluation Committee approved the study (internal code: 1560-N-18) following the criteria of the Declaration of Helsinki. The families were explained the purpose of the study and the anonymous use of the information provided before they signed their informed consent.

Results

Eighteen boys (58.1%) and 13 girls (41.9%) participated in the study, making a total of 31 subjects. The average age of the fathers was 37.07 (SD = 4.19) and mothers 34.93 (*SD* = 3.37). Most of the fathers had medium level of education (48.4%), and the mothers had high level (41.9%). The very prematures infants comprised 61.3% of the babies, and the average birth weight was 1089.65 g (*SD* = 225.329). The scores obtained in the different areas of development were in a range considered as "average range" (Table 1).

Table 1
Sample characteristics and normality tests.

Variable	n (%)	M(SD)	p*
Fathers Age		37.07 (4.12)	0.161
Mothers Age		34.93 (3.37)	0.040
Father's educational level			
High	8 (25.8%)		
Medium	15 (48.4%)		
Low	5 (16.1%)		
Mother's educational level			
High	13 (41.9%)		
Medium	12 (38.7%)		
Low	5 (16.1%)		
Sex			
Boys	18 (58.1%)		
Girls	13 (41.9%)		
GA			
Extremely preterm	12 (38.7%)		
Very preterm	19 (61.3%)		
Birth weight		1089.65 (225.33)	0.200
Cognition		99.55 (7.615)	0.001
Motor		95.81 (16.42)	0.133
Language		99.45 (11.39)	0.315

M: Mean; SD: Standard deviation; * Shapiro-Wilk test

Significant correlations were obtained between the age of the fathers and the age of the mothers, and between the father's age and birth weight. The development areas evaluated were correlated among them, being the relationship between the Language area and the other two development areas moderate/large (Table 2).

Regarding prematurity, both groups were in the average range, although extreme premature infants obtained lower achievements in the three areas of development, showing the greatest difference in the Motor area. However, the effect size is large in the areas of Cognition and Motor, and medium in the area of Language (Table 3).

As for the differences in development by sex, although both were in the average range, the results of the girls were better. However, the difference was only significant in the Motor area ($p = 0.03$) (Table 4). The effect sizes were medium in the areas of Cognition and Motor and small in the area of Language.

In the analysis of the relationship between Cognition, Motor and Language and the fathers' level of study, it was observed that higher educational levels were related to better developmental achievements, although this differences were not statistically significant. On the other hand, taking into account the effect sizes, it can be drawn that these are medium in the three areas of development when high and low educational levels are compared, and high in the case of Language when comparing medium and low educational levels (Table 5).

In the case of the mothers, high and medium educational levels were associated with better results in the three areas of development. This relationship was only significant in Language when comparing the medium and low educational level ($p = 0.015$). Regarding the effect sizes, some of them were large, like in the higher and low educational level, and medium and low in Motor and Language, and a medium effect was seen in Cognitive (Table 6).

As previously noted, there was a significant correlation between the achievements in the three areas (Table 2). However, the results in Language further explain the other two areas to a greater extent, increasing the level of language when the scores in the other two areas increase. The Motor and Cognitive areas explain 68% of the results obtained in Language ($B = 0.910$; $p < 0.001$, and $B = 0.234$; $p = 0.010$), and this is, in turn, responsible for almost 60% of the results in Cognition ($B = 0.514$; $p < 0.001$). In the Motor area, Language ($B = 0.686$; $p = 0.001$), GA ($B = 3.443$; $p = 0.002$) and a high educational level in the mother ($B = 11.902$; $p = 0.010$) would explain more than 68% of the results (Table 7).

Discussion

The premature children's population, and more specifically those who are extremely preterm and very premature, are considered to be at greater risk of experiencing difficulties in developmental achievement. However, the results found indicate a development within the average range, although with some differences according to the degree of prematurity, the sex and the educational level of the parents.

More specifically, it can be seen that although both groups of prematurity are in the average range, very premature have better developmental outcomes than extremely premature; while this difference is

Table 2
Correlations between parental age, birth weight and developmental level.

	Mothers Age	Birth weight	Motor	Language	Cognition
Fathers Age	**0.502 $p = 0.007$[b]**	**0.419 $p = 0.026$[a]**	−0.108 $p = 0.583$[a]	−0.160 $p = 0.417$[a]	−0.240 $p = 0.218$[b]
Mothers Age		0.113 $p = 0.554$[b]	−0.261 $p = 0.164$[b]	−0.283 $p = 0.130$[b]	−0.223 $p = 0.235$[b]
Birth weight			−0.064 $p = 0.731$[a]	−0.161 $p = 0.387$[a]	−0.090 $p = 0.629$[b]
Motor				**0.627 p ≤ 0.001[a]**	**0.366 $p = 0.043$[b]**
Language					**0.745 p ≤ 0.001[b]**

[a] Pearson's correlation. [b] Spearman's correlation.

Table 3
Differences in the development level between preterm groups.

	Extremely preterm M (SD)	Very preterm M (SD)	p	Effect size
Cognition	97.08 (8.38)	101.11 (6.86)	0.14[a]	0.56[c]
Motor	86.33 (12.83)	101.79 (15.85)	0.08[b]	**1.07[d]**
Language	94.92 (14.11)	102.32 (8.49)	0.78[b]	0.63[d]

[a] Mann-Whitney U test; [b] Student's T-test. [c] Rosenthal r. [d] Cohen's d

Table 4
Differences in the level of development according to the sex.

	Boy M (SD)	Girl M (SD)	p	Effect size
Cognition	97.56 (8.183)	102.31 (5.991)	0.81[a]	−0.31[c]
Motor	90.44 (11.932)	103.23 (19.227)	**0.030[b]**	**−0.79[d]**
Language	97.67 (12.112)	101.92 (10.251)	0.313[b]	−0.37[d]

a Mann-Whitney U test; b Student's T-test. [c] Rosenthal r. [d] Cohen's d

not significant, the effect size is medium to high in all three areas. This result is in line with previous studies. Romeo et al. (2015), using the same scale, showed the influence of GA, with the very premature obtaining significantly lower scores than late preterm infants. For its part, Schonhaut et al. (2015) also showed that they had a lower risk of developmental delay than moderately preterm infants. Serenius et al. (2016), using the Wechsler Intelligence Scale for Children (WISC-IV), found that disability rates were substantially higher with a lower GA and when they were evaluated at the higher the age in extremely premature infants, compared to full-term infants. These results may highlight the importance that GA below 32 weeks would have on the development of preterm births.

Attending to gender, girls obtaining best outcomes in the three development areas, being more accentuated in the motor area. This result also agrees with Romeo et al. (2015) where the Mental Development Index was better in girls, and those of Macedo and Cardoso (2019), where at 20 months of age corrected with Bayley scales, girls obtained better scores in the Mental Development Index and in the Motor area, although this result did not reach statistical significance. These results may be influenced by a small number of girls in the extreme preterm group compared to boys. However, it has been documented that children are more vulnerable to prematurity, with about 55% of premature births (Blencowe et al., 2013). Girls have better immune responses and resistance to infection, while boys are more likely to suffer from respiratory conditions in the perinatal period (Drevenstedt et al., 2008) and higher incidence to brain hurt (Skiöld et al., 2014). So regardless of GA, children are more likely to have other conditions that can affect their development.

With regard to parents socio-demographic variables, the age of the father and mother are directly related, and the age of the father is related to the weight of the children at birth; so that, the older the father greater the baby's weight. This result is partly in line with the findings found in a study where babies of young fathers were at increased risk of low birth weight, and small for GA (Alio et al., 2012). On the other hand, attending to fathers' education level, although there is no evidence of significant relationship with their development child's level, there is evidence of its influence. Thus, the higher the fathers' educational level, the better the results in each area of development. In this line, Hall et al. (2015) found that fathers who had a higher education level had better interactive behavior, providing greater cognitive stimulation and were more sensitive and less withdrawn with a sample of children born prematurely and full-term, compared to parents who had a lower education level,. Sidhu et al. (2010) found that a low educational parental level was a risk factor for language development in children. Potharst et al. (2011) show that a high level of education in both parents was associated with better results in the cognitive area when comparing preterm and full-term infants. Moreover, parents with a lower educational level often have worse health literacy, which is associated with limited health knowledge, poor preventive care behaviours for children and more injuries (Sanders et al., 2009). With respect to the mothers' level of studies and the development areas children, there is a relationship between language and the educational level of the mother medium and low. However, developmental level scores in all three areas are better for mothers with studies medium and high. This result is in line with other studies using the same scale. One of these found in the three development areas the higher the educational mother level (Ko et al., 2013; Patra et al., 2016). In addition, in the linear regression analysis model, it was found that in mothers with a high educational level, the child's motor level was higher, as well as in the studies by Janssen et al. (2011) and Patra et al. (2016).

It is possible that the influence of the mother's educational level on the children development may be due to various biopsychosocial causes. One of them is that mothers with a higher educational level have more resources and training about the risks to which their babies are exposed and make greater efforts to stimulate them and optimize their development. In addition, Hall et al. (2015) found that mothers of premature babies were found to be more active, stimulating and controlling during interaction and to use more verbal communication, which may be due to the need for providing greater stimulation to

Table 5
Level of development according to the educational level of the fathers.

	Father's educational level			p^0	p^1	p^2	p^3	Effect size 1	Effect size 2	Effect size 3
	High M(SD)	Medium M(SD)	Low M(SD)							
Cognition	103.13(5.30)	99.07(7.478)	94(10.84)	0.130[a]	0.213[a]	0.065[a]	0.349[a]	0.07[c]	−0.47[c]	−0.26[c]
Motor	100.50(22.70)	95.40(13.788)	90.60(14.10)	0.581[b]	0.574[b]	0.404[b]	0.511[b]	0.27[d]	0.51[d]	0.33[d]
Language	103.38(13.93)	99.60(10.239)	91.80(10.69)	0.225[b]	0.465[b]	0.142[b]	0.161[b]	0.31[d]	0.74[d]	**0.93[d]**

[0]High-Medium-Low; [1] High-Medium; [2] High-Low; [3]Medium-Low [a] Mann-Whitney U test; [b] Student's T-test; [c] Rosenthal r. [d] Cohen's d

Table 6
Level of development according to the educational level of the mothers.

	Mother's educational level			p^0	p^1	p^2	p^3	Effect size 1	Effect size 2	Effect size 3
	High M(SD)	Medium M(SD)	Low M(SD)							
Cognition	100.38(6.60)	101.25(5.28)	92.20(11.9)	0.233[a]	0.887[a]	0.138[a]	0.101[a]	−0.07[c]	0.39[c]	0.44[c]
Motor	101.08(19.29)	94.50(8.85)	81.40(15.65)	0.065[b]	0.283[b]	0.060[b]	0.138[b]	0.44[d]	**1.12[d]**	**1.03[d]**
Language	100.38(13.50)	101.50(6.78)	89.60(11.24)	0.120[b]	0.799[b]	0.134[b]	**0.015[b]**	−0.10[d]	**0.87[d]**	**1.28[d]**

[a]Mann-Whitney U test; [b]Student's T-test; [0]High-Medium-Low; [1]High-Medium; [2]High Low; [3]Medium-Low. [c] Rosenthal r. [d] Cohen's d.

Table 7
Factors associated with the childrens's development level. Multiple linear regression models.

Models	Variables	B	IC (95%)	p
Cognition level ($R^2 = 0.591$)	Language	0.514	0.352–0.676	0.000
Motor level ($R^2 = 0.686$)	Language	0.712	0.336–1.087	0.001
	GA	3.443	1.388–5.498	0.002
	Mother's educational level Highs	11.902	3.061–20.74	0.010
Language level ($R^2 = 0.679$)	Cognition	0.910	0.537–1.283	0.000
	Motor	0.234	0.061–0.407	0.010

babies. Another reason may be that mothers interact with infants more verbally, while fathers interact more physically. It is also possible that, in this context, women devote more time to childcare.

It has also been possible to see the influence between the different development areas. Farkas and Corthorn (2012) indicated that there is an interrelationship in the development within these areas of Bayley during the first years of life, mainly in the earliest stages, where children's cognitive development is characterized by knowledge of the environment through motor and sensory exploration of nearby objects, other people and their own body, and all this information is transformed into "mental schemes". They also indicated that success in language acquisition is a good indicator of cognitive maturation, acquisition which is in turn modulated by other factors such as social interaction with parents. Therefore, it can be said that each one of the areas is not developed independently from the others, but they are related, mainly in this first stage.

In addition to the above, the Motricity is influenced by the GA, being this result according to the one of Farkas and Corthorn (2012), that by means of a linear regression model, found that a higher GA implied better achievements in motor development.

Practice implications

It would be important to monitor these children over a longer period of time, for example until the start of compulsory schooling (6 years). This would allow us to gain a more specific understanding of cognitive skills, as developmental tests have limited predictive value. Furthermore, it should be taken into account that the demands of the environment and the influence of socio-demographic factors are more relevant with increasing age, which may increase difficulties. It would be necessary to teach the family parenting practices and interactive skills with babies from the time they are in the Neonatal Intensive Care Unit (NICU) until hospital discharge. Moreover, it might be important to assess the emotional ambit of parents, because if they do not have a good emotional state, it could influence their interaction with babies. This could justify the development of assessment protocols and intervention programs aimed at less educated parents with very preterm male children. In this way, support groups for parents or specific reinforcement at school could be established. Finally, we believe that families with fewer resources should be targeted for intervention, as they may find it more difficult to go into the private sphere if necessary.

Limitations

This study is not without its limitations. The small number of children in the sample, due to its specificity and difficult accessibility, is only available in third level hospitals; and the experimental mortality, very common in studies about early development, perhaps because of the many controls in the different medical specialties, may make it difficult to generalize results. On the other hand, the two premature babies groups were not equivalent, are higher the girls number in the very premature group, as it happens with those born with these characteristics. This could influence the results when comparing their development level according to sex. The Bayley is an appropriate scale for this population, but the validation and adaptation into Spanish does not take into account two important areas such as the Adaptative behavior and Social-emotional. Also, the Bayley is only used in one service, but it is a third-tier referral hospital for this population in a wider region. On the other hand, it is relevant to add some strengths such as evaluation at 36 months, which differs from the more frequent follow-up protocol, where measurements are usually make at 12 and 24 months. In addition, the educational father level has been taken into account, something rare in the existing literature. These differential aspects provide preliminary data to further explore these relationships in future research. It would be interesting for future research to expand the sample and carry out multicenter studies with other reference hospitals in order to obtain more powerful results. If we take into account that the evolution of each area depends on the others, it would be necessary to strengthen the area of greatest vulnerability. This would promote a better harmonious development in this group. In fact, this issue should be explored in depth, as there is very limited literature in this regard.

Conclusions

It can be concluded that, although the developmental level of children assessed is within the average values established by the Bayley-III test, these are influenced by the prematurity level, sex and parents educational level. These results confirm the hypothesis regarding greater vulnerability in certain families, specifically parents with a lower educational level, with boys and/or very premature children.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they do not have conflict of interest.

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