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Predictive value of the Bayley Scales applied to a group of preterm infants, on their results on the Wechsler Scales at 10 years of age

María-Paz García-Martínez[1,3,*], Juan Sánchez-Caravaca[2,3,4], María-Pilar Montealegre-Ramón[3], and Julio Pérez-López[3,4]

1 Asociación APSA, Alicante (Spain)
2 Psychopaedagogic and Educational Orientation Team for Early Intervention of the Department of Education of the Autonomous Community of the Region of Murcia (Spain)
3 Early Intervention Research Group. University of Murcia (Spain)
4 Department of Evolutionary Psychology and Education. University of Murcia (Spain)

Título: Valor predictivo de las escalas Bayley aplicadas a un grupo de niños nacidos pretérmino, sobre sus resultados en las Escalas Wechsler a los 10 años.
Resumen: *Objetivo*.- El presente trabajo pretende comprobar si las puntuaciones obtenidas por un grupo de niños nacidos pretérmino durante los primeros 3 años de vida, evaluados con las escalas Bayley, predicen las capacidades cognitivas posteriores, evaluadas con las escalas Wechsler. *Método*.- Se utilizó un método cuasi-experimental de tipo descriptivo con un diseño longitudinal. Para examinar la capacidad predictiva de las evaluaciones realizadas con la Escala BSID-II sobre los resultados de la Escala WISC-IV, se efectuaron tres análisis de correlación canónica, uno inicial, con los datos del primer mes de edad corregida, otro, a los 18 meses de edad corregida y, un tercero, a los 36 meses de edad cronológica. *Resultados*.- Las puntuaciones obtenidas en las Escalas BSID-II tanto a los 18 meses de edad corregida, como a los 36 meses de edad cronológica guardan una relación significativa con los resultados obtenidos a los 9-11 años en la Escala WISC-IV. Sin embargo, las puntuaciones obtenidas al mes de edad corregida no sirven para predecir dichos resultados. *Conclusiones*.- Estos resultados nos permiten subrayar el valor predictivo de las evaluaciones del desarrollo realizadas a partir de los 18 meses de edad corregida, con una buena estabilidad en el desarrollo cognitivo a lo largo del tiempo. Defendemos la intervención y los seguimientos a largo plazo.
Palabras clave: Escalas Bayley; Escalas Wechsler; Atención temprana; Desarrollo; Capacidades cognitivas; Inteligencia; Estudio longitudinal; Nacimiento pretérmino.

Abstract: *Objective*: The present work aims to verify if the scores obtained by a group of preterm infants during the first 3 years of life, evaluated with the Bayley scales, predict posterior cognitive abilities, evaluated with the Wechsler Scales. *Method*: A quasi-experimental method of descriptive type with a longitudinal design was used. To examine the predictive capacity of the assessments made with the BSID-II Scale on the results of the WISC-IV Scale, three canonical correlation analyses were carried out: an initial one using the data from the first month of corrected age; another at 18 months corrected age; and a third at a chronological age of 36 months. *Results*: The scores obtained in the BSID-II Scales both at 18 months corrected age and at 36 months of chronological age have a significant relationship with the results obtained at 9-11 years old on the WISC-IV Scale. However, the scores obtained at the corrected age of one month do not serve to predict such results. *Conclusions*: These results allow us to highlight the predictive value of developmental assessments performed after 18 months of corrected age, with good stability in cognitive development over time. We defend intervention and long-term follow-ups.
Keywords*:* Bayley Scales; Wechsler Scales; Early intervention; Development; Cognitive outcome; Intelligence; Longitudinal study; Preterm birth.

Introduction

Preterm birth is a significant biological risk factor that may negatively affect brain development (Ball et al., 2013; Grieve et al., 2008) and, as a result, the overall development of the child affected (Narberhaus, 2004; Pérez-López, García-Martínez, & Sánchez-Caravaca, 2009; Rose, Feldman, Jankowski, & Van Rossem, 2005). Thanks to advances in medicine and the care provided in NICUs (neonatal intensive care units), the survival of premature and extremely premature infants and/or those with a low birthweight has improved substantially and the frequency of what are termed "new morbidities" in this population group, among which we can highlight neuropsychological, behavioural and cognitive difficulties, has also been brought to the fore (Anderson, 2014; Aylward, 2005; Bayless, Pit-ten Cate, & Stevenson, 2008; Johnson & Marlow, 2017; Lobo & Galloway, 2013; Orchinik et al., 2011; Reuner, Hassenpflug, Pietz, & Philippi, 2009; Taylor, 2006). This fact appears to be associated with an increased identification of difficulties related to brain development at school age, although the magnitude of these problems is still unknown (Anderson, Doyle, & the Victorian Infant Collaborative Study Group, 2003; Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Larroque et al., 2008).

It is quite commonplace that preterm infants, compared with their peers born at full term, present a poorer cognitive function during childhood (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Anderson, Doyle, & the Victorian Infant Collaborative Study Group., 2004; Aylward, 2002; Bhutta et al., 2002; Linsell et al., 2018), adolescence (Aarnoudse-Moens et al., 2009; Allin et al., 2008; Anderson et al., 2004; Linsell et al., 2018; Saigal, 2000), or adulthood (Aarnoudse-Moens et al., 2009; Løhaugen et al., 2010; Nosarti et al., 2007). Moreover, this problem seems to be exacerbated in the case of infants born with a very or extremely low birth weight (Heinonen et al., 2017), whether or not their weight is in line with their gestational age.

Numerous scientific works have found that, in the long term, the results in the developmental assessment conducted using the Bayley Scales of Infant Development, 2nd Edition

*** Correspondence address [Dirección para correspondencia]:**
María de la Paz García-Martínez. Grupo de Investigación en Atención Temprana. Facultad de Psicología. Universidad de Murcia. Campus de Espinardo. 30100, Murcia (España). E-mail: pazgmar@gmail.com
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(Aylward, Pfeiffer, Wright, & Verhulst, 1989; Sajaniemi, Hakamies-Blomqvist, Katainen, & von Wendt, 2001), as well as the average general intellectual ability (IQ) scores at school age of infants born preterm, who have not presented significant changes or pathologies, tend to be within the norm (Bhutta et al., 2002; Kerr-Wilson, Mackay, Smith, & Pell, 2011; Larroque, 2004), but lower than those of their peers born at full term (Aarnoudse-Moens et al., 2009; Bhutta et al., 2002; Gu et al., 2017; Nyman et al., 2017; Twilhaar et al., 2018). Hence, there appears to be a "certain stability over time in the levels of achievement of the population of individuals born preterm, regardless of their year of birth, average chronological age or place of origin", as pointed out by García-Martínez, Pérez-López, Sánchez-Caravaca, & Montealegre-Ramón (2018, p.54-55). However, for Narberhaus (2004), "there is no consensus regarding whether or not the cognitive deficits in premature children worsen, remain the same or improve over time" (p. 321).

On the other hand, a selection of works have found that when populations of infants born preterm who have participated in early intervention programmes are studied, a tendency to obtain better results on the development scales is perceived than for those who have not participated in such programmes. In addition, those who have may even obtain the same scores as full-term infants. Brito de la Nuez, Díaz-Herrero, Pérez-López, Martínez-Fuentes, & Sánchez-Caravaca (2004) and Sánchez-Caravaca (2006) pointed out that the mental development of this group of children, following a slight plateau at the start, showed a gradual, sustained improvement at around 12 months corrected age, although the regulatory scores for their age group were still not reached. Piñero (2014), for her part, in a work in which intervention started prior to hospital admission, highlighted that the progress of preterm infants through to a corrected age of 18 months who had participated in the intra-hospital programme was better than that of those infants who had not been subject to such intervention since birth. Furthermore, in the study by Sølsnes et al. (2016) it was demonstrated that a group of high-risk preterm infants, who had received educational support from an early age, as well as specific follow-up by the health service, improved their IA scores at 8 years of age. In fact, Guralnick (1998) had already defended the importance of the participation of preterm and/or low birthweight infants in early intervention programmes during the first 3 years of life in order to optimise their cognitive development.

In the meta-analysis by Luttikhuizen dos Santos, de Kieviet, Konigs, van Elburg, & Oosterlaan (2013), a strong positive link was found between the Mental Development Index scores of the BSID-II and the posterior cognitive functioning outcome, although they warn that the predictive value is limited. Furthermore, in Table 1, it can be seen in greater detail that there seems to be a significant relationship between the assessments carried out in the first few years and those carried out at school age, based on studies conducted by different authors along these lines (Doyle & Casalaz, 2001; Munck et al., 2012; Nordhovet al., 2010; Potharst et al., 2012; Romeo et al., 2012; Sajaniemi, Hakamies-Blomqvist, Katainen, & von Wendt, 2001).

Table 1. Results in follow-up studies on preterm infants.

Study	Country	Years of birth	Subg.	N.	Birth-weight	GA	Assess-ment age	Assessment test: BSID-II Average MDI (SD)	Assessment test: WISC-IV Average FSIQ (SD)		MDI-FSIQ correlation (*p*)	Explained variance MDI-FSIQ
(Doyle & Casalaz, 2001)*1	Australia	1979-1980 1981-1982	P F	88 60	< 1,000 g > 3,000 g	< 30 40	2 corr. 5 chron. 8 chron. 14 chron.	90.7 (17.1) 105.8 (16.4)	WPPSI WISC-R WISC-III (Verbal Scale)	102.1 (16.2) 113.8 (15.6) 96.3 (15.0) 109.6 (15.7) 90.1 (16.5) 103.2 (13.7)	< .05	
(Sajaniemi et al., 2001)	Finland	1992-1994	P	81			2 chron. 4 chron.	86.7 (17.8)	WPPSI-R	91.8 (21.5)	< .05	
(Munck et al., 2012)*2	Finland	2001-2004 2001-2003	P F	124 168	≤ 1,500 g > 2,500 g	< 36 ≥ 37	2 corr. 5 chron.	101.2 (16.3) 109.8 (11.7)	WPPSI-R	99.3 (17.7) 111.7 (14.5)	< .0001 < .0001	
(Romeo et al., 2012)	Italy	2005	P	62		33-36.9	12 mth. corr. 18 mth. corr. 5 chron.	MDI > 85 (n = 60) MDI < 85 (n = 2) MDI > 85 (n = 61) MDI < 85 (n = 1)	WPPSI-R	103.9 (14.3)	< .05	
(Potharst et al., 2012)	Nether-lands	2007-2009	P	102	< 1,000 g	< 30	2 corr. 3 corr. 5 corr.	91 (18) 102 (14)	WPPSI-III	93 (17)		44% 56%
(Nordhov et al., 2010)	Norway	1999-2000	P1 (EI) P2 (no EI) P1 (EI) P2 (no EI)	67 67 66 65	< 2,000 g	≤ 33	3 chron. 5 Chron.	97.9 (11.1) 92.3 (15.6)	WPPSI-R	102.3 (13.5) 95.6 (19.2)		

Abbreviations: Subg.: subgroup; P: preterm; F: full term; EI: received early intervention; GA: gestation age; corr.: corrected age; chron.: chronological age; MDI: Mental Development Index; FSIQ: Full Scale Intelligence Quotient.
*1: VICS (Victorian Infant Collaborative Study Group).
*2: PIPARI (PIPARI Study Group).

However, due to their contrary findings, the work of Wong, Santhakumaran, Cowan, Modi, & Medicines for Neonates Investigator Group (2016) is remarkable as it affirms that at least half of the infants born prematurely that showed normal development during the first 3 years of life presented cognitive difficulties at school age.

Furthermore, regarding the stability of the intelligence test scores over time, in some studies conducted on populations born at full term, it is common to find that said stability appears to be maintained (Calero & García-Martin, 2014), which leads us to believe that it is necessary to wait for the same to happen in populations born preterm.

As far as the question of early implementation of specific intervention programmes for children born prematurely is concerned, upon taking a closer look at the different works that have dealt with this matter, there appears to be a generalised consensus in highlighting its importance (Anderson, Cheong, & Thompson, 2015; Johnson & Marlow, 2017), as well as in maintaining said intervention until the start of primary education, that is, for at least the first six years of life (Breslau, Johnson, & Lucia, 2001; Løhaugen et al., 2010; Pritchard et al., 2009; Vohr et al., 2000).

The defence of this continuity is put forward as, although the results in development may be maintained for the first two or three years of life, this period is not long enough to enable potential learning difficulties to be detected that manifest themselves in a more subtle manner and which, in this case, will present themselves and be identified as such later on (Aylward, 2005; Casasbuenas, 2005; Luu et al., 2009; Munck et al., 2012; Ornstein, Ohlsson, Edmonds, & Asztalos, 1991; Patrianakos-Hoobler et al., 2010; Potharst et al., 2012; Wocadlo & Rieger, 2006). To further reinforce the argument for long-term follow-up, it is necessary to remember that some specific characteristics related to cognitive development at a more advanced age, such as attention (de Kieviet et al., 2014; Murray et al., 2014; Scott, Winchester, & Sullivan, 2017; Wilson-Ching et al., 2013), working memory (Farooqi, Adamsson, Serenius, & Hägglöf, 2016; Rose, Feldman, Jankowski, & Van Rossem, 2005; Vollmer et al., 2017), or the speed at which information is processed (Murray et al., 2014; Soria-Pastor et al., 2008), are usually particularly affected in infants born preterm by the specific characteristics of their brain development.

Therefore, there seems to be a consensus in the need to carry out specific preventive work with infants born preterm given that the adoption of early corrective measures in this case may prevent problems in the child's development and the wellbeing of the child and its family in the short, mid and long term. Furthermore, given that there may be tools that allow us to detect at an early stage which of these children could present specific difficulties at pre-school age, it is necessary to research what tools may provide us with this information in order to be able to use them. It is along these lines that this work fits in.

The problem, objectives and hypothesis

The aim of this study has been to analyse to what extent the level of mental and psychomotor development of a group of infants born preterm, who participated in early intervention programmes from birth to three years of age, contributes towards explaining their cognitive development at 9-11 years, ages which correspond with the second phase of primary education in the Spanish education system.

Based on the findings from previous studies, we put forward the following hypothesis: Mental and psychomotor development in the first three years of life of infants born preterm, assessed using the BSID-II scales, will condition their cognitive development in the second phase of primary education, assessed with the WISC-IV scale.

Method

Format and participants

A quasi-experimental method of descriptive type with a longitudinal design was used.

This work is part of a longitudinal study started in the year 2000 with 53 participants. The initial sample of children was selected at random from infants born prematurely in the university hospital "Virgen de la Arrixaca" in Murcia (Spain) between November 2000 and October 2002. The initial characteristics of the sample studied had already been presented in previous works (García-Martínez, Pérez-López, & Sánchez-Caravaca, 2010; Pérez-López et al., 2009; Pérez-López & Sánchez-Caravaca, 2008; Sánchez-Caravaca, 2006). For this study, 29 children (17 boys and 12 girls) were assessed at 9 to 11 years of age (*Mean*=10.08, *SD*=0.62). Three children (two boys and one girl) were excluded from the final analysis, given the impossibility of applying the WISC-IV scale due to the high degree of cognitive impairment presented. The rest of the initial population were either unable to be located or declined to participate in this phase of the study (see Figure 1).

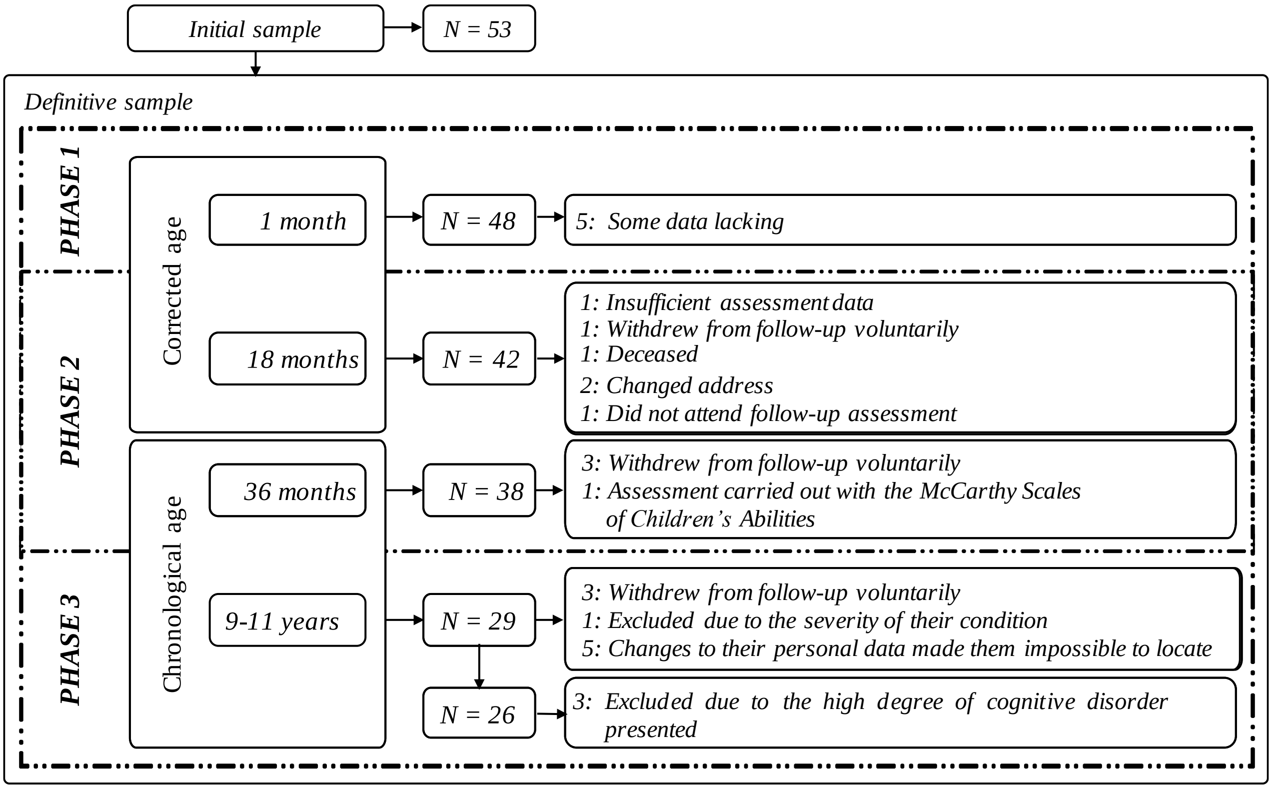


Figure 1. Flow chart of children participating in the study.

As had already been established in the previous works mentioned, no significant differences were detected in terms of the sociodemographic characteristics of the children and families participating in the study. The perinatal characteristics of the children are presented in Table 2.

Table 2. Perinatal characteristics of the sample.

		N	%
Gestation at birth	Extremely preterm (< 28 weeks)	3	11.5
	Very preterm (28<32 weeks + 6 days)	9	34.6
	Moderate to late preterm (33<36 weeks + 6 days)	14	53.8
Birthweight	Extremely low weight (< 1,000 g)	5	19.2
	Very low weight (< 1,500 g)	8	30.8
	Low birthweight (< 2,500 g)	12	46.2
	> 2,500 g	1	3.8
Weight According to Gestational Age (GA)	Small for the GA (birthweight < the 10th percentile)	6	23.1
	Suitable for the GA (birthweight between the 10th and 90th percentiles)	18	69.2
	Large for the GA (birthweight > the 90th percentile)	2	7.7

Instruments

Bayley Scales of Infant Development, 2nd Edition (BSID-II)

The Bayley Scales of Infant Development, 2nd Edition (BSID-II, Bayley, 1993), are a set of standardised assessment scales which enable us to evaluate the cognitive, motor and behavioural development of children between 1 and 42 months.

The Mental Scale is formed by 178 items and the Motor Scale by 111. More specifically, the mental scale assesses: the child's capacity to adapt to auditory and visual stimuli; sensory-perceptual acuity; learning and ability to solve problems via discrimination and the ability to respond to stimuli; early acquisition of object and memory permanence (constancy); early ability to generalise and classify; the concept of numbers; vocalisation and language; and social skills. For its part, the motor scale evaluates: the degree of control of fine and gross muscle groups via primary movements; quality of movement; muscle tone; perceptual-motor integration; coordination of large muscle mass; the manipulative skills of hands and fingers, without differentiating between fine and gross motor skills. For this study, the data resulting from the Behaviour Assessment Scale have not been taken into account, given that this is merely a qualitative assessment of the child's performance during the test.

The items are classified in increasing order of difficulty, thus adjusting to the idea of an evolutionary process. The time for performing the test varies according to the age and stamina of the child, with an estimated time frame of 25-35 minutes for children under 15 months and around 45-60 minutes for children over that age (Bayley, 1993).

The scale provides raw scores that are transformed into standard scores called Mental Development (MDI) and Psychomotor Development (IDP) Indexes (with a mean of 100 and standard deviation of 15) and, moreover, enable us to obtain an equivalent developmental age for the mental and motor scales respectively.

Wechsler Intelligence Scale for Children – Fourth Edition (WISC- IV)

The Wechsler Intelligence Scale for Children – Fourth Edition (WISC- IV, Wechsler, 2003) is a psychoeducational assessment instrument used individually to perform a complete measurement of the cognitive abilities of children aged between 6 years and 0 months and 16 years and 11 months.

This version, leaving behind the subdivision of earlier versions, is made up of four indexes that provide information on intellectual functioning in certain specific fields and which, when combined, enable a total score or measurement of the general intellectual ability (or general IQ, FSIQ) to be obtained. Moreover, several additional processing scores can be calculated without having to apply more tests. The four indexes are the Verbal Comprehension Index, which assesses verbal skills, including reasoning, comprehension and concepts; the Perceptual Reasoning Index which measures perceptual reasoning and organisation; the Working Memory Index which assesses attention, concentration and working memory; and, finally, the Processing Speed Index which aims to assess the speed of mental and graphomotor processing.

The WISC-IV consists of 10 main tests and 5 optional tests. The test provides direct scores, from which scale scores can be derived with which it is possible to obtain composite or index scores (with a mean of 100 and a standard deviation of 15). For this work, the data resulting from the full scale have been taken into account, considering the composite scores (Wechsler, 2003).

Both the BSID-II scale and the WISC-IV scale are widely known tests in the clinical and scientific sphere and are considered to be suitable instruments for measuring development and general intellectual ability respectively. The BSID-II scale contains data that guarantee its reliability for the different scales, with average Cronbach's α values of 0.88 for the mental scale and 0.84 for the motor scale (Bayley, 1993). The reliability data of the WISC-IV scale in the Spanish population present Fisher z scores of around 0.83 for the different tests, values that are very similar to those obtained in the American population, and for the composite scores the values fluctuate between 0.86 and 0.95 (Wechsler, 2003).

Procedure

Firstly, each family was contacted by phone and informed about the research and the requirements (space and time) of the assessment. Secondly, signed informed consent was obtained from the parents who agreed to participate voluntarily in this third phase of the study. Thirdly, the participants of this study were assessed using the WISC-IV scale and the results of said assessments were compared with those obtained using the Bayley Scales at corrected ages of one month and 18 months and a chronological age of 36 months. Said assessments, using the WISC-IV scale, were performed between October 2011 and January 2013.

Approval to carry out the research was obtained from the Ethics Committee at the University of Murcia (2000) and the criteria for ethical conduct in scientific research were followed as set out in the Declaration of Helsinki of 1964 and its later amendments (World Medical Association, 2017).

Analysis of data

The statistical analysis of the data was performed using the statistics package SPSS v.15.0.1 for Windows.

The association between the quantitative variables was analysed via three canonical correlation analyses, taking as dependent variables the *composite scores* of the Wechsler Intelligence Scale *(WISC-IV)* and, as predictive variables, the *scores obtained* on the Mental and Motor Scales of the Bayley Scales of Infant Development, 2nd Edition *(BSID-II)* during the first three years of life.

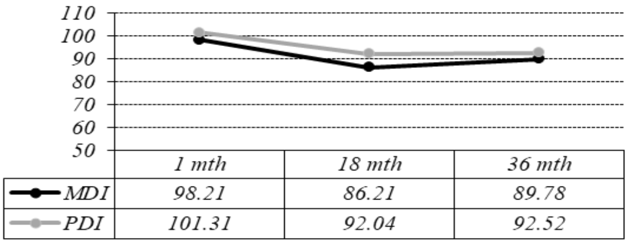
The canonical correlation analysis is a highly efficient statistical technique which can be used to check the magnitude and sense of the relationship between a set of predictive variables and a set of dependent variables (Ríos-Risquez, Sánchez-Meca, & Godoy-Fernández, 2010, p.602), which is the aim of this research.

Results

The descriptive statistics obtained for the children in the three assessments carried out with the BSID-II and those obtained with the WISC-IV are shown in Tables 3 and 4, Figures 2 and 3.

Table 3. Evolution of the development of the children from the sample according to the development indexes.

	M	*SD*	Range
Mental Development Index 1 month (corrected age)	98.21	11.04	(80-122)
Psychomotor Development Index 1 month (corrected age)	101.31	13.08	(64-125)
Mental Development Index 18 months (corrected age)	86.21	19.65	(45-115)
Psychomotor Development Index 18 months (corrected age)	92.04	22.01	(45-130)
Mental Development Index 36 months (chronological age)	89.78	21.40	(45-120)
Psychomotor Development Index 36 months (chronological age)	92.52	22.99	(45-129)

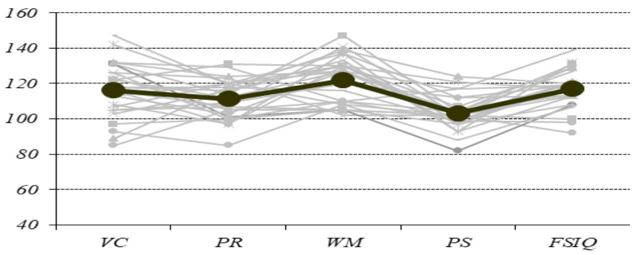


Abbreviations: MDI: Mental Development Index; PDI: Psychomotor Development Index.

Figure 2. BSID-II, mean scores obtained on the BSID-II.

Table 4. Composite scores of the WISC-IV, intelligence assessment.

	M	*SD*	*Range*
CS – Verbal Comprehension	116.15	15.597	(85-147)
CS – Perceptual Reasoning	111.42	11.129	(85-131)
CS – Working Memory	121.77	13.595	(102-147)
CS – Processing Speed	103.19	9.654	(82-124)



Abbreviations: VC: Composite score – Verbal Comprehension Index; PR: Composite score – Perceptual Reasoning Index; WM: Composite score – Working Memory Index; PS: Composite score – Processing Speed Index; FSIQ: Full Scale Intelligence Quotient.
* The profile of the mean scores of the whole sample is in bold.

Figure 3. Mean composite scores obtained by the boys and girls (WISC-IV)

To examine the predictive ability of the assessments performed with the BSID-II scale (Bayley, 1993) during the first three years of life in terms of later results on the WISC-IV scale (Wechsler, 2003), three canonical correlation analyses were carried out: an initial one at a corrected age of one month; an interim one at a corrected age of 18 months; and a final one at a chronological age of 36 months..

In said analyses, the set of dependent variables was formed by the four indexes obtained in the WISC-IV: verbal comprehension, perceptual reasoning, working memory and processing speed. The set of predictors was formed by the two development indexes of the BSID-II: mental and psychomotor.

For each canonical function (see Table 5), the standardised canonical coefficients are presented, as well as the structural coefficients (r_s) and the latter squared which, in terms of percentages, represent the variance percentage that each variable observed shares with its canonical function. As a criterion to facilitate interpretation, the structural coefficients equal to or greater than 0.45, in an absolute value, are highlighted and can be considered to be the values that represent the variables observed that are most strongly linked to the canonical variable (Cf. Ríos-Risquez et al., 2010; Sherry & Henson, 2005).

Table 5. Results of the analysis of canonical correlation between the MDI and PDI and the composite scores of the WISC-IV.

Variable	1 month Canonical Function 1			18 months Canonical Function 2			36 months Canonical Function 3		
	Coef.	r_s	r_s^2 (%)	Coef.	r_s	r_s^2 (%)	Coef.	r_s	r_s^2 (%)
Dependent variables:									
CS – Verbal Comprehension	-0.849	***-.932***	86.86	0.108	-.008	0.01	-0.479	***-.580***	33.64
CS – Perceptual Reasoning	-0.105	***-.550***	30.25	-0.445	***-.568***	32.26	-0.137	-.430	18.49
CS – Working Memory	-0.348	-.415	17.22	-0.842	***-.904***	81.72	-0.820	***-.647***	41.86
CS – Processing Speed	0.087	-.078	0.61	0.076	-.177	3.13	0.430	-.309	9.55
R_c^2			14.40			59.70			67.20
Predictive variables:									
MDI	0.675	-.335	11.22	-0.970	***-.999***	99.80	-0.977	***-.545***	29.70
PDI	-1.002	***-.772***	59.60	-0.055	***-.560***	31.36	0.943	***-.496***	24.60

Coef: standardised canonical function coefficients. rs: structural coefficients, representing the correlation of each variable observed and the canonical variable (the rs values ≥|0.45| appear in bold). rs:^{2}: structural coefficients squared (as a percentage), representing the variance percentage shared by the observed variable and the canonical variable. Rc^2: variance percentage shared by the two sets of variables.

The results of the analysis performed with the values of the development index of the BSID-II *at a corrected age of one month* are shown in Table 5. The analysis produced two canonical functions with explained variance percentages (R_c^2) of 14.40% and 1%. Overall, the set of the two canonical functions did not achieve any statistical significance according to the Wilks' Lambda criterion λ= .849 [F (8, 40) = 0.431, *p* = .895]. This result suggests that there are no interpretable relationships between both groups of variables. That is, the scores obtained by the children at a corrected age of one month do not serve to predict the results obtained years later on the WISC-IV scale.

The dimensionality reduction analysis revealed that, just as occurred in the complete model, the analysis of functions 1 to 2 was not statistically significant [Wilks' lambda λ = 0.990; F (3, 21) = 0.067, *p* = .977]. This, together with the fact that only the first canonical function obtained shared variance percentages greater than 10% (14.40%), led us to dismiss these results.

The results of the analysis performed with the values of the development index of the BSID-II *at a corrected age of 18 month*s are shown in Table 5. The analysis produced two canonical functions with explained variance percentages (R_c^2) of 59.70% and 6.30%. Overall, the set of the two canonical functions achieved statistical significance according to the Wilks' Lambda criterion λ = 0.377 [F (8, 30) = 2.354, *p* = .043]. This result suggests that in this case there are relationships between both groups of variables. The dimensionality reduction analysis revealed that only the complete model was statistically significant. For this reason, we shall only focus our attention on the first canonical function (in Table 5, Canonical Function 2), which obtained shared variance percentages greater than 10% (59.70%).

In this canonical function 2, we can see that all of the variables in the set of dependent variables presented negative structural coefficients and in the case of perceptual reasoning and working memory they were greater than |0.45|, the frequency of the latter standing out with a shared variance of 81.72% with the canonical variable. In the set of predictors, the two variables obtained relevant structural coefficients, the Mental Development Index (MDI) standing out with a shared variance of 99.80%. The negative sign of the structural coefficients from the set of predictors and the set of dependent variables indicates the existence of a positive relationship between the two canonical variables; that is, the greater the value in the development indexes, the greater the cognitive ability scores at 9-11 years of age.

The results of the analysis performed with the values of the development index of the BSID-II *at a chronological age of 36 month*s are shown in Table 5. The analysis produced two canonical functions with explained variance percentages (R_c^2) of 67.20% and 8.80%. Overall, the set of the two canonical functions achieved statistical significance according to the Wilks' lambda criterion λ = 0.299 [F (8, 28) = 2.899, *p* = .017]. This result suggests that in this case there are relationships that achieve statistical significance between both groups of variables.

The dimensionality reduction analysis revealed that only the complete model was statistically significant in the first canonical function (in Table 5, Canonical Function 3), which achieved shared variance percentages greater than 10% (67.20%), and therefore we will focus our attention on this.

In this canonical function 3 we can see that all of the variables in the set of dependent variables presented negative structural coefficients, except for in the case of processing speed. In the case of verbal comprehension and working memory, said coefficients were greater than |0.45|, the frequency of the latter standing out with a 41.86% of shared variance with the canonical variable. In the set of predictors, the two variables obtained relevant structural coefficients, the Mental Development Index standing out with 29.7% of shared variance.

Discussion and conclusions

The results obtained partially corroborate our hypothesis, given that the scores of the development assessment at a corrected age of one month do not appear to be related with those obtained for cognitive skills at 9-11 years of age, although they are generally in line with the hypothesis put forward given that a significant relationship has been found between the results obtained in assessments at 18 and 36 months and the scores in the later cognitive ability assessments. That is, the scores obtained by the children at a corrected age of 18 months and a chronological age of 36 months could serve to predict the results obtained years later on the WISC-IV scale. These results are in line with those obtained by other authors (Doyle & Casalaz, 2001; Munck et al., 2012; Potharst et al., 2012; Romeo et al., 2012), who also found a significant relationship between the development assessment carried out with the BSID-II scales and the cognitive ability assessment carried out with the Wechler Scales (WPPSI, WISC) at school age.

However, and possibly due to the different versions of the Wechsler Scales, the interpretation of the predictive value between the development and cognitive assessment scores could differ. More specifically, in the work of Doyle & Casalaz (2001) it was found that the MDI score on the BSID-II scale had a significant relationship with the FSIQ at 5 years (WPPSI) and at 8 years (WISC-R), as well as with the verbal comprehension index at 14 years (WISC-III), but not with the FSIQ scores at that age. These data support the predictive value of the initial assessments carried out using the Bayley Scales. Munck et al., 2012; Romeo et al., (2012) and Sajaniemi et al., (2001) also found a certain stability between the MDI scores on the BSID-II scale and the FSIQ scores obtained with the WPPSI-R scale at 4 and 5 years of age.

Another study that found a predictive value between one scale and the other was that of Potharst et al. (2012), who analysed the different composite scores of the Wechsler

Scale (WPPSI-III) and their relationship with the scores obtained previously in the Mental Development Index of the BSID-II. Nordhov et al. (2010), for their part, took into account the two development indexes (mental and psychomotor) of the BSID-II scale, as well as the composite scores of the WPPSI-R scale, and their findings are in line with those presented in our work.

Conversely, regarding the explained variance, in Table 5 it was shown that at a corrected age of one month this was 14.40%, but it increased together with the age of the subjects, being 59.70% at a corrected age of 18 months and 67.20% at a chronological age of 3 years. This finding concurs with that of Potharst et al. (2012), who found similar percentages of explained variance; in their case, 44% at a corrected age of 2 years and 56% at a corrected age of 3 years.

Despite the above, it is worth highlighting that, although the assessment using the classic IQ may generally be considered a reliable assessment, it appears to be inadequate when we wish to carry out a more detailed assessment on the evolution and development in the mid and long term of children who were born preterm (Lezak, M.D.; Howieson, D.B.; Bigler, R.D. and Tranel, D., 2012, quoted in Anderson, 2014). In these cases, due to their specific peculiarities, it may be necessary to complement these assessments with others that provide information on specific aspects of learning or neuropsychological functioning.

In line with this affirmation, it is worth highlighting the significant relationship that has been found between the scores of the Mental Development Index at a corrected age of 18 months, and at a chronological age of 36 months, and the working memory index, which appears to coincide with the observations of other studies, such as that of Rose et al. (2005), who had already pointed out that problems with the working memory at a school age could be detected before 2 years of age with the BSID-II scales. If to all this we add that Sølsnes et al. (2016) affirmed that the regulation of some neurobehavioural functions, such as the working memory, seemed to be related to several subcortical structures, which are usually less mature in preterm children, it is appropriate to highlight the necessity to continue researching this matter so that, at some point, we may know which elements assessed by the Bayley Scales would be more directly related to the different indexes of the Wechsler Scales, thus enabling the predictive value of the former to be improved in more detail.

It also seems necessary to defend the proposal that development assessments be carried out on all preterm children from the very first moment, with follow-up through to advanced stages. This follow-up could be especially useful for identifying, in relevant cases, the risk of any problems that may arise, as well as to establish suitable educational measures to prevent the appearance of minor problems (Aylward, 2005; Casasbuenas, 2005; Luu et al., 2009; Munck et al., 2012; Ornstein et al., 1991; Patrianakos-Hoobler et al., 2010; Potharst et al., 2012; Wocadlo & Rieger, 2006), or to lessen the effects of more serious disorders (Breeman, Jaekel, Baumann, Bartmann, & Wolke, 2015; Hack et al., 2005; Lobo & Galloway, 2013; Pérez-López et al., 2012; Roberts, Doyle, & Anderson, 2009).

So, as has already been pointed out, the evolutionary follow-up of infants born preterm should continue until at least the end of the first stage of primary education, that is, up to 9-10 years of age (Breslau et al., 2001; Løhaugen et al., 2010; Pritchard et al., 2009; Vohr et al., 2000), given that if the stability of the scores in intelligence tests were to increase together with the age of preterm infants, as it appears to in full-term infants (Calero & García-Martin, 2014), the quality of the intervention services and the quality of life of those born preterm could be improved. All of this could, in all probability, reduce the suffering of the individual affected and their family and could mean a significant saving for the health and education systems as they would have more information for the implementation of intervention programmes and it would facilitate adaptation of the necessary educational resources (Pérez-López et al., 2012). We must take into account that the cost of the resources used in prevention or in later treatment of infants born preterm includes measures taken by both obstetricians and gynaecologists, neonatal treatment and the provision of medical, education and social services in the long term (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Johnson et al., 2009; Johnson, Patel, Jegier, Engstrom, & Meier, 2013; Loftin et al., 2010; Petrou, Abangma, Johnson, Wolke, & Marlow, 2009).

Taking these results into account, it seems logical to think that, although preterm birth is a risk factor for later development (Ball et al., 2013; Grieve et al., 2008; Narberhaus, 2004; Pérez-López et al., 2009; Rose et al., 2005), and that within this group of children we can find cases that evolve normally and others who present permanent damage in their central nervous system (Breeman et al., 2015; Doyle & Casalaz, 2001; García-Martínez, Pérez-López, Sánchez-Caravaca, & Montealegre-Ramón, 2018; Nyman et al., 2017), it is necessary to implement early intervention programmes for some subjects from the moment they are born as said participation seems to condition their evolution and improves development in all cases (Brito de la Nuez et al., 2004; Guralnick, 1998; Nordhov et al., 2010; Piñero, 2014; Sajaniemi et al., 2001; Sánchez-Caravaca, 2006; Sølsnes et al., 2016).

Therefore, we consider that the results obtained will enable important points of reflection to be opened up in terms of the improvement of communication channels between the different areas involved in intervention with families of preterm infants and will allow improvements to be introduced into early intervention services.

Limitations and future prospects

Firstly, the size of the sample of preterm infants was small and was also affected by the loss of participants, which is normal in longitudinal-type studies, as well as the exclusion of some cases due to the personal characteristics of the subjects. On the one hand, this factor obliges us to interpret the statistical analyses with care and, on the other hand, to be careful when interpreting the results, reducing the possibility of making any generalisations.

For this reason, it would be interesting to be able to analyse a larger sample with a control group, as this could provide more conclusive data on the effects of perinatal risks in the later development of infants born preterm.

In line with that defended by Narberhaus (2004), we consider that the use of complementary tests (neuropsychological and neuroimaging) would also offer a broader and more detailed view of the results presented here.

Thus it is necessary to continue investigating in order to try to find an answer to the numerous questions posed here, for which at present there is not enough scientific evidence to support them or to guide them in one direction or the other.

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