



Neurodevelopmental outcome of Italian preterm children at 1 year of corrected age by Bayley-III scales: An assessment using local norms

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ABSTRACT

Background: Premature birth is often associated with neurodevelopmental difficulties throughout childhood. In the first three years of life, the Bayley Scales of Infant and Toddler Development-Third Edition (Bayley-III) constitute one of the most used tools for assessing child development. Since Bayley-III original norms are based on United States (US) population, it remains uncertain whether their use in other countries (e.g., European) is appropriate.

Aims: This research aimed to examine neurodevelopment of preterm infants and full-term infants, using Bayley-III US norms in comparison to Italian (IT) norms. Patterns of developmental outcomes for both infant groups were also explored.

Methods: 104 preterm and 58 full-term infants were included in the study. Bayley-III was used for neurodevelopmental assessment at 1 year of corrected age, considering both IT and US norms for scores computation.

Results: Comparing scores obtained with IT vs US norms, differences in means were all significant across five subscales ($p < 0.05$ at least) for preterm infants, whereas for full-term peers significant differences were found only for Receptive Language and Fine Motor subscales ($p < 0.001$). Effect size (η^2) ranged from 0.22 to 0.94. Within each group, significant discrepancies across subscales were found. Moreover, Italian preterm infants had significantly lower performances than full-term peers, excepting for Expressive Language and Gross Motor subscales.

Conclusions: As regards to Italian 1-year children, our study seems to provide evidence for the tendency of Bayley-III US norms to overestimate development compared to IT norms. These findings emphasize the need to early detect children at risk for developmental delay and to plan early intervention.

1. Introduction

As reported by the World Health Organization, the rates of children born preterm (before 37 completed weeks of gestation) have been increasing over the past two decades in almost all countries. It has been estimated that in 2010, throughout the world, almost 15 million babies were born preterm (11% of all live-births); approximately 37,000 occurred in Italy, corresponding to 6.5% of all births [1,2]. However, rates

of very preterm delivery (before 32 weeks of gestation) show significant variations across European regions [3]. Specifically, in Lazio (Italy) this rate computed on the total births in region (i.e., 569/51,939 live births in 2003) was found below the national average, reaching 11/1000, that is approximately 500 very preterm newborns per year [3]. This increasing rate of preterm births worldwide may be influenced by different factors, such as the greater number of assisted reproduction, the multiple pregnancies, the increase in maternal age and health

Abbreviations: Bayley-III, Bayley Scales of Infant and Toddler Development-Third Edition; US, United States; IT, Italian; NICU, Neonatal Intensive Care Unit; BW, birth weight; GA, gestational age at birth; RDS, respiratory distress syndrome; IVH, intra-ventricular hemorrhage; PVL, peri-ventricular leukomalacia; RL, Receptive Language; EL, Expressive Language; FM, Fine Motor; GM, Gross Motor

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problems, smoking, and environmental exposure [4,5]. Furthermore, the chances for preterm babies to survive is enhanced by the more advances in neonatal intensive care [6].

Although making worldwide comparisons is challenging, rates of neurodevelopmental impairment and disorders have remained relatively unchanged over the last decades [7,8]. Specifically, about a quarter of survivors have relevant neurological disabilities [8], and other neurodevelopmental difficulties concern a high rate of preterm children, including low cognitive functioning, attention impairment, and behavioural problems [7]. Some of these adverse outcomes can be detected in the first years of life, while others arise throughout childhood and adolescence and may persist into adulthood [9,10,11].

In many countries, developmental assessment of preterm infants from early age is strongly recommended to quickly recognise developmental problems, and to provide timely intervention programs when needed [1]. Standardized developmental assessments are fundamental in the detection of developmental delay in children and, for this purpose, the Bayley-III represents one of the most used assessment tools in the follow-up of preterm infants [12,13].

Bayley-III scales have been widely used in many cultures, including European countries, for both research and clinical goals. The Bayley-III Cognitive and Language scores have been found to have a strong predictive validity for WPPSI-III (Wechsler Preschool and Primary Scale of Intelligence - III) Intelligence Quotient at age 4 years in preterm children [14] and to be discriminative of developmental performance between term and preterm infants until at least 24 months [15].

However prior research suggests that the Bayley-III might overestimate children's performances and consequently children with developmental problems could fail to be identified [15,16,17,18]. To date, in most countries local reference data for interpreting the Bayley-III scores do not exist, and in this case the original US norms may be used instead, leading to potential misinterpretation of child assessment and delay identification. To this regard, some studies based on non-US samples found developmental scores that differed from US norms and suggest the need of considering a re-standardization of Bayley-III on specific local populations [19,20]. For example, the results of a cross-cultural Australian study suggested that US-standardized scores of the Bayley-III tend to underestimate the developmental delay in 2-year-old preterm children compared with national reference groups [21]. A Danish study assessing children's development during the first 13 months of life showed higher mean scores in Cognitive scales but not in Language and Motor performances compared to US norms [22]. Furthermore, in a large group of Dutch children, significant differences were found between scores based on national norms and those based on US norms in all subtests. The US scores tended to overestimate Cognitive, Language, and Fine-Motor skills and to underestimate Gross-Motor skills [23]. In a recent review by Anderson & Burnett [16], the authors proposed a number of strategies for dealing with inflated scores on the Bayley-III, one of which is having new standardization data excluding the 10% of children from high-risk clinical groups.

Based on previous research, it seems extremely important to use norms within each country in order to consider the cultural characteristics that may contribute to performance. Moreover, data on the use of Bayley III in Italy are limited, especially on preterm populations [24].

Recently local Italian norms of the Bayley-III have been published [25] and to our knowledge this is the first study using them to investigate early development of preterm children. Specifically, our principal aim was to examine developmental performances at 1 year of corrected age using and comparing scores obtained from both US and IT norms on Bayley III. Additionally, we assessed the developmental profile of preterm and full-term infants, considering their performances on Cognitive, Language, and Motor scales.

2. Methods

2.1. Participants

This study is part of a larger investigation examining neurodevelopment of preterm children compared to their full-term counterparts during the first years of life. Participants were 104 preterm (44.2% female) and 58 full-term children (63.8% female), recruited from 2011. All participants were born between 2010 and 2013. Preterm group was enrolled from the clinical follow-up program involving all the babies born before 36 gestational weeks and earlier admitted to the Neonatal Intensive Care Unit (NICU) in Bambino Gesù Children's Hospital and Hospital Policlinico Umberto I (Rome, Italy). Children with a genetic syndrome or severe neurosensory and/or motor disability or with major brain lesions on cerebral ultrasound (intraventricular hemorrhage grade III–IV or cystic periventricular leukomalacia) in the neonatal period were excluded from the study.

The development of preterm children was assessed at around 12 months of corrected age ($M = 12.5$ months; $SD = 0.70$; range: 12–15 months); corrected age was calculated by “subtracting the number of weeks born before 40 weeks gestation from the chronological age” [26]. For all preterm children, birth and medical data were collected from hospital medical charts, including gender, birth weight (BW), gestational age at birth (GA), multiple birth, type of delivery (spontaneous or cesarean section), length of stay, presence of respiratory distress syndrome (RDS), sepsis (culture-proven bloodstream infection or meningitis), and abnormal head ultrasound findings (defined as the presence of Grade I or higher intraventricular hemorrhage - IVH - and/or periventricular leukomalacia - PVL).

Full-term infants were also seen at about 12 months of age ($M = 12.7$ months; $SD = 0.70$; range: 12–15 months) and were recruited randomly from different nursery schools, which gave consent to participate. These schools were located in the same geographic area of the Hospitals where preterm group was recruited. These children were assessed during regular school hours and, after completing the assessments, a feedback was given to parents about the findings.

The study protocol was approved by Hospital Ethics review board. An informed consent was presented to participant's parents to be signed before the testing session. The research also complied with the ethical standards of the American Psychological Association (APA).

2.2. Instruments: the Bayley-III scales

The Bayley Scales of Infant and Toddler Development-Third Edition [12] represent a norm-referenced assessment tool widely used to measure children's developmental abilities from 0 to 42 months of age, especially among the preterm population. The Bayley-III includes Cognitive, Language, Motor, Social-Emotional and Adaptive Behaviour scales. Specifically, the Language scale consists of the Receptive (RL) and Expressive (EL) Language subscales, and the motor scale consists of the Fine Motor (FM) and Gross Motor (GM) subscales. The Bayley-III also contains two caregiver-report questionnaires for assessing child Social-Emotional and Adaptive Behavior respectively. For the goals of the current study, we only considered the Cognitive, Language, and Motor scores. Each scale provides a Composite Index Score ($M = 100$; $SD = 15$), while each subscale provides a normative-referenced Scaled Score ($M = 10$; $SD = 3$) [12].

The *Bayley-III American version* was based on a standardization sample of 1700 American children aged between 16 days and 43 months and 15 days, who were representative of the 2000 U.S. population census survey data. A proportion of the children from the special group study (approximately 10%) were added to the normative sample of typically developing children. The internal consistency estimated for both Scales and Subscales was found to be good, with Cronbach's α ranging from 0.86 (FM) to 0.93 (Language Index) and test-retest reliability ranging from 0.80 (FM) to 0.87 (EL) [12].

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