Bayley Scale of Infant and Toddler Development (BSITD-III). Chronological Or Corrected Age: Which Is More Appropriate to Assess Preterm Infants' Cognitive, Linguistic, and Motor Performances?

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Abstract

The use of chronological or/and corrected age administering BSITD-III in preterm children was investigated in a sample of preterm infants and full-term infants. BSITD-III was administered at 12 months corrected age. The performance scores for the three BSITD-III subscales were calculated according to the child' chronological age and considering the BSITD-III request for correction referring to the 40th week or the 37th week of gestation. Results indicate that corrected age should be used with the cognitive subscale only, not with the Motor nor with the Language ones.

Keywords: Bayley Scales-III; corrected age; chronological age; preterm infants; children development.

Introduction

This research is intended to be a contribution toward resolving the controversy about how to measure the performance of preterm children specifically using BSITD-III: should the chronological age or the corrected age be used and which length of gestational time should be considered indicating a completed pregnancy to obtain the most informative results with this measure?

The World Health Organisation (WHO) (2012) defines preterm births as "Babies born alive before 37 weeks of pregnancy are completed". Preterm birth can be further sub-divided based on gestational age: extremely preterm (<28 weeks), very preterm (28 - <32 weeks) and moderate preterm (32 - <37 completed weeks of gestation). This distinction corresponds to the infant's different levels of maturation. When the child is born before the standard gestational age h/s is unable to, for instance, swallow, to regulate body temperature etc. Moreover, several pre and perinatal complications seen in preterm infants are well known risk factors for the development of future psychological and neurological disabilities. Indeed, the incidence of major physical and mental disabilities is inversely related to gestational age (Ment, Vohr, Allan et al., 2003; Tallandini, Franco, Morsan, 2013) and consequently it is important to develop and benchmark methods to detect the presence of early difficulties.

The importance of the phenomenon of preterm birth is signified by its high rates presence world-wide. Rates range from 11.8% on average for low-income countries, to 9.4% and 9.3% for upper middle- and high-income countries. However, relatively high preterm birth rates are seen in many individual high-income countries where they contribute substantially to neonatal mortality and morbidity. For these reasons preterm birth is considered an extremely relevant health problem (WHO, 2012).

Over the last 30 years, perinatal epidemiology has shifted from measuring birth-weight alone to focusing on gestational age as the dominant effect on survival and long-term impairment, and the parameters for the measurement of gestational age have changed over time.

"Gestational age" is the time elapsed between the first day of the last normal menstrual period and the day of delivery (American Academy of Pediatrics, AAP, 2004) but the parameters suggested to establish when gestation should be finished, differ. In particular, AAP states 40 weeks for a completed pregnancy, whereas WHO considers 37 weeks the dead line after which the child is born full-term. These different positions become relevant when the assessment of the child performance is carried out during the first years of life.

A second important issue is how the length of the gestation should be accounted for when assessing the developmental outcome of preterm infants. There are two lines of thought: to consider a child's chronological age or to "adjust" the child's age for the degree of prematurity. Age adjustment involves subtracting the number of weeks that the child was born prematurely from the child's chronological age to arrive at the adjusted age (March of Dimes, 2007). In this case a full-term pregnancy is considered to be 40 weeks. A frequent controversy in the literature on this topic is whether the neurological and psychological developments of preterm infants without major neurological sequels are either delayed, accelerated or equivalent to term infants' development (Restiffe & Gherpelli, 2006).

Marlow (2004) among others, support the use of the corrected age as the most appropriate way to assess preterm children during the first years of life. This approach is also supported by important institutions such as the AAP (American Academy of Pediatrics, 2002) and March of Dimes (2007). From another point-of-view, use of the corrected age can lead to an overcorrection and may present a situation that does not correspond to the level of development reached by the child which therefore results overrated. As a consequence, the potential discovery of the child's difficulties can be delayed and so would be any supportive intervention related to them. For the chronological age the risk is the opposite, i.e., to underestimate infants' level of development by postulating developmental delays that do not in fact exist.

Moreover, the analyses carried out on preterm infants development also reach different conclusions. Some authors report difficulties in gross and fine motor development, others underline the presence of difficulties mostly in cognitive development.

To help resolve these disputes there is a need for the use of reliable measures of development and BSITD-III is considered one of the most reliable measures.

Bayley Scale of Infant and Toddler Development III (BSITD-III)

BSITD-III (2006) is an extensively revised version of BSITD-II (1993). It is an individually administered instrument that assesses the developmental functioning of infants and young children between 1 month and 42 months of age. Its primary purposes are to identify children with developmental delays and to provide information useful for planning intervention.

BSITD-III assesses infant and toddler development across five domains: Cognitive, Language, and Motor domains (using items administered to the child), Social-Emotional and Adaptive domains (using primary caregiver's responses to a questionnaire). In this work we will limit our inspection to the data collected from infants.

The Cognitive Scale includes items that asses sensory-motor development, exploration and manipulation, object relatedness, concept formation, memory, and other aspects of cognitive processing.

The Language scale is composed of a receptive communication sub-scales with items assessing preverbal behaviours, vocabulary development, social referencing and an expressive communication sub-scale (assessing preverbal communications, vocabulary development, and morpho-syntactic development).

As far as the controversy of chronological vs. corrected age presented above is concerned, the BSITD-III manual takes a clear position in favour of the use of corrected age: "If you are testing a child who was born prematurely, adjust for the child's prematurity through 24 months of chronological age" (BSITD-III, Administration Manual, page 28)" However, some comments about the criteria suggested appear to be somewhat contradictory. In particular in the Manual itself "premature birth is defined as 36 weeks or less gestation" (ib.), whereas APP (2004) states that full birth is reached at 40 weeks gestation.

In this study the developmental lines of the performance scores of children born preterm will be derived using the following different criteria: • Scores obtained considering the child's chronological age; • Scores obtained with a corrected age adjusted to 37 weeks of gestation (WHO, 2012); • Scores obtained with a corrected age adjusted to 40 weeks of gestation (APP, 2004). These children preterm performance scores will be compared with those of children born full-term. The investigation will be concerned with determining if the use of different criteria could be interpreted as indicating different developmental lines, compared to the one presented by the full-term children. Developmental discontinuities might rise depending on the presence and type of age correction adopted and should thus be diagnostic about the advisability of performing the correction in the different developmental domains.

Method

Participants

Children were consecutively recruited at the *S. Maria della Misericordia* Hospital in Udine (Italy). The recruitment is still in progress. The reported data refer to a partial sample. The mothers were all at least 18 years old, all Caucasian, and were either married or partnered. The study's inclusion criteria were: absence of congenital malformations and genetic impairments for infants and absence of medical and/or psychiatric pathology for mothers. Premature infants were 26 to 36 weeks of gestational age, with a birth-weight of less than 2500 gr. The final sample comprised both preterm infants and full-term infants. All infants were in normal good health at their 12-month pediatric check-up.

Procedure

The researchers met the mothers and illustrated the purpose of the study: this was done the day after delivery in instances of full-term birth, and within a week after birth for preterm delivery. Demographic and medical data were collected by reviewing medical scores. BSITD-III was administered at 12 months corrected age (toddlers age), using WHO (2012) suggested correction (for < 37 weeks gestational age). Subsequently, the performance scores were calculated following: • the child's chronological age; • AAP's (2004) indications; and • WHO (2012) indications for the three BSITD-III subscales.

All procedures were approved by the University of Trieste (Italy) Ethics Committee and complied with American Psychological Association ethical standards. Informed written consent was obtained from all parents of the infants participating in the study.

Results & discussion

In order to verify whether the scorings within the three developmental domains (Cognitive, Language, and Motor) followed similar trends as a function of gestational age we first conducted a multiple regression analysis on valid scores of full- term children. Results revealed a strong difference between the way in which gestational age predicts child's performances among the three developmental domains: motor performance proportionally increased as the age increased from 37 to 40 weeks, while scores in both the cognitive and language domains were not influenced by gestational age.

A second analysis was performed to test the expectation that BSITD-III should provide a continuous estimate of the developmental functioning over gestational age among both preterm and full-term infants without major neurological sequels, across the different scales (Restiffe & Gherpelli,

2006). Developmental discontinuities, statistically signalled by a significant interaction between gestational age and type of delivery (term vs. pre-term), might rise depending on the types of age correction. To investigate this issue, preterm toddler scores in the three developmental domains were first computed according to both their chronological and corrected age (with both the two leading types of age correction being applied: i.e., < 37 and < 40 weeks), and their correlation with the gestational age was contrasted with the one of full-term born children. Given the difference in pattern in the three developmental domains revealed by the former analysis, a separate analysis was conducted for each developmental domain, with one continuous predictor, the gestational age, and two categorical predictors: the type of delivery (full-term vs. pre-term) and the type of age correction (Chronological, Corrected < 37, Corrected< 40).

Again, results revealed a major difference between developmental domains and the way in which the gestational age of preterm children should be treated to optimally account for the actual developmental skills. With regards to the motor domain, neither the Corrected < 37 nor the Corrected < 40 scores followed the same trend of the full term infant. This confirms that neither one of the two corrections adequately represents the motor development of preterm children. Surprisingly, the opposite result was obtained for uncorrected chronological motor scores, that vice-versa resulted to be accounted by a model which was similar to the one best fitting the scoring of full-term children. Thus, according with our results BSITD-III motor scores should not be corrected. This is confirmed by post-hoc analyses revealing that, relative to the more reliable chronological scores, both the 37 weeks and the 40 weeks corrections, produced significant overestimation of motor preterm performance. According to these results BSITD-III motor scores of preterm toddler should better be computed considering the chronological, rather than the corrected age.

Different results were obtained for the Cognitive domain in which both types of corrections (not the chronological scores) led to a trend similar to the one presented by full-term children. Only for the chronological scores the gestational age × type of delivery interaction resulted to be significant, but not for the corrected scores. The scores of preterm children were significantly underestimated in relation to the one of full-term children when calculated according to their chronological age, but not when corrected. According to these results BSITD-III cognitive scores of preterm infants should therefore be corrected.

The pattern of results change again when considering the Language domain in which all scoring types similarly accounted for the distribution of performances of preterm and full-term children: the gestational age and the type of delivery had no effect and did not produced any significant interaction neither for the corrected nor for the chronological scores. Post-hoc analysis however revealed that, relative to the average scores of full-term children chronological scores were underestimated, while both types of corrections produced no meaningful statistical differences.

Conclusions

In summary our results are challenging for the most appropriate use of the BSITD-III scoring system, suggesting that age correction is appropriate only for the cognitive domain but neither for the motor domain, in which uncorrected scores provide a more reliable measure of performance, nor for the language domain, in which the reliability of corrected and uncorrected scores is similar.

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