Early Human Development 94 (2016) 1–6

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

Correcting for prematurity affects developmental test scores in infants born late and moderately preterm

Shalin A. Parekh [a], Elaine M. Boyle [a], Alexa Guy [a], Samarita Blaggan [a], Bradley N. Manktelow [a], Dieter Wolke [b], Samantha Johnson [a,*]

[a] Department of Health Sciences, University of Leicester, Leicester, UK
[b] Department of Psychology and Health Sciences Research Institute and Division of Mental Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK

ARTICLE INFO

Article history:
Received 30 October 2015
Received in revised form 4 January 2016
Accepted 5 January 2016

Keywords:
Developmental assessment
Preterm
Developmental delay
Corrected age
Neurodevelopmental outcomes

ABSTRACT

Background: Corrected age is typically applied when assessing the development of children born <32 weeks of gestation. There is no consensus as to whether corrected age should be applied when assessing children born late/moderately preterm (LMPT; 32–36 weeks of gestation).
Aims: This study explored the impact of corrected age on developmental test scores in infants born LMPT.
Study design: 221 LMPT infants were assessed at two years corrected age using the Bayley-III cognitive and language scales, from which cognitive and language composite scores were derived (Normative Mean 100; SD 15). Assessments were then re-scored using chronological age. Bayley-III composite scores <80 were used to define developmental delay. Paired sample t-tests were used to assess the difference in mean test scores derived using corrected versus chronological age, and McNemar's tests to assess the difference in the proportion of infants with developmental delay using corrected versus chronological age.
Results: Mean corrected age scores were significantly higher than chronological age scores (cognitive: 2.1 points; 95% CI 1.6, 2.5; language 2.5; 95% CI 2.1, 2.8). Overall, significantly more LMPT infants were classified with developmental delay when chronological (18.3%) versus corrected (15.0%) age was used ($p = 0.016$).
Conclusions: Correcting for prematurity results in significantly higher developmental test scores and a significantly lower prevalence of developmental delay in LMPT infants and may affect eligibility for intervention services. Researchers and clinicians should be aware that the use of corrected age may impact on developmental test scores at both an individual and population level among infants born LMPT.

1. Introduction

Late and moderately preterm (LMPT; 32–36 weeks of gestation) births constitute up to 84% of all preterm births [1]. Children born at these gestations are at higher risk for developmental delay, cognitive deficits, attention problems and special educational needs than their term-born peers [2–5]. These problems are evident in infancy and recent population-based studies have shown that children born LMPT are at twice the risk for neurodevelopmental disability compared with term-born controls at two years of age [6].

Developmental assessments in the early years are regarded as important for identifying children at risk and for targeting early intervention [7,8]. As such, developmental tests at two years are widely used to assess neurodevelopmental outcomes and to ascertain eligibility for intervention services [9,10]. For assessing the development of infants born very (<32 weeks) and extremely (<28 weeks) preterm, it is common practice to correct for gestation at birth up to two years of age. However, there is uncertainty as to whether to use corrected age when assessing children born LMPT. Mounting evidence regarding the increased risk for impairments across multiple developmental domains leads one to question whether corrected age should be applied when assessing these infants. This is an important practical consideration as the application of corrected age may affect group mean scores on standardized developmental tests, the identification of children with developmental delay and subsequent eligibility for early intervention services. Moreover, it has been shown to impact on the statistical significance of study results in which developmental outcomes are compared between LMPT infants and term-born controls [11].

There is a lack of studies that have assessed how corrected age affects test scores and the identification of developmental delay in children born LMPT. The Bayley Scales of Infant and Toddler Development 3rd Edition (Bayley-III) [12] is one of the most recently standardized developmental tests and is widely used in clinical practice and in perinatal

Abbreviations: BSID-II, Bayley Scales of Infant Development 2nd Edition; Bayley-III, Bayley Scales of Infant and Toddler Development 3rd Edition; LMPT, late and moderately preterm; LAMBS, Late and Moderately preterm Birth Study; MDI, Mental Development Index.

* Corresponding author at: Department of Health Sciences, 22-28 Princess Road West, Leicester LE1 6TP, UK. Tel.: 0116 252 5798; fax: 0116 252 3272.
E-mail address: sjj19@le.ac.uk (S. Johnson).

http://dx.doi.org/10.1016/j.earlhumdev.2016.01.002
0378-3782/

and pediatric research. There is broad global consensus that developmental outcomes should be measured at 18–24 months of age, at which point standardized tests have greater reliability than earlier measures for identifying adverse developmental outcomes [13,14]. The aim of this study was to determine the effect of correcting for prematurity on Bayley-III developmental test scores and the identification of developmental delay in infants born LMPT at two years of age.

2. Method

2.1. Participants

Participants for this study were drawn from the Late and Moderately Preterm Birth Study (LAMBS), a prospective geographical population-based study of outcomes following LMPT birth. The study was conducted in the East Midlands region of the United Kingdom and recruited 1113 infants born at 32^{+0} to 36^{+6} weeks of gestation from 1st September 2009 to 31st December 2010. This cohort was followed up at two years of age using parent questionnaires. At this time a sub-sample of 253 infants was recruited to LAMBS-II, a sub-study in which infants' cognitive and language development was formally assessed by a study psychologist with the aim of validating a parent questionnaire assessing the same developmental domains. Parents of children in the full LAMBS cohort were contacted via email or telephone and invited to participate in LAMBS-II. A home visit was arranged for those who expressed interest and written parental consent was obtained at the start of the visit, prior to data collection. A feedback letter summarizing their child's test results was sent to parents after the assessment. LAMBS and LAMBS-II were approved by the Derbyshire National Health Service Research Ethics Committee (ref: 09/H0401/25). This report comprises secondary analysis of LAMBS-II data.

2.2. Measures

Infant development was assessed using the Bayley Scales of Infant and Toddler Development 3rd Edition (Bayley-III) [12]. This is a standardized, norm referenced test of development consisting of separate scales to assess cognitive, language and motor development. Each scale comprises a series of developmental play activities and the child's performance is scored based on the total number of items completed appropriately. This raw score is then compared with age standardized normative reference data derived from the standardization sample in order to obtain a scaled score (Mean 10; SD 3) and a composite score (Mean 100; SD 15) for each scale.

For this study, the Bayley-III cognitive and language scales were administered in a single session by one of two study psychologists (AG; SB) who were formally trained in test administration and scoring prior to commencing the study. Throughout the study, 10% of Bayley-III assessments were scored independently by both examiners to assess inter-rater reliability; this was shown to be excellent with 97% agreement across test items on all assessments. All Bayley-III assessments were administered and scored using the child's corrected age (to 40 weeks of gestation). Subsequently, the assessments were re-scored using the start point and norm reference table appropriate for the child's chronological age.

A Bayley-III composite cognitive or language score more than 2 SD below the standardized mean of 100 (i.e., score < 70) has conventionally been used to define moderate to severe developmental delay. However, a number of studies have shown that the Bayley-III produces higher scores than the corresponding Mental Development Index (MDI) scores obtained using the 2nd Edition of the Bayley Scales of Infant Development (BSID-II) [15] and that the conventional cut-off of scores <70 underestimates developmental delay relative to the BSID-II [16–21]. Given the growing concern regarding constitution of the Bayley-III standardization sample and the underestimation of developmental delay, a cut-off score of 80 is recommended for defining moderate to severe developmental delay when using Bayley-III composite scores [21]. We therefore defined developmental delay for this study as follows: Bayley-III cognitive composite score <80 as cognitive delay; Bayley-III language composite score <80 as language delay; and a cognitive *or* language composite score <80 as any developmental delay.

2.3. Statistical analyses

Data were analyzed using SPSS software (version 22 IBM Corporation). Paired sample t-tests were used to assess the difference in mean Bayley-III cognitive and language composite scores derived using corrected versus chronological age. A change score was computed by subtracting the child's chronological age composite score from that derived using corrected age for each scale. The number of infants with developmental delay was cross tabulated and McNemar's tests for paired data were used to assess the difference in the proportion of children with developmental delay classified using corrected versus chronological age. Subgroup analyses using paired sample t-tests were also conducted to explore the difference in mean cognitive and language composite scores by corrected versus chronological age where re-scoring of the test resulted in the application of a different start point or norm table.

3. Results

3.1. Study sample

Recruitment and sampling are described in Fig. 1. Of the 1113 LMPT children in the LAMBS cohort, the parents of 394 were contacted in

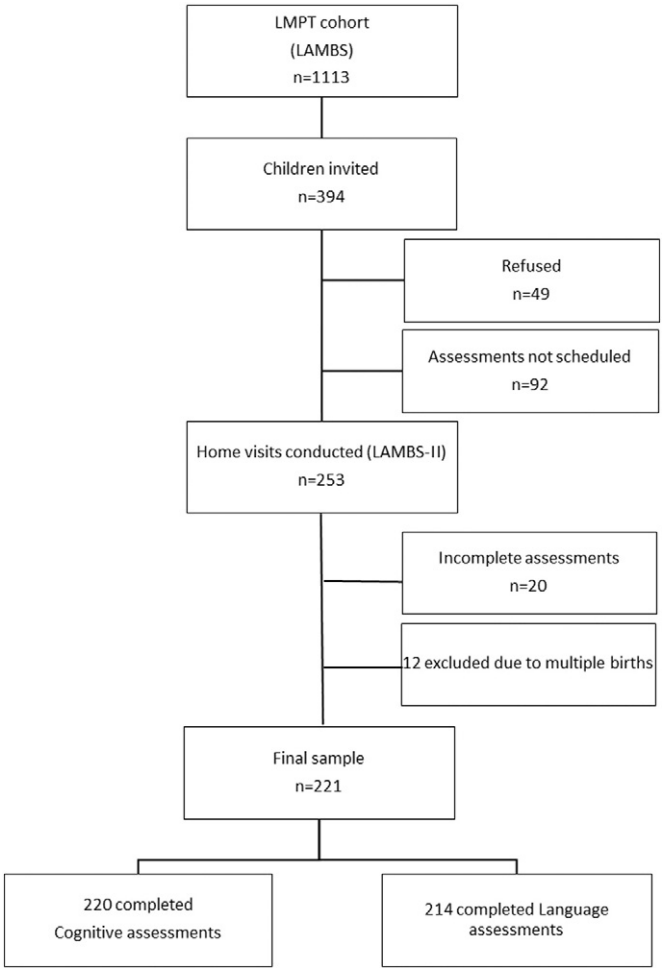

Fig. 1. Participant recruitment and follow-up for the LAMBS-II Study.