



Postnatal growth of preterm born children ≤ 750 g at birth

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ABSTRACT

Background: Extremely low birth weight (ELBW) infants are at risk of impaired postnatal growth. Impaired postnatal growth has been reported to be associated with delayed cognitive and motor development.

Aims: To describe postnatal growth patterns of appropriate and small for gestational age (AGA and SGA) ELBW children in relation to their cognitive and motor outcome at age 5.5.

Study design: Retrospective cohort study.

Subjects: One hundred one children with a BW ≤ 750 g, born between 1996 and 2005 in the University Hospital Utrecht, The Netherlands.

Outcome measures: Height (Ht), weight (Wt), occipital–frontal circumference (OFC) at birth, 15 months and 2 years corrected age and 3.5 and 5.5 years.

Cognitive and motor outcome at 5.5 years of age, classified as normal (Z-score ≥ -1), mildly delayed ($-2 \leq$ Z-score < -1) or severely delayed (Z-score < -2). AGA (Ht, Wt or OFC at birth ≥ -2 SDS) infants were compared with SGA (Ht, Wt or OFC at birth < -2 SDS) infants.

Results: Between birth and 5.5 years catch-up growth in Ht, weight for height (Wt/Ht), Wt and OFC was seen in 72.2%, 55.2%, 28.6% and 68.9% respectively of the SGA infants. For AGA infants we found substantial catch-down growth in Ht (15.4%) and Wt (33.8%). Cognitive and motor outcome was normal in 76.2% and 41.6% of the 101 children. A significantly higher percentage of normal cognitive outcome was found in AGA infants with Wt growth remaining at ≥ -2 SDS compared to AGA infants with catch-down growth (83% vs 63%). Next, SGA infants who caught-up in OFC had a higher prevalence of normal cognitive outcome compared to SGA infants who did not catch-up in OFC. Furthermore, a higher percentage of severely delayed motor outcome was found in SGA infants without catch-up growth in Wt compared to SGA infants who caught-up in Wt (61.5% vs 32.2%).

Conclusions: Catch-up growth in Ht, Wt/Ht and OFC occurred in the majority of the SGA infants with a BW ≤ 750 g, but was less common in Wt. AGA children who remained their Wt at ≥ -2 SDS have a better cognitive and motor developmental outcome at 5.5 years of age. Catch-up growth in OFC was associated with a better cognitive outcome at 5.5 years of age.

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Abbreviations: BW, birth weight; g, gram; ELBW, extremely low birth weight; GA, gestational age; AGA, appropriate for gestational age; SGA, small for gestational age; CA, corrected age; UCA, uncorrected age; NICU, neonatal intensive care unit; IRDS, infant respiratory distress syndrome; PDA, patent ductus arteriosus; Wt, weight; Ht, height; Wt/Ht, weight for height; OFC, occipital–frontal circumference; SD, standard deviation; SDS, standard deviation score; min, minimum; max, maximum; BMI, body mass index; RAKIT, Revisie Amsterdamse Kinder Intelligentie Test; WPPSI, Wechsler Preschool and Primary Scale of Intelligence; SON-R, Snijders-Oomen Nonverbal Revised; IQ, intelligence quotient.

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1. Introduction

It is well known that extremely preterm born infants and extremely low birth weight (ELBW) infants are at increased risk of cognitive and motor impairment as well as growth failure [1–18].

In many studies ELBW children are classified as appropriate for gestational age (AGA) or small for gestational age (SGA). However, the definition used for SGA differs in the literature. The 3rd, 5th or 10th percentile as well as a standard deviation score (SDS) of < -2 of birth weight and/or length for gestational age (GA) is commonly used [11,15,19–22].

SGA children have been reported to show catch-up growth, mostly during the first 2 years of life. However, the percentage of catch-up growth in height (Ht) of preterm ELBW and VLBW SGA children is

different in various studies ranging from 55% to 92% [10,15,16,23–25]. AGA children may display catch-down growth, percentages varying from 2% to 28.9% [15,23,25].

Postnatal growth failure has been reported to be associated with an increased risk of poor cognitive and motor developmental outcome [12,13,15–18]. Poor growth, particularly of the head, as well as of Ht and weight (Wt), has been associated with poorer cognitive and motor outcomes at school age in a number of studies [15,16,18,26–32].

Some studies found that neurodevelopmental impairments are especially common in SGA children [11,33–35]. However, others showed that the course of postnatal growth rather than the appropriateness of Wt for GA at birth seems to predict later neurodevelopmental outcome in preterm children with very low birth weight [15,26].

Improvements in neonatal care have resulted in an increased survival of ELBW infants born at decreasing birth weights and gestational ages. The fact that these children still remain at increased risk of developmental impairments illustrates the importance of follow-up studies [1–18]. We have reported outcomes for this cohort previously; in this paper we relate outcome evaluations to the adequacy of postnatal growth through to 5.5 years of age [9,36–38].

The objectives were to describe anthropometric measurements at birth, 15 months corrected age (CA), 2 years CA, 3.5 and 5.5 years of age. AGA children (Ht, Wt or occipital–frontal circumference (OFC) at birth ≥ -2 SDS) were compared with SGA children (Ht, Wt or OFC at birth < -2 SDS). The occurrence of catch-up and catch-down growth was examined. Furthermore, this study aimed to examine the association between postnatal growth patterns and cognitive and motor developmental outcome at 5.5 years of age.

2. Materials and methods

2.1. Subjects

The original study population consisted of 146 infants who were admitted to the level three Neonatal Intensive Care Unit (NICU) of the Wilhelmina Children's Hospital Utrecht in the Netherlands. Thirty-five infants died in the NICU. One hundred eleven (76%) survived, these children were invited to take part in the standardised follow-up programme for children born at a GA < 30 weeks and/or a BW < 1000 g who had been admitted to our NICU (Fig. 1).

2.2. Details of ethics approval

The parents of the study subjects agreed to participate in the neonatal follow-up programme of the Wilhelmina Children's Hospital,

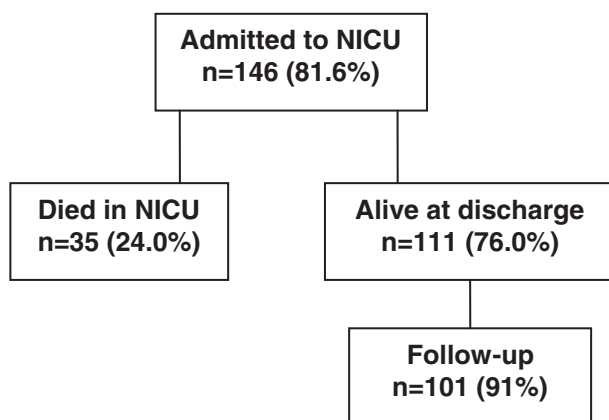


Fig. 1. Study population of 146 infants with a birth weight ≤ 750 g born between 1996 and 2005.

and gave consent for using these data for scientific research in which their data are processed anonymously.

2.3. Data collection and definitions

Data were collected by reviewing the medical charts. GA was based on the last menstrual period and early ultrasound examination. Parental educational levels were recorded according to the occupational classification standard of Statistics Netherlands [39]. Socio-economic status was recorded according to the zip code estimated income of The Netherlands Institute for Social Research [40].

Perinatal events that are known to affect postnatal growth were retrospectively collected [13,17]: infant respiratory distress syndrome (IRDS) grades I to IV was defined according to Giedion [41]. Bronchopulmonary dysplasia was defined as the need for oxygen at 36 weeks GA according to Shennan et al. [42]. Postnatal hydrocortisone use was registered. Patent ductus arteriosus (PDA) was diagnosed clinically and confirmed by cardiac ultrasound. Periventricular leukomalacia and intraventricular haemorrhage were graded according to de Vries et al. [43]. Septicaemia was defined as clinical signs in combination with a positive blood culture. Necrotizing enterocolitis was classified according to the criteria of Bell et al. [44].

The children were measured (Ht, Wt and OFC) at birth, at 15 months CA, 2 years CA, 3.5 years and 5.5 years of age. A correction for prematurity was made by subtracting the amount of prematurity (40 minus GA at birth) from the actual age at measuring and was used until two years of age.

Wt, Ht and OFC at birth were obtained for respectively 101, 96 and 97 children. At 15 months and 2 years CA Ht, Wt and OFC were obtained for respectively 92, 86 and 93 children and 95, 94 and 93 children. At 3.5 years of age Ht was measured in 59 children, Wt in 60 and OFC in 56, and at 5.5 years of age Ht and Wt were available for 70 and 69 children and OFC for 67 children. Length measurement was used at birth, and height measurement from 15 months onwards.

BW was converted into SDS according to the Dutch growth curves of the Perinatal Registry of the Netherlands [45,46]. Wt for GA at the 50th percentile was used as mean and the average SD (calculated by the formula $(-1SD + 1SD)/2$) was utilised.

Ht and OFC at birth were converted into SDS according to the Canadian age- and sex-specific growth diagrams of Usher and McLean using Growth analyser 3.5 software (2007, Dutch Growth Foundation) [47], as GA-specific Dutch diagrams are not available. Children were per individual parameter (Ht, Wt and OFC) classified as SGA or AGA, defined as a Ht, Wt or OFC at birth < -2 SDS and ≥ -2 SDS respectively [19,20].

The subsequent anthropometric measurements (Ht, weight for height (Wt/Ht), Wt and OFC) at 15 months CA, 2 years CA, 3.5 years of age and 5.5 years of age were converted into a SDS according to the Dutch age- and sex-specific growth diagrams of Fredriks et al. also using Growth analyser 3.5 software [48]. Wt/Ht SDS were calculated from 15 months CA onwards, since no Dutch age- and sex-specific growth diagrams are available for Wt/Ht at birth.

The growth patterns of SGA children were either classified as no catch-up if their growth parameters remained below the -2 SDS, or as catch-up growth indicating the achievement of Ht, Wt/Ht or Wt at or above the -2 SDS. The growth patterns of AGA children were either classified as growth remaining at or above the -2 SDS ('appropriate'), or as catch-down growth indicating a decrease in growth from ≥ -2 SDS to < -2 SDS.

The standardised follow-up programme was previously described [9,36–38]. In this study we only used the results of the assessments at 5.5 years of age, which included an intelligence test and the Movement Assessment Battery for Children (M-ABC). An intelligence test was performed in 61 children, this was either the Revision

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