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Attainment of gross motor milestones by preterm children with normal development upon school entry[☆]



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ABSTRACT

Background: Little is known on the motor development of moderately preterm born (MPT) children, in comparison with early preterm born (EPT) children and fullterm born (FT), for children with normal motor outcomes at school entry.

Aims: To compare attainment rates of gross motor milestones reached between ages 1–24 months for MPT, EPT, and FT children, all with normal development upon school entry.

Study design: Prospective cohort study.

Subjects: We included 1247 preterm (PT) children (gestational age [GA] 24.0–35.6 weeks) and 488 FT children (GA 38.0–41.6 weeks), with normal gross motor development at 4 years according to the Ages and Stages Questionnaire.

Outcome measures: We assessed 11 gross motor milestones assessed in preventive child healthcare during six standardized visits at calendar age.

Results: During the first six months, all PT categories had lower milestone attainment-rates than FTs children (differences 9–60% for PTs compared with FTs children). For all PT categories attainment rates gradually increased during toddlerhood. For PT children with higher GA, differences in attainment rates compared with FTs children were smaller and attainment rates became comparable to FT children at an earlier age. At age 24 months only attainment rates for PT children born < 30 weeks GA remained lower than for FTs children (85% versus 95%, $P < 0.01$).

Conclusion: Milestone attainment rates are highly dependent on GA during the first two years. Differences between PT and FT children are larger and persist longer with lower GA. For PT children < 30 weeks GA, differences still occur at 24 months.

Clinical Trial registry name and registration number: controlled-trials.com, ISRCTN 80622320.

1. Introduction

Worldwide, the development of preterm-born (PT) children

(gestational age [GA] < 37 weeks) is closely monitored by preventive child health care (PCHC). Monitoring is important, because PT children are at greater risk of developmental delay, [1–3] including motor delay

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Dr. de Kroon supervised the execution of the analyses, critically reviewed and revised the manuscript and approved the final manuscript as submitted.

Prof. Bos conceptualized and designed the study, critically reviewed and revised the manuscript and approved the final manuscript as submitted.

Prof. Reijneveld conceptualized and designed the study and data handling, critically reviewed and revised the manuscript and approved the final manuscript as submitted.

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[4–6]. Persistent problems in the motor domain have been linked to long-term difficulties in other developmental domains, such as poor adaptive and cognitive functioning, learning disabilities, and behavioral problems [7–9].

Developmental monitoring is a core task of PCHC, commonly implemented by assessing developmental milestone attainment. Early preterm-born (EPT) children (GA < 32 weeks) reach motor milestones later than do FT children during infancy and toddlerhood [10,11]. This may be due to ontogenetic differences in maturation as a consequence of a shorter period in the womb compared to fullterm (FT) children. In addition, EPT children experience more perinatal problems than FT children [12]. Both factors may also contribute to delayed attainment of milestones for moderately preterm-born (MPT) children (GA 32–36 weeks), who experience motor delay in early childhood more often than FT children as well [13–15]. However, for MPT children, evidence on rates of gross motor milestone attainment is limited.

In developmental monitoring in community pediatrics, age of assessment is generally adjusted for GA during the first two years of life as recommended by the American Academy of Pediatrics for EPT children [16]. For MPT children, there is no published guideline. Whether correction for GA should also be applied for MPT children when assessing gross motor milestones is unknown. Such knowledge can help clinicians in interpreting developmental findings on MPT children, potentially leading to timelier developmental interventions. Therefore, this study aimed to compare the rates of gross motor milestones attainment between 1 and 24 months calendar age by PT and FT children both with normal development upon school entry. Second, we aimed to assess differences in risk of failing gross motor milestones by degree of prematurity.

2. Methods

2.1. Participants

We used data from the Longitudinal Preterm Outcome Project (LOLLIPOP) study, a community-based cohort of children born in 2002–2003, with data on the growth and development of both EPT and MPT compared with FT children. From 13 PCHCs we checked a total of 45,446 child files, roughly 25% of all Dutch 4-year-olds within a complete year cohort. We selected all children with a GA < 36 weeks. After every second PT child, we selected the next FT child from the same birth year as a control. The cohort was enriched with all EPT children from 5 neonatal intensive care units (NICUs), also born in 2003, and alive upon discharge. PCHC physicians included all children upon their final visit at the age of 4 years. PCHC physicians were not blinded to the clinical history and GA of children. Children with major congenital malformations and syndromes were excluded. Eventually 2517 children participated in the LOLLIPOP study.

For 79% of the children developmental data were available (512 EPT [GA < 32 weeks], 927 MPT [GA 32–35.6 weeks] and 544 FT children [GA 38–41.6 weeks]). For the present study we included only children with a normal gross motor development upon school entry (N = 1735, 87.5%). The study was approved by the Ethics Review Board of the University Medical Center Groningen, and written informed consent was obtained from all parents.

2.2. Measures and procedure

2.2.1. Gross motor milestones in the first two years of life

PCHC physicians scored gross motor milestones between 1 and 24 months of age according to the protocol of the Dutch version of the Denver Developmental Screener (DDDS). The DDDS is a valid and reliable instrument to measure gross motor milestone attainment in the Dutch population [17]. Most gross motor milestones had to be actively observed by the PCHC physicians according to this protocol. We collected the scores retrospectively, upon inclusion of children in the

Table 1

Developmental gross motor milestones of the Dutch version of the Denver Developmental Screener by time-points (months) and corresponding age ranges (weeks).

Developmental milestone	Time-point (months)	Age-range (weeks)
Raises chin for a moment	1	0–8
Raises chin to 45°	3	8–16
Looks around 90° with head raised	6	22–30
Flexes legs while being swung		
Sits stable unaided ^a	12	44–60
Crawls, abdomen on the floor ^a		
Pulls up to standing ^a		
Crawls, abdomen off the floor ^a	15	56–72
Walks along ^a		
Squats while picking up things	24	96–112
Walks well alone		

Children with missing individual milestone scores for a time-point with multiple milestones were excluded for that time-point.

^a Parental information on attainment of this milestone sufficed.

LOLLIPOP study. According to local protocols, children were scored with the DDDS at standardized DDDS time-points between 1 and 24 months of age. We included six standardized DDDS time-points, comprising a total of 11 gross motor milestones (Table 1). The number of milestones that could be scored varied per time-point (from one to three). A child was categorized as failing a time-point if failing at least one milestone at that time-point. Both PT and FT children were assessed at calendar ages for milestone attainment, following the Dutch guidelines for PCHC; with prematurity subsequently taken into account during the interpretation of the findings.

2.2.2. Developmental outcome upon school entry

For the present study, we have included only children with normal gross motor development upon school entry. In this way, we could assess the developmental pattern that reflects only the transient motor delay because of prematurity, for which adjusting via correction for GA is appropriate. Normal gross motor development upon school entry was assessed using the parent completed Ages and Stages Questionnaire 48 months' form (ASQ-48). The ASQ-48 contains 30 questions on five developmental domains, including the gross motor domain. The Dutch ASQ has been shown to be a valid, reliable, cost-effective, fast and easy way to screen children for developmental delay [18]. We calculated an ASQ-48 gross motor domain score as the sum of the six gross motor scores. Following the ASQ manual, all ASQs were completed at calendar age, and a score below -2SD for the Dutch FT reference group was considered as abnormal [19].

2.2.3. Gestational age and covariates

GA was defined as the period between the mother's last day of menstruation and the child's day of birth, and was verified by early ultrasound measurements in over 95% of the cases. In all cases, estimates were checked against clinical indications of GA after birth. If GA could not be reliably established, children were excluded. For the present study, we categorized GA per 2 weeks, except for PT children with a GA < 30 weeks; these were combined into one category.

Our choice of covariates was based on the literature on risk factors related to both being born preterm and age of developmental milestone attainment [20,21]. As covariates we included gender, ethnicity, being born small-for-gestational-age (SGA, defined as < P10 on Dutch Kloosterman curves), [22] and maternal educational level. Information on all covariates was extracted from a general questionnaire and matched to both hospital files and PCHC files.

2.3. Statistical analyses

First, we assessed background characteristics of the participating children per GA category, testing differences using χ^2 tests for trends

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