



# Motor performance, postural stability and behaviour of non-disabled extremely preterm or extremely low birth weight children at four to five years of age <sup>☆</sup>

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## ABSTRACT

**Background:** Extremely preterm or extremely low birth weight (ELBW) children who are non-disabled and otherwise healthy are at risk of neurodevelopmental impairments. Further understanding of these impairments is needed before commencement of formal education to optimise participation levels at a critical time point for these children.

**Aims:** To explore motor co-ordination, postural stability, limb strength and behaviour of non-disabled four to five year old children with a history of extreme prematurity or ELBW.

**Study design:** Prospective–descriptive-cohort-study.

**Subjects:** 50 children born at less than 28 weeks gestation or who had a birth weight less than 1000 g with minimal/mild motor impairments and no significant neurological/cognitive impairments.

**Outcome measures:** Movement Assessment Battery for Children second-edition (MABC-2), single leg stance test (SLS), lateral reach test, standing long jump test and Child Behaviour Checklist for preschool children (CBCL).

**Results:** The mean percentile rank of the extremely preterm or ELBW sample on MABC-2 was 31% (SD 23%). SLS right (mean  $\pm$  SD;  $4.6 \pm 2.5$  s) and lateral reach to the right ( $10.0 \pm 3.9$  cm) were slightly stronger than SLS left ( $4.4 \pm 3.3$  s) and lateral reach left ( $9.9 \pm 3.5$  cm). The average for standing long jump was 71.6 cm (SD 21.0 cm). All participants were classified as 'normal' on CBCL syndrome scale scores, internalizing and externalizing syndrome T scores and total problem T score.

**Conclusions:** This sample of non-disabled extremely preterm or ELBW children performed in the lower range of normal. These children continue to be at risk of impairments, therefore, ongoing monitoring and tailored intervention may optimise development.

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## 1. Introduction

Survival rates amongst extremely low birth weight (ELBW; birthweight <1000 g) infants have improved over time with technological advancements in neonatal intensive care, but since the late 1990s survival rates have plateaued and there remains a need for further improvement in the neurodevelopmental outcomes of these

children [1,2]. Major disabilities amongst the ELBW or the extremely preterm (born less than 28 weeks gestational age) population have stayed fairly constant or have somewhat decreased over the past decade, but the incidence of more mild problems appears to be rising [1, 3,4]. In association with this increase in neurodevelopmental impairments amongst children born ELBW or extremely preterm who are non-disabled, there has been a realisation that these issues may persist [5–7]. However, currently, there are minimal, if any, support services available for non-disabled children born ELBW or extremely preterm with mild neurodevelopmental impairments. Children who are non-disabled refer to those children who have no major disability, such as cerebral palsy, and are otherwise healthy and apparently able.

In reference to the International Classification of Functioning, Disability and Health (ICF) framework, health and well being of non-disabled extremely preterm or ELBW children may be affected as a result of disturbances to the natural developmental process [8]. Neurodevelopmental impairments may emerge, which may lead to

**Abbreviations:** CBCL, Child Behaviour Checklist for Preschool Children; DCD, developmental co-ordination disorder; ELBW, extremely low birth weight; ICF, International Classification of Functioning, Disability and Health; MABC-2, Movement Assessment Battery for Children second-edition; SLS, single leg stance test; NSMDA, Neurosensory Motor Developmental Assessment; PRT, Paediatric Reach Test.

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activity limitations and participation restrictions for these children. More specifically, impairments in gross motor function and postural stability are common amongst the non-disabled extremely preterm or ELBW population, as well as behavioural issues [5,6,9–12]. These impairments may translate into limitations in motor and balance tasks, which may restrict the participation levels of these children in society. Importantly, the contextual factors related to the environment and the individual have the capacity to be modified and may minimise the potential long term sequelae that may unfold amongst this population of children. Therefore, addressing the contextual factors, as well as factors associated with gross motor function, postural stability and behaviour, may provide opportunities for improvement for this group of children.

The impact of neurodevelopmental impairments on the lives of extremely preterm or ELBW children is of particular concern when these children commence formal education, which may start at four and a half years chronological age. It is often considered that non-disabled children who were born 12–16 weeks before term, lack school readiness and this concern is shared by both teachers and parents [13,14]. Inadequate preparation for school places children at risk of school failure and a cascading series of events that may follow.

Four to five years of age is a critical time point for extremely preterm or ELBW children as their performance at this age is closely linked to their motor performance in their early teenage years [15–17]. The predictive value of performance at four to five years of age means that those children likely to have ongoing difficulties may be identified early and perhaps linked in with intervention, so that more positive long term outcomes may be reached.

Furthermore, in terms of development, the period between four to six years of age has been referred to as a transitional phase [18]. This means that non-disabled extremely preterm or ELBW children at school entry age may be more vulnerable to external influences and have greater capacity to adapt to change at this time.

Studies have emerged exploring the general motor performance of non-disabled extremely preterm or ELBW children at four years of age. Zanudin et al. reported that 45.7% of ELBW children in their study had minimal to mild deviations from normal on the Neurosensory Motor Developmental Assessment (NSMDA) at four years corrected age [19]. Furthermore, Zwicker et al. found that 42% of four to five year old children born less than 1250 g were classified as having developmental co-ordination disorder (DCD) determined by a score on the Movement Assessment Battery for Children (MABC) of less than or equal to the 15th percentile [20]. DCD refers to minor motor difficulties that impact on learning and performance in daily activities, which cannot be explained by the child's age, intellect, or known physical disorder [21].

It has been reported that motor performance and behavioural issues are closely linked amongst extremely preterm or ELBW children [7]. Davis et al. concluded that DCD is more common amongst extremely preterm or ELBW children compared to normal birthweight children and that DCD is associated with poor cognitive and academic performance and a higher prevalence of behavioural problems [7]. The authors of this study used a stricter cut-off with the MABC to define DCD. One possible explanation for the co-existence of motor and behavioural problems amongst preterm children may be related to abnormalities in the cerebellum and prefrontal cortex which are closely linked [22].

A range of perinatal and social factors have been linked to outcomes at four years of age amongst non-disabled extremely preterm or ELBW children, including male gender being associated with poorer performance [20,23]. Zwicker et al. reported that male gender and lower birth weight were significant predictors of DCD and children with DCD had significantly greater postnatal steroid exposure than those children without motor impairment [20]. In another study by Dewey et al., bronchopulmonary dysplasia, postnatal steroids and increasing gestational age were associated with increased severity of motor

impairment in ELBW children at five years of age (children with major disabilities excluded) [24].

Therefore, further investigation to gain a more in-depth understanding of the impairments and activity limitations amongst non-disabled extremely preterm or ELBW children at four to five years of age is warranted. The findings will provide useful information to assist in the development of strategies to support better outcomes for this population of children and may enhance participation levels and thus the health and well-being of these individuals.

The current study is part of a larger RCT that will address the role of intervention amongst this population of children. However, the current study, which forms the baseline for the RCT, aimed to explore the motor co-ordination, postural stability, limb strength and behavioural and emotional performance of a sample of non-disabled extremely preterm or ELBW children at four to five years of age. It also investigated the possible relationships between performance measures and perinatal and social factors. Additionally, the study aimed to examine the relationship between gender and perinatal and social factors and the relationship between gender and performance.

## 2. Methods

### 2.1. Inclusion criteria

Children were born between May 2005 and November 2008. They had a birth weight of less than 1000 g or had a gestational age of less than 28 weeks (extreme prematurity) and were managed in the Neonatal Intensive Care Unit at the Mater Mothers' Hospital, Brisbane, Australia. Therefore, the study population included children that were ELBW and/or extremely preterm, but for conciseness, this population will hereafter be referred to as ELBW. Only children who lived within one hour travel of the testing centre were invited to participate. Children were aged between four to four and a half years corrected for prematurity when commencing involvement in the study and had not started formal education (preparatory year of schooling). Included children had attended their four year (corrected age) Growth and Development clinic follow-up assessment and had a score from the NSMDA of 9 to  $\leq 12$  and an IQ of  $> 70$  on the Stanford Binet test.

The NSMDA is a criterion-referenced assessment tool of gross and fine motor performance, postural development, neurological characteristics and the motor responses to sensory input [25]. A score of 9 to  $\leq 12$  indicates minimal to mild deviation from age expected motor performance. NSMDA score at four years corrected age is of particular relevance as it has been shown to independently predict motor co-ordination at 11–13 years of age with a positive predictive value of 87% [15].

The Stanford Binet Test is a standardised test that assesses intelligence and cognitive abilities and is suitable for ages two to 85 plus years [26]. A score of  $< 70$  corresponds to an IQ classification of delayed development.

### 2.2. Exclusion criteria

Children with significant congenital anomalies, diagnosed neurological impairments including cerebral palsy, a visual impairment not corrected by wearing corrective lenses, or a hearing impairment not corrected by aids, were excluded. Additionally, due to practical implications for the larger study, children were not eligible to participate if their parents/carers did not speak English or if their family identified that they could not commit to the study attendance requirements.

### 2.3. Procedures

Eligibility to participate in the study was determined after completion of the four year (corrected age) assessment at the Growth and Development clinic. Parents of eligible children were then contacted to

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