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Trajectories and predictors of developmental skills in healthy twins up to 24 months of age

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ABSTRACT

Background: Low birth weight and low 5-min Apgar scores have been associated with developmental delay, while older maternal age is a protective factor. Little is known about trajectories and predictors of developmental skills in infant twins, who are generally born with lower birth weights, lower Apgar scores and to older mothers.
Methods: Developmental skills were assessed at 3, 6, 9, 12, 18 and 24 months using the Ages and Stages Questionnaires in 152 twins from the Birmingham Registry for Twin and Heritability Studies. Multilevel spline and linear regression models (adjusted for gestational age, gender, maternal age) were used to estimate developmental trajectories and the associations between birth weight, maternal age and Apgar scores on developmental skills.
Results: Twins performed worse than singletons on communication, gross motor, fine motor, problem solving and personal-social skills ($p < 0.001$). Twins caught up around 6 months (score within −1 standard deviation of norm), except on gross motor skills, which did not catch up until after the age of 12 months. A one-year increase in maternal age was significantly associated with decreases in gross motor and personal–social z-scores of up to −0.09, whereas one unit increases in Apgar score increased z-scores up to 0.90 ($p < 0.01$).
Conclusions: Healthy twins should be considered at a higher risk for developmental delay. Whether these results are comparable to preterm singletons, or whether there are twin-specific issues involved, should be further investigated in a study that uses a matched singleton control group.

1. Introduction

Developmental skills can be roughly categorised as cognitive, communicative, social and emotional, and psychomotor development. Children are expected to have reached developmental milestones in each of these categories within a certain age window (Anderson, Northam, Hendy, & Wrennal, 2005). Developmental delays have been related to a variety of biological,

Abbreviations: ASQ-3, Ages and Stages Questionnaires-3; BiRTHS, Birmingham Registry for Twins and Heritability Studies.

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economic and lifestyle factors. Firstly, children need to have access to resources that allow them to have the opportunity to learn necessary skills; these resources may be lacking in families of lower socioeconomic status (SES). Indeed, low SES has been found to be a risk factor for developmental and behavioural problems (Bradley & Corwyn, 2002; Laucht, Esser, & Schmidt, 1997; Pike, Iervolino, Eley, Price, & Plomin, 2006). Further, biological factors that have been related to delays in cognitive skills are mostly ante- and perinatal, such as lower birth weight (Datar & Jacknowitz, 2009; Jeng, Yau, Liao, Chen, & Chen, 2000), shorter gestations (Hediger, Overpeck, Ruan, & Troendle, 2002; Sullivan & Margaret, 2003; Thun-Hohenstein, Largo, Molinari, Kundu, & Duc, 1991) and Apgar scores lower than 7 (de Moura et al., 2010; Odd, Rasmussen, Gunnell, Lewis, & Whitelaw, 2008). Maternal age could be a mediator between perinatal outcomes and developmental skills in the following ways: very young maternal age (<15 years) (Mousiolis, Baroutis, Sindos, Costalos, & Antsaklis, 2013) has been associated with an increased risk for preterm birth, while older maternal age (>40 years) has been related to shorter gestations and low birth weight (Lung, Shu, Chiang, & Lin, 2009). Lung et al. (2009) also reported that older mothers were more likely to opt for assisted reproductive treatment, particularly in vitro fertilisation (IVF), which has been related to preterm birth and low birth weight (Hvidtjorn et al., 2009). In a recent review on the developmental consequences of IVF, Hart and Norman (2013) found no evidence that children conceived through IVF were at higher risk for developmental delays. However, they reported several studies that suggested any differences between IVF- and naturally conceived children could be due to factors related to maternal age and preterm birth.

Not all domains are equally affected by perinatal and maternal factors. For instance, maternal age has been more often related to cognitive development and behaviour (Fergusson & Lynskey, 1993; Ketterlinus, Henderson, & Lamb, 1991), while motor skills seem more sensitive to perinatal morbidity (Sullivan & Margaret, 2003). Gender differences in behavioural and cognitive development may be observed as early as infancy, but become more apparent from childhood onwards (Alexander & Wilcox, 2012).

Even though most children seem to catch up on developmental skills in early (Gasson & Piek, 2003; van Haastert, de Vries, Helders, & Jongmans, 2006) and middle childhood (Thorpe, 2006), a major consequence of developmental delay is the higher use of special school services (Sullivan & Margaret, 2003) and higher risk of subsequent emotional and behavioural problems (Emerson & Einfeld, 2010). Furthermore, children with general developmental delay (delays in at least 2 developmental domains) show less activity participation compared to their peers, which can be partly explained by impaired social and motor skills (Leung, Chan, Chung, & Pang, 2010). Psychomotor skills have also been argued to change the way an infant interacts with its environment, which could be important for the development of communicative skills (Iverson, 2010). Moreover, fine motor skills in infancy are strong predictors of later intellectual functioning (Thun-Hohenstein et al., 1991) and general academic achievements at school age (Sullivan & Margaret, 2003). Furthermore, earlier attainment of gross motor milestones have been associated with better executive performance at school age (Piek, Dawson, Smith, & Gasson, 2008) and learning to stand at an earlier age has been associated with better cognitive categorisation in adulthood (Murray et al., 2006), which in turn has been associated with reasoning ability (Salthouse, 2005) and specific areas of language development (Gopnik & Meltzhoff, 1987).

Tools to assess these developmental milestones include the Bayley Scales of Infant Development (Bayley, 2006), Wechsler Intelligence Scales for Children (Wechsler, 2003) and Griffiths Mental Development Scales (McLean, McCormick, & Baird, 1991). There are also developmental screening tools, which give a general overview of a child's cognitive abilities and do not take as much time to administer, as they are often questionnaires that can be completed by parents. Examples of such screening tools are the Ages and Stages Questionnaire (Squires, Bricker, & Potter, 2009) and the Parents Evaluations of Developmental Status (Glascoe, 2010). Generally, normative groups for developmental assessments consist of healthy singletons. Sutcliffe and Derom (2006) addressed the question whether twins can be directly compared to singletons. Even when otherwise physically healthy, twins are likely to be born at earlier gestations (average of 37 weeks), with lower average birth weights and have older mothers. All of these factors have been directly or indirectly related to developmental delay and later cognitive skills as outlined above. Twins have been previously found to have lower intelligence quotients (IQ) than their singleton peers up to adolescence (Cooke, 2010; Drillien, 1969; Ronalds, De Stavola, & Leon, 2005). Furthermore, it has been suggested that development may vary between types of twins, whereby dizygotic twins attain gross motor milestones at an earlier age than monozygotic twins (Brouwer, van Beijsterveldt, Bartels, Hudziak, & Boomsma, 2006).

The majority of previous studies have mainly focused on risk factors for developmental delay after the first 2 years. However, to our knowledge, no previous research has been conducted into the development in the first 2 years of healthy twins, who were not born extremely small, small-for-gestational-age or very premature. Therefore, this study serves to investigate the association of perinatal outcomes (birth weight and Apgar score) and maternal age with developmental skills in the first 2 years of life in healthy infant twins. Additionally, we used a developmental screening tool to compare the development of healthy twins between the ages of 3 and 24 months with the standardised scores based on normally developing singletons.

2. Materials and methods

2.1. Participants

Participants were part of the Birmingham Registry for Twin and Heritability Studies (BiRTHS) (Krone et al., 2006), a multiple birth registry, which recruits eligible families from three large hospitals in Birmingham, United Kingdom. Mothers