



Original article

Developmental trend of children with Down's syndrome – How do sex and neonatal conditions influence their developmental patterns?

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Abstract

Objective: This study investigated factors that would influence developmental trend of children with Down's syndrome (DS) in three different domains (motor, cognitive, language), specifically focusing on the effect of sex and neonatal conditions, including preterm birth, low birth weight, and congenital heart disease (CHD).

Methods: The participants were 158 children with DS (mean age at the initial test = 25.5 months) receiving clinical service at a rehabilitation center in Yokohama, Japan. Kyoto Scale of Psychological Development was used to measure developmental level, which derive total developmental age (DA), Posture-motor DA, Cognitive-adaptive DA, and Language-social DA. For the analyses, a multilevel model for change was adopted, as the model allowed us to investigate intrapersonal growth and the between-personal factors that are associated with individual differences in the pattern of growth.

Results: The developmental speed of children with DS was found to be slower than that of typical children in all the three developmental domains assessed (i.e., the estimated coefficient of the slope for chronological age on DA was less than 1). DS Girls developed significantly faster than boys in non-verbal cognitive and language abilities. Low birth weight and CHD had a significant negative impact on development of non-verbal cognitive abilities for boys, but had a somewhat positive effect for girls.

Conclusion: As was shown in previous studies, the result of this study indicated that the children with DS develop slower than non-disabled children. Low birth weight and CHD were found to influence developmental trend of children with DS, differently for boys and girls.

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Keywords: Down's syndrome; Motor development; Cognitive development; Language development; Kyoto Scale of Psychological Development; Low birth weight; Congenital heart diseases; Sex difference

1. Introduction

Down's syndrome (DS) is one of the most common chromosomal abnormality, which is associated with various unique physical traits and developmental delay in motor, cognitive, and language domains [1–4]. Recently, researchers began to focus on developmental profile of

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children with DS. Patterson et al. [5] conducted a systematic review of the studies examining patterns of cognitive development in children with DS and found their decline in developmental quotient (DQ)/IQ over time presented across 6 different studies which assessed overall DQ/IQ.

In this way, findings have accumulated about developmental change in children with DS. Despite this research trend, little is known about the factors that facilitate or impede their development. Except for one study showing that gender, infantile spasms, and 24-month mental functioning were associated with later intelligence and adaptive functioning [6], no study seemed to investigate moderating factors on development of DS children. Meanwhile, it is well known that developmental profiles of children with DS vary considerably, including their range of IQ [7] and the timing when developmental milestones are met [3]. Thus, it is quite reasonable to explore factors that would affect development in children with DS.

What are possible factors that would influence on development of children with DS? One of such factors can be neonatal conditions at birth. Previous studies indicated that pre-term birth and low birth weight have negative impact on children's cognitive development [8–12]. Another possibly influential factor that is particularly remarkable characteristics of children with DS is congenital heart disease [13]. As the diseases were found to be a risk factor of low cognitive development both in childhood and in adulthood [14–16], they may affect development of children with DS. Furthermore, children's sex may also differentiate their developmental pattern, as was found in another study following children with Down's syndrome [5,17].

In this study, we investigated whether neonatal conditions (preterm birth, low birth weight, congenital heart disease) have an influence on patterns of overall development as well as development in three specific domains (motor, cognitive, and language) of children with DS. In addition, main effects of sex and interaction effects between sex and these factors were also examined.

2. Method

2.1. Participants

The participants of the study were 158 children (94 boys and 64 girls) with DS, who took a developmental test, Kyoto Scale of Psychological Development 2001 (KSPD) [18] at least once at or before age 48 month, between April 2013 and March 2017, at the Yokohama Rehabilitation Center, Japan, or at one of the other four local rehabilitation centers in Yokohama. The age of the children at the initial testing ranged from 10 to 48 months (mean = 25.5 months). Among the participants, 18.4% of them were born preterm, 25.3% showed low birth

weight, and 65.2% were born with a congenital heart disease. The percentages of children who met each neonatal condition, as well as their average gestational week and birth weight are also presented in Table 1. See below section for the definition of each neonatal condition.

2.2. Measure

2.2.1. Neonatal conditions

Preterm birth was defined as a birth before 37 gestational week. Low birth weight referred to weight at birth less than 2500 g. Congenital heart disease (CHD) included various heart diseases (e.g., atrioventricular septal defect, ventricular septal defect) diagnosed by a pediatrician or a pediatric cardiologist, at or near birth.

2.2.2. Developmental test

Kyoto Scale of Psychological Development 2001 (KSPD) [18] was used to measure developmental level of the participants. KSPD is a standardized developmental test that has been widely used in Japanese clinical settings, specifically for young children. The test provides the examinee's overall developmental age (DA) as well as Total Developmental Quotient (DQ), which is calculated by estimated DA divided by chronological age. The test also yields DAs and DQs in three distinct developmental domains: Postural-Motor (P-M), Cognitive-Adaptive (C-A), and Language-Social (L-S). KSPD has shown good split-half reliability on its domain scores [18] and good construct validity, with its DQ being highly correlated ($r = 0.88$) with the Full-scale IQ obtained through Tanaka-Binet Intelligence Scale (Japanese version of the Stanford-Binet Intelligence Scale [19]). In this study, DA was used for the main outcomes because DQ, by its definition, is influenced by the children's age which is one of the independent variables in this study.

2.3. Data collection procedure

The data were collected by reviewing the medical record of the children obtained between April 2013 and March 2017. The medical record includes both neonatal conditions (i.e., gestational week, birth weight, and congenital heart disease) of the participants and their results of the KSPD. In the rehabilitation centers, the information about neonatal conditions was gathered at the intake interview, through review of the reference letter from the other pediatrician and transcription of Mother-Child handbook, which is distributed to all Japanese pregnant women by local governments to record information about prenatal/postnatal treatment. The KSPD was administered by a trained clinical psychologist when the treatment plan was created and revised.

Among the 158 participants, 80 of them were tested once, 57 were twice, and 21 were three times. As noted

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