



Original article

# Behavioral outcomes of school-aged full-term small-for-gestational-age infants: A nationwide Japanese population-based study

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## Abstract

**Background:** Small for gestational age (SGA) birth is linked with neurological deficits among children at pre-school age, but the evidence is still limited on whether such deficits are still observable at school age. We investigated the association between SGA birth and behavioral development at school age among full-term infants.

**Methods:** We analyzed data from a large, Japanese, nationwide, population-based longitudinal survey that started in 2001. We restricted the study participants to children born at 37–41 weeks of gestation with information on birth weight and behavioral outcomes at 8 years of age ( $n = 33,795$ ). Behavioral outcomes including three attentional problems and four aggressive behaviors queried at 8 years of age by survey questions were used as outcome indicators. We then used logistic regression to estimate odds ratios (OR) and 95% confidence intervals (95% CI) for the associations between SGA birth and each outcome, adjusting for potential infant- and parent-related confounding factors.

**Results:** Among full-term children, SGA children were more likely to interrupt people (OR 1.10, 95% CI 1.01, 1.20), unable to wait his/her turn (OR 1.17, 95% CI 1.00, 1.38), and destroy toys and/or books (OR 1.15, 95% CI 1.00, 1.31).

**Conclusions:** This is the largest study ever conducted on this issue. SGA birth is negatively associated with some attentional problems and aggressive behavior at school age among full-term children. Appropriate long-term developmental follow-up and support may be needed for full-term SGA infants.

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## 1. Introduction

Small for gestational age (SGA) usually refers to infants born with weight and length below the 10th

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percentile for gestational age [1]. It is a risk factor for neonatal morbidities such as hypoglycemia, polycythemia, thrombocytopenia, and patent ductus arteriosus [2]. Furthermore, SGA infants are at increased risk of short stature, obesity, hypertension, and insulin resistance in later life [3]. Recently, much attention has been focused on the neurological prognoses of SGA infants [4].

A recent meta-analysis showed that neurological development in full-term SGA infants was poorer than that in full-term appropriate for gestational age (AGA) infants [5]. Indeed, we recently reported negative impacts of SGA birth on neurological development at 2.5 years of age and, although the magnitude was weaker, on behavioral development at 5.5 years of age among full-term children using the data from a nationwide population-based study in Japan [6]. A further concern is whether the observed deficits in neurobehavioral development among children who were born as full-term SGA infants is still observable at school age. However, the evidence is still limited and the findings are inconclusive. Most previous studies compared neurobehavioral development at school age among full-term SGA children with those among controls (i.e., full-term AGA children) and these controls may have derived from different source populations [7–9]. This issue has rarely been explored based on a population-based study. To our knowledge, only two population-based studies examined this issue and showed a negative impact of full-term SGA birth on behavioral development at school age [10,11].

To address this, the present study extended the follow-up period from the previous study [6] and examined the impact of SGA birth on behavioral outcomes at 8 years of age using data from a Japanese nationwide survey, focusing on full-term infants.

## 2. Methods

### 2.1. Study participants

The Japanese Ministry of Health, Labour and Welfare has implemented an annual survey of newborn babies and their parents, the Longitudinal Survey of Babies in the 21st Century, since 2001 [12–14]. Briefly, baseline questionnaires were distributed to all families throughout the country with 6-month-old infants born between the 10th and 17th of January or the 10th and 17th of July, 2001. Of 53,575 mailed questionnaires, 47,015 were completed and returned (88% response rate). Follow-up questionnaires were sent to the initial respondents every year, beginning at 18 months. Birth records were also linked to each child included in this survey. Birth record data included length, weight, gestational age, singleton, twin or other multiple births, sex, parity, and parental age.

We excluded children without information on birth weight ( $n = 14$ ) and then gestational week ( $n = 24$ ) because SGA status of the newborns was determined using published Japanese standards for birth weight according to pregnancy duration [15,16]. In the present study, we focused on full-term infants; therefore, we excluded children born before 37 weeks ( $n = 2380$ ) and born after 42 weeks ( $n = 414$ ), leaving 44,183 children for analysis. We targeted children whose behavioral outcomes were collected in the eighth survey at 8 years of age, which excluded 10,388 children and left 33,795 children in the analysis.

### 2.2. SGA status

According to the International Classification of Diseases-10, SGA is defined as both birth weight and birth height below the 10th percentile for gestational age. However, SGA has been defined simply by birth weight in many previous studies [5], because of inaccuracies in birth height measurements. We therefore classified SGA babies as those whose birth weight was <10% of the population according to pregnancy duration [6] based on Japanese birth weight percentiles for each gestational week and day from the Committee for Newborns in Japanese Pediatric Society [15,16]. Birth weight and gestational age data were collected from birth records.

### 2.3. Behavioral outcomes

Behavioral outcomes were assessed at 8 years of age by survey questions and seven of them were common to the Child Behavior Checklist (CBCL)/4–18 Japanese Edition, designed for children aged 4–18 years [17]. Three were related to attention problems [18,19]: (1) Does your child interrupt people?; (2) Can your child wait his/her turn during play?; (3) Can your child pay attention to surrounding areas when crossing the street? The remaining four questions were related to delinquent/aggressive behaviors [18,19]: (4) Does your child tell lies?; (5) Does your child destroy toys and/or books?; (6) Does your child hurt other people?; and (7) Does your child cause disturbances in public? We also defined an outcome of “all attention problems” as the existence of all three attention problems, and an outcome of “all aggressive behaviors” as the existence of all four delinquent/aggressive behaviors, according to the previous study [18,19].

### 2.4. Statistical analyses

We compared baseline characteristics of the participants according to SGA status among eligible children. We also compared the baseline characteristics between children included in the analysis and those without

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