



Association of maternal pre-pregnancy weight, weight gain during pregnancy, and smoking with small-for-gestational-age infants in Japan



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ABSTRACT

Aim: The aim of this study was to evaluate the associations of maternal pre-pregnancy body mass index (BMI), weight gain during pregnancy, and smoking, with small-for-gestational-age (SGA) births among Japanese women.

Materials and methods: Subjects were pregnant women who gave birth to single, term infants (37–42 weeks) at a clinic and hospital in the Nagasaki area between 2012 and 2013. To examine associations with SGA, 49 underweight (BMI < 18.5 kg/m²) and 579 normal-weight (18.5 ≤ BMI < 25.0 kg/m²) Japanese women with either appropriate-for-gestational-age or SGA infants were selected and analyzed.

Results: The prevalence of SGA infants was 6.8%. Seven percent of women were current smokers. Prevalence of pre-pregnancy underweight and gestational weight gain less than recommendation were 20.8% and 16.7%, respectively. Multivariate logistic regression was performed to assess factors affecting SGA infants in the pregnant women. After adjusting for covariates, the amount of maternal weight gain below recommendation (odds ratio (OR), 2.72; 95% confidence interval (CI), 1.37–5.39) and maternal smoking status (OR, 2.80; 95% CI, 1.14–6.91) were significantly and independently associated with SGA births. Pre-pregnancy maternal weight status showed a borderline association (OR, 1.91; 95% CI, 0.96–3.83, *p* = 0.067).

Conclusion: To prevent SGA births, education regarding the adequate nutrition and the adverse effect of maternal smoking is important for the women of reproductive age.

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1. Introduction

Although the total number of births in Japan is decreasing, low-birth-weight births are increasing. This increase in low-birth-weight infants seems mainly attributable to the increasing frequency of small-for-gestational-age (SGA) infants [1]. SGA infants are recognized as carrying an increased risk of developing chronic diseases in adulthood, such as hypertension, type-2 diabetes, and coronary heart disease [2,3]. In addition, SGA infants reportedly show higher rates of neonatal mortality and morbidity than normal birth weight infants [4,5]. This increase in SGA infants thus represents a serious health problem for modern society.

Low pre-pregnancy body mass index (BMI) has been identified as a risk factor for low-birth-weight births [6,7]. Several studies have suggested that a low pre-pregnancy BMI and low weight gain during pregnancy are associated with the incidence of SGA infants [8–10].

Unfortunately, the proportion of underweight individuals among women of childbearing age in Japan has doubled compared with 20 years ago [11].

Maternal smoking habits increase the risk of SGA births [10,12]. Suzuki et al. [12] conducted a questionnaire survey among 1100 mothers registered at Koshu City, Japan, and showed that maternal smoking was associated with SGA infants. Watanabe et al. [10] surveyed hospital records of 3661 women in the Tokyo metropolitan area, Japan, and showed that maternal smoking more than 10 cigarettes per day was associated with an increased risk of having an SGA infant.

An insufficient number of studies have described or evaluated the influences of pre-pregnancy BMI, weight gain during pregnancy, and maternal smoking on perinatal outcomes in Japan [10]. The aim of the present study was therefore to evaluate the associations of pre-pregnancy BMI, weight gain during pregnancy, and maternal smoking with SGA infants in Japanese pregnant women.

2. Subjects and methods

Subjects were identified using data from 915 pregnant women who gave birth to single, term infants (37–42 weeks) at a clinic and a

Abbreviations: BMI, body mass index; SGA, small-for-gestational-age; OR, odds ratio; CI, confidence interval; AGA, appropriate-for-gestational-age; WHO, World Health Organization; CRL, crown rump length.

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hospital in the Nagasaki area between 2012 and 2013. A total of 294 pregnant women were excluded due to: pregnancy-induced hypertension in 58 women; pre-pregnancy hypertension in 7 women; renal disease in 7 women; gestational diabetes mellitus in 61 women; diabetic pregnancy in 9 women; placenta previa in 17 women; threatened premature delivery in 61 women; overweight status (BMI ≥ 25.0 kg/m²) that might affect fetal growth in 67 women; and missing information in 1 woman. To examine associations with SGA infants, 49 underweight (BMI < 18.5 kg/m²) and 579 normal-weight (18.5 \leq BMI < 25.0 kg/m²) Japanese women with appropriate-for-gestational-age (AGA) or small-for-gestational-age (SGA) infants were finally selected and analyzed. Pre-pregnancy BMI categories were defined according to the standards of the World Health Organization (WHO). The definition of SGA was defined as an infant with a birth weight less than the 10th percentile of the intrauterine growth curves of Japan in 2010, according to the workshop meeting of the committee on Fetus and Newborn and Consultants in 1966.

Gestational age was determined according to the last menstrual period and confirmed by ultrasound examination, in which crown rump length (CRL) of the fetus was measured at 8–9 weeks of gestation. Maternal and infant birth data were extracted retrospectively from hospital records. Information from the maternal records included age, parity, medical history, pre-pregnancy weight, weight gain during pregnancy, current smoking status, and pregnancy complications. Information extracted from the infant records included birth weight, length, and sex. Total gestational weight gain was defined as the difference between measured weight at the prenatal visit closest to the delivery and self-reported pre-pregnancy weight. Maternal weight gain during pregnancy was classified into the three categories of the recommended levels of the Maternal and Child Health Division, Ministry of Health, Labour and Welfare, Japan: below (<9 kg), within (9–12 kg), and above (>12 kg) for underweight (BMI < 18.5 kg/m²) women; and below (<7 kg), within (7–12 kg), and above (>12 kg) for normal-weight (BMI 18.5–25 kg/m²) women [13].

2.1. Statistical analysis

Student's *t*-test for continuous variables and the chi-square test for categorical variables were used to determine differences between women with SGA and AGA infants. Multivariate logistic regression analysis was performed to explore the associations of pre-pregnancy BMI, recommended weight gain, and maternal smoking status with SGA infants. Only those variables showing a significant association in univariate analyses ($p < 0.05$, chi-square test) were included in the model. Adjusted odds ratio (OR) and 95% confidence interval (95% CI) were then estimated. A value of $p < 0.05$ was considered significant. Analyses were performed using SPSS for Windows version 14.0 (SPSS, Chicago, IL). This study was approved by the Ethics Committees of Nagasaki University Hospital.

3. Results

Table 1 summarizes the characteristics of subjects. The prevalence of SGA infants was 6.8%. Seven percent of women were current smokers. The prevalence of pre-pregnancy underweight women and maternal gestational weight gain below recommendation were 20.8% and 16.7%, respectively.

Table 2 compares variables between women with SGA and AGA infants according to univariate analysis. Women with SGA infants showed significantly lower pre-pregnancy weight ($p = 0.02$), pre-pregnancy BMI ($p = 0.04$), maternal gestational weight gain ($p < 0.01$), and birth weight of infants ($p < 0.01$). In Fig. 1, the prevalence of factors were shown among women with SGA infant and those of women with AGA infant. Women with SGA infants also showed a significantly more frequent pre-pregnancy underweight ($p = 0.04$) and smoking ($p = 0.03$) status compared to women with AGA infants.

Multivariate logistic regression was performed to assess factors affecting SGA births (Table 3). After adjusting for covariates, maternal gestational weight gain below recommendation (OR, 2.72; 95% CI, 1.37–5.39) and maternal smoking status (OR, 2.80; 95% CI, 1.14–6.91) were significantly and independently associated with SGA infants. Pre-pregnancy underweight status tended to show a borderline association (OR, 1.91; 95% CI, 0.96–3.83; $p = 0.067$).

4. Discussion

According to a WHO report [14], the prevalence of underweight women in developed countries is 3.3% in the United States, 5.9% in the United Kingdom, and 4.1% in Canada. In Asian countries, the prevalence is 8.5% in China and 6.5% in Korea. The National Health and Nutrition Survey Japan reported in 2012 the prevalence of underweight women as 11.4% [11]. Furthermore, the prevalence was 21.8% among 20- to 29-year-old women. This phenomenon has been reported to reflect an overestimated body size and 'desire for a thin body image', unnecessary weight control, fasting diets, self-reported eating disorders, and low dietary intake [15]. The prevalence of underweight women was 20.8% in the present study. Watanabe et al. [10] reported the prevalence of underweight women as 15.8% among women who gave birth to single, term infants, similar to our result. The relatively high proportion of thinness in young women may thus be problematic in Japan.

We have shown that maternal weight gain below the recommended level was associated with having a SGA infant. Previous studies have also reported that poor weight gain increases the risk of a SGA birth [16–18]. In addition, poor maternal nutritional status during pregnancy

Table 1
Participant characteristics.

Variable	(N = 621)	
	Mean \pm SD	Range
Age (years)	31.6 \pm 5.2	16–44
Height (cm)	158.4 \pm 5.4	140–176
Pre-pregnancy weight (kg)	51.0 \pm 6.3	31–72
Pre-pregnancy BMI ^a (kg/m ²)	20.3 \pm 2.1	14.1–25.0
Maternal gestational weight gain (kg)	10.6 \pm 3.6	–8.0–26.5
Gestational age at delivery (weeks)	38.7 \pm 1.2	37–41
Fetal birth weight (g)	2972.9 \pm 337.4	1582–3852
	N	%
<i>Prevalence of AGA^b or SGA^c</i>		
AGA ^b	579	93.2
SGA ^c	42	6.8
<i>Pre-pregnancy BMI^a (kg/m²)</i>		
18.5 \leq BMI < 25.0	492	79.2
BMI < 18.5	129	20.8
<i>Maternal smoking status</i>		
Non-smoker	576	92.8
Smoker	45	7.2
<i>Recommended gestational weight gain^d</i>		
Below	104	16.7
Within	316	50.9
Above	201	32.4
<i>Parity</i>		
Primiparous	275	44.3
Multiparous	346	55.7
<i>Infant sex</i>		
Male	327	52.7
Female	294	47.3

^a Body mass index.

^b Small-for-gestational-age.

^c Appropriate-for-gestational-age.

^d Below (<9 kg), within (9–12 kg), and above (>12 kg) for underweight (BMI < 18.5 kg/m²) women, and below (<7 kg), within (7–12 kg) and above (>12 kg) for normal weight (BMI 18.5–25 kg/m²) women.

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