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Changes in Gestational Weight Gain and Birth Weight in Women who Delivered at Hyogo Prefectural Kaibara Hospital in Tamba, Japan during 27 Years

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Two independent guidelines on appropriate weight gain for Japanese pregnant women have been established in 1997 and 2006. This study aimed to evaluate changes in the amount of gestational weight gain in pregnant women, the birth weight of their neonates, and the incidence of complications of pregnancy and neonatal outcome in women who delivered at Hyogo Prefectural Kaibara Hospital. Between 1988 and 2014, 6367 women delivered live singleton neonates at full term. The study period was divided into period I (1988–1996), period II (1997–2005), and period III (2006–2014). Changes in weight gain and birth weight were assessed. Complications of pregnancy and neonatal outcome were compared among the periods. Weight gain had been decreased in periods I and II, and weight gain was increased in period III. There was no difference in birth weights between the periods. The incidences of pregnancy-induced hypertension in periods II and III were higher than that in period I ($p<0.01$). The incidences of vacuum extraction in periods II and III were less than that in period I ($p<0.01$). The incidence of macrosomia in periods II was less than that in period I ($p<0.01$). There were no significant differences in the incidence of cesarean section, light-for-date, heavy-for-date, or low birth weight among the three periods. The establishment of guidelines for weight gain and maternity education based on the two guidelines significantly affected complications of pregnancy and neonatal outcome. Prevention of pregnancy-induced hypertension might be difficult when only reducing weight gain in pregnant women.

INTRODUCTION

The amount of gestational weight gain (WG) is associated with risks of complications of pregnancy, including pregnancy-induced hypertension (PIH), gestational diabetes mellitus

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(GDM), and cesarean delivery. WG during pregnancy is also associated with neonatal outcome, including macrosomia, heavy-for-date (HFD), low birth weight, and light-for-date (LFD) [1, 2]. Two independent guidelines on appropriate WG for Japanese pregnant women have been established. The Japan Society of Obstetrics and Gynecology (JSOG) created the first guidelines in 1997. Thereafter, the Ministry of Health, Labour and Welfare (MHLW) of Japan released the next guidelines in 2006. The JSOG guidelines mainly aimed to prevent PIH. The MHLW guidelines aimed to prevent LFD. The caloric intake in pregnant women is more reduced in the JSOG guidelines than in the MHLW guidelines. How these two guidelines affect the amount of WG in pregnant women, birth weight, the incidence of complications of pregnancy, and neonatal outcome chronologically is unclear. This study aimed to evaluate changes in the amount of WG in pregnant women, the birth weight of their neonates, and the incidence of complications of pregnancy and neonatal outcome in women who delivered at Hyogo Prefectural Kaibara Hospital in Tamba, Japan over a 27-year period.

PATIENTS AND METHODS

The present study enrolled 6367 women who delivered live singleton neonates at full term at Hyogo Prefectural Kaibara Hospital in Tamba, Japan between 1988 and 2014. We selected a hospital that was located in a rural area where demographics have been relatively stable for decades. The hospital has no neonatal intensive care unit (NICU), and women with premature labor or multiple pregnancy are referred to general hospitals with NICU. Therefore, this study excluded preterm delivery and multiple pregnancies. Cases with stillbirth, congenital abnormality, or post-term delivery were also excluded from the study. During the study period, 2682 women gave birth once, 1282 did twice, 330 did three times, 29 did four times, and 3 did five times. Clinical information was collected from medical records.

The amount of WG (kg) was calculated by subtracting individual body weight of the mother prior to pregnancy from their body weight at delivery. Body mass index (BMI) prior to pregnancy was calculated using the following formula: BMI (kg/m^2) = body weight (kg)/ [height (m)]^2. According to the MHLW guidelines, based on BMI prior to pregnancy, all of the mothers were classified into three groups, including underweight (BMI <18.5 kg/m^2), normal weight (BMI ≥ 18.5 and <25 kg/m^2), and overweight (BMI ≥ 25 kg/m^2).

The study period was divided into three periods: period I (1988–1996), period II (1997–2005), and period III (2006–2014). There were no guidelines for WG in pregnant women in period I. The JSOG guidelines were used in period II, while the MHLW guidelines were used in period III. The numbers of mothers/neonates in periods I, II, and III were 1852, 2363, and 2152, respectively. In general, pregnant women were advised to maintain their WG according to the JSOG guidelines between 1997 and 2005 (period II), and according to the MHLW guidelines after 2006 (period III) at the Hyogo Prefectural Kaibara Hospital. Maternity education about appropriate WG during pregnancy based on the two guidelines were performed by doctors or midwives.

The tendency of changes in WG and birth weight during 27 years was assessed. The amount of WG and birth weight for 3-year terms were compared with those of the late period II (2003–2005), which was designated as the control in this study. Maternal age, gravidity, parity, BMI prior to pregnancy, WG, gestational weeks at delivery, the incidence of complications of pregnancy, including PIH, cesarean section, and vacuum extraction, as well as neonatal outcome, including LFD, HFD, low birth weight, and macrosomia, were compared among the periods. LFD and HFD are defined as a birth weight less than the 10th percentile and greater than the 90th percentile for the gestational age, respectively. Low birth

weight and macrosomia are also defined as a birth weight less than 2500g and greater than 4000g, respectively. Differences were analyzed by the Student's t test and the chi-square test. Bonferroni correction was used for adjustment in multiple comparisons. Statistical significances were determined for a value of $p<0.05$ in comparison of 2 terms and Bonferroni-adjusted $p<0.01$ in comparison of 3 periods.

RESULTS

Table I shows the clinical characteristics of the 6367 women. Maternal age increased during the three periods ($p<0.01$). Gravidity in period III was more frequent than that in the other two periods ($p<0.01$). WG in period I was larger than those in the other two periods ($p<0.01$). Gestational weeks at delivery in period I were longer than those in the other two periods ($p<0.01$).

Percentages of underweight, normal weight, and overweight prior to pregnancy are shown in Figure 1. The proportion of these weight groups was significantly different among periods I, II, and III ($p<0.05$) by 2x3 chi-square test. The percentage of underweight women prior to pregnancy in period III was higher than that in periods I ($p<0.01$).

The 3-year averages of the amount of WG are shown in Figure 2. The 3-year averages of the amount of WG in period I (1988–1990, 1991–1993, and 1994–1996), early period II (1997–1999), and late period III (2012–2014) were higher than that of the control period ($p<0.05$).

The 3-year averages of birth weight are shown in Figure 3. There was no significant difference in the 3-year averages of birth weight compared with the control.

Table II shows the incidence of complications of pregnancy and neonatal outcome. The incidences of PIH in periods II and III were higher than that in period I ($p<0.01$). The incidences of vacuum extraction in periods II and III were less than that in period I ($p<0.01$). The incidence of macrosomia in period II was less than that in period I ($p<0.01$). There were no significant differences in the incidences of cesarean section, LFD, HFD, or low birth weight among three periods.

Table I. Clinical characteristics of the women enrolled in the study

	Period I (1988–1996) n=1852	Period II (1997–2005) n=2363	Period III (2006–2014) n=2152
Age, years	28.3 ± 4.0 *, **	29.0 ± 4.4 *, ***	30.4 ± 4.8 **, ***
Gravidity	1.1 ± 0.02 **	1.1 ± 0.02 ***	1.2 ± 0.03 **, ***
Parity	0.8 ± 0.01	0.7 ± 0.01	0.8 ± 0.01
Percentage of primipara	43.7%	44.9%	42.8%
BMI prior to pregnancy, kg/m^2	20.8 ± 2.7	20.7 ± 2.8	20.8 ± 2.9
Gestational weight gain, kg	11.1 ± 3.5 *, **	9.9 ± 3.7 *	10.0 ± 3.9 **
Gestational weeks at delivery	39.5 ± 1.4 *, **	39.3 ± 1.4 *	39.4 ± 1.4 **

Values are mean ± SD or %. BMI, body mass index. * Significantly different between periods I and II ($p<0.01$). ** Significantly different between periods I and III ($p<0.01$). ***Significantly different between periods II and III ($p<0.01$).

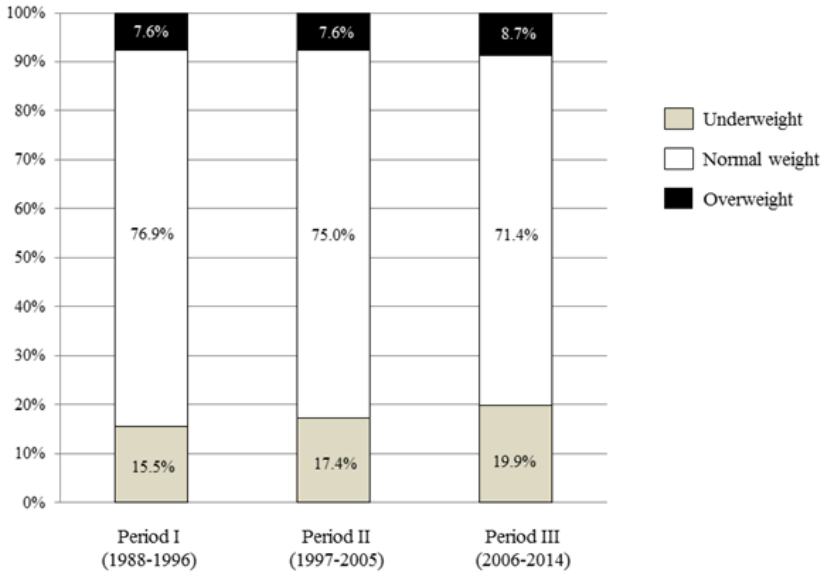

Figure 1. Percentages of underweight, normal weight, and overweight prior to pregnancy in the three periods.

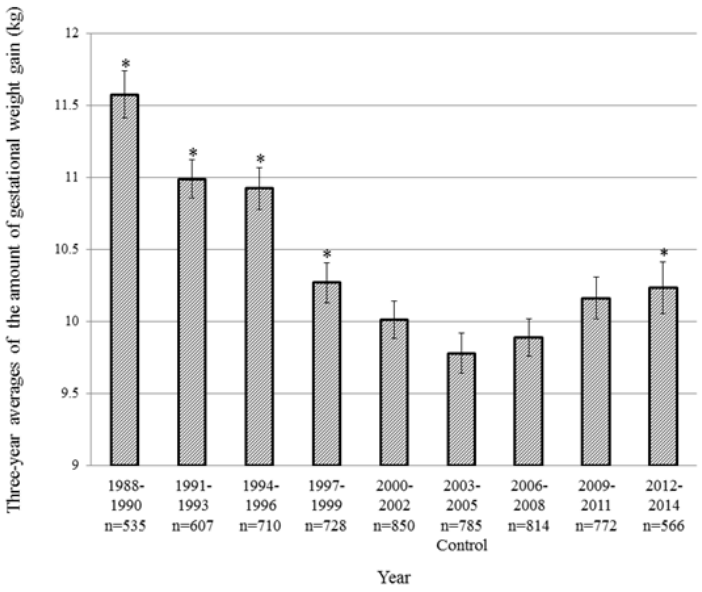

Figure 2. Three-year averages of the amount of gestational weight gain in pregnant women. The bars represent SD. *p<0.05 compared with the control (2003–2005).

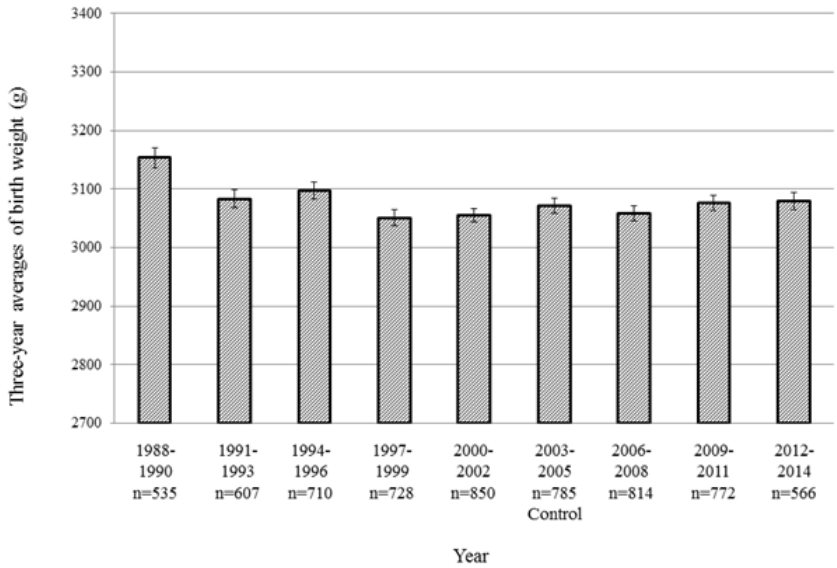

Figure 3. Three-year averages of birth weight of neonates. The bars represent SD. There was no significant difference in the 3-year averages of birth weight compared with the control.

Table II. The incidence of complications of pregnancy and neonatal outcome

	Period I (1988–1996) n = 1852	Period II (1997–2005) n=2363	Period III (2006–2014) n=2152
Pregnancy-induced hypertension	2.9% *,**	5.0% *	5.1% **
Cesarean section	22.3%	24.2%	21.7%
Vacuum extraction	13.6% *,**	4% *	3.4% **
Light-for-date	6.6%	6.6%	6.6%
Heavy-for-date	13.3%	10.8%	11.2%
Low birth weight	4.8%	4.7%	4.9%
Macrosomia	1.4% *	0.5% *	0.7%

* Significantly different between periods I and II ($p<0.01$). ** Significantly different between periods I and III ($p<0.01$). ***Significantly different between periods II and III ($p<0.01$).

DISCUSSION

In the present study, the amount of WG in pregnant women had been decreased in periods I and period II, whereas WG was increased in period III. Establishment of the JSOG guidelines and maternity education based on the JSOG guidelines in outpatient clinics are likely to have decreased WG in period II and a change to the MHLW guidelines in 2006 reversed this trend. The reason for this could be because the caloric intake was more restricted in the JSOG guidelines than in the MHLW guidelines. The amount of WG was also decreased during period I in which no guidelines were available. Perceptions and preferences for beauty of the body have changed over several decades, especially among younger women, and physical appearance and the body shape of women tend to be thin in Japan [3, 4]. The proportion of pregnant women who were underweight prior to pregnancy had tended to increase throughout the three periods (Figure 1). Changes of preferable body image in women of child-bearing age might cause the decrease in WG during period I when no guideline was available.

The present study showed that the incidences of vacuum extraction and macrosomia in period II were less than those in period I. A recent study reported that women with a WG less than the Institute of Medicine guidelines, which were used in the United States until 1990, had a low risk of obstetric interventions, but they had a high risk of LFD [1]. An increase in WG is known to increase the risks of macrosomia and HFD [2, 5]. In our study, the incidence of macrosomia in period I was higher than those in period II, this fact is consisted with the results of the previous studies.

The incidences of PIH increased in periods II and III as compared with period I, while WG decreased. Maternal age in periods II and III was older than that in period I. The advanced maternal age increases the risk for PIH [6]. However, a univariate logistic regression analysis demonstrated no association between maternal age and the incidence of PIH in the present study ($p=0.8$).

Neither a decrease in birth weight nor increased incidence of LFD, HFD, or low birth weight was found during the three periods. Changes in WG did not affect birth weight significantly during study period.

These results suggest that maintaining WG according to the guidelines could not prevent PIH. A large amount of WG is a risk for the development of GDM [7]. The incidence of GDM was not evaluated in the present study because the criteria of GDM were changed by the JSOG in 2010 [8].

Our results contain useful information for practitioners, paramedics, and pregnant women, as well as for public health and administration. However, this study was conducted in only one hospital that was located in Tamba, Hyogo Prefecture. Further studies are necessary to confirm the conclusions of this study.

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