Blood pressure during pregnancy is a useful predictive maker for hypertension and dyslipidemia later in life, a population-based, cross-sectional study

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ABSTRACT

Objective: Pregnancy is an opportunity for women to become aware of their risk of cardiovascular disease (CVD), because physiologic responses to dynamic hemodynamic changes can be observed during pregnancy. Accordingly, we hypothesized that blood pressure levels during pregnancy may be associated with the risk of CVD later in life.
Study design: We used data from the Iwaki Health Promotion Project and designed a population-based, cross-sectional study. In this study, Maternity Health Record Books were collected from women over 40 years of age in order to obtain reliable data regarding past pregnancies. Of a total of 642 women, 432 were selected according to the study criteria.
Main outcome measures: The associations between blood pressure levels during pregnancy and major CVD risk factors (hypertension and dyslipidemia) were analyzed retrospectively.
Results: A 10 mmHg increase in the mean diastolic blood pressure level between gestational weeks 12 and 42 conferred a 1.70- and 1.55-fold increase in the risk of hypertension and dyslipidemia, respectively, in later life.
Conclusions: Blood pressure levels during pregnancy may be associated with CVD risk and could therefore be a useful predictive marker.

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1. Introduction

It is well known that women with pre-eclampsia have an increased risk of developing cardiovascular disease (CVD) later in life [1–10]. Sattar et al. hypothesized that women with complicated pregnancies have intrinsic vascular risk factors and proposed that pregnancy provides an opportunity for screening for hidden CVD risk factors and intervention, given that the risk factors manifest themselves as a consequence of the physical burden of pregnancy [11]. Indeed, pregnancy itself may play a role in "screening" for future CVD. However, previous studies have not evaluated pregnancy itself as a stress test for CVD because maternal complications are well established and studies have focused on the prognosis of perinatal care. Therefore, it was necessary to investigate whether the risk of CVD would become apparent during pregnancy, and which parameters could be useful predictive markers of CVD. In this study, we used blood pressure levels during pregnancy as a candidate predictive marker for CVD. This is because the cardiovascular system changes dramatically during pregnancy and as a result, blood pressure levels also change [12–16]. We hypothesized that women who have more risk factors for CVD may not be able to adapt to these changes and that blood pressure levels during pregnancy may reflect the risk of CVD.

We therefore designed a population-based, cross-sectional study to test this hypothesis. Maternity Health Record Books were collected as a source of data regarding women over 40 years of age. Since 1942, all pregnant Japanese women receive a Maternity Health Record Book from the government. Medical history and

demographic features such as body weight, abdominal circumference, uterine fundus height, blood pressure, and the presence or absence of proteinuria, glycosuria, and edema, were recorded regularly every 1–4 weeks depending on the gestational age. Attending physicians also recorded information regarding the neonate and the course of delivery. Because the records are occasionally important as public documents, almost all Japanese women hold on to these books for decades after delivery. This allowed us to acquire past data regarding pregnancies and deliveries among Japanese women. In general, hospital medical records are only stored for 10 years; therefore, long-term observational studies are difficult. To circumvent this issue, we used the maternity health records to collect reliable data. In this study, most of the participants were healthy, middle-aged women with a low prevalence of CVD. Thus, we used two major CVD risk factors, hypertension and dyslipidemia, as the outcomes in the study [17–21]. The objective of our study was to assess whether blood pressure levels during pregnancy could be a useful predictive maker of future hypertension and dyslipidemia in Japanese women.

2. Methods

2.1. Participants

This study was undertaken as a part of the Iwaki Health Promotion Project that has been performed annually since 2005. The Iwaki Health Promotion Project is a longitudinal observational study of all adult residents living in the rural area of Iwaki, Japan. The cohort comprises roughly 1000 participants, which corresponds to approximately 10% of all habitants in the Iwaki area. We collected 1223 Maternity Health Record Books from 642 parous women from 2011 to 2013. Of 642 women, we selected 452 who (1) were over 40 years old, (2) had a singleton pregnancy, (3) had undergone at least five blood pressure measurements during pregnancy, (4) delivered at least five years before the study began, and (5) did not have hypertension or dyslipidemia prior to pregnancy. In this study, we selected women over 40 years old because the prevalence of hypertension is very low among women under 40 years of age in Japan [22]. Meanwhile, the prevalence of dyslipidemia markedly increases in women in their fifties [22]. We examined the first pregnancy for two reasons. One reason is the longer observational period. The other is that we could more readily identify women who developed pregnancy-induced hypertension (PIH), as the incidence rate of PIH is highest in the first pregnancy. Twenty women developed pregnancy-induced hypertension (PIH). These women were excluded from the study, because PIH is recognized as a potent risk factor for hypertension later in life [9,10]. The diagnosis of PIH was based on the criteria of the Japan Society for the Study of Hypertension in Pregnancy (2004) [23]. Finally, we analyzed the first singleton pregnancy data for 432 women.

At the same time that the data from the Maternity Health Record Books were collected, trained staff recorded the height, weight, blood pressure levels, general information regarding smoking and alcohol consumption, and the history of illness of the participants. The body mass index (BMI) was calculated as weight divided by height squared (kg/m²). The morbidities of hypertension and dyslipidemia, which were the major focus of this study, were determined based on the use of anti-hypertension and dyslipidemia medications at the time of the study. Six women who had high blood pressure (over 160/100 mmHg) at the time of the survey were also added to the hypertension group as untreated patients.

Table 1
Characteristics of participants at baseline and during pregnancy (N = 432).

Observational period (years)	28.4 ± 10.1
Data at the time of the study	
Age (years)	54.4 ± 8.3
Body mass index (kg/m²)	22.7 ± 3.1
Smoking	
Never or former smoker	399 (92.4%)
Current smoker	33 (7.6%)
Alcohol consumption	
Yes	156 (36.1%)
No	276 (63.9%)
Systolic blood pressure (mmHg)	129.3 ± 17.9
Diastolic blood pressure (mmHg)	77.9 ± 10.7
Hypertension[a]	80 (18.5%)
Dyslipidemia	80 (18.5%)
Data at delivery	
Age at delivery (years)	26.0 ± 4.1
Gestational age (week)	
<37	42 (9.7%)
≥37	390 (90.3%)
Birth weight	
<2500	57 (13.2%)
≥2500	375 (86.8%)

Values are presented as the mean ± standard deviation or as a percentage.
  [a] Anti-hypertensive and systolic blood pressure ≥ 160 and/or diastolic blood pressure ≥ 100.

2.2. Statistical analysis

Differences in blood pressure levels between each group were analyzed using one-way analysis of variance followed by Games-Howell's multiple comparison tests. Using the data from the Maternity Health Record Books, we obtained the mean values of the systolic blood pressure (SBP) and diastolic blood pressure (DBP) from 432 normotensive women for the total period of pregnancy (12–42 weeks), the second trimester (13–26 weeks), and the third trimester (27–42 weeks). The average SBP and DBP of all blood pressure measurements obtained during the specified time period were examined. Because there were no adequate data regarding the first trimester, we did not analyze this time period. We also analyzed the SBP and DBP during the puerperium (one month after delivery) as a control. Then, odds ratios for the association between the average gestational and postpartum SBP and DBP and the development of hypertension and dyslipidemia were calculated using logistic regression analyses for each period separately. For adjustment, we used the current age, age at delivery, number of delivery, current body mass index, and current smoking and alcohol habitus. In this study, the multivariable-adjusted odds ratios and 95% confidence intervals were calculated after simultaneously controlling for potential confounders. Statistical analyses were performed using the SPSS software package, version 22.0 (SPSS Inc., Chicago, IL, U.S.A.). All results were considered statistically significant at a level of P < 0.05.

3. Results

The demographic and clinical characteristics of the 432 subjects are shown in Table 1. The mean age of the 432 women was 54.4 years old. The average observational period after the last delivery was 28.4 years. During the observational period, 80 women developed hypertension and 80 developed dyslipidemia. In addition, 29 women had been taking medication for both hypertension and dyslipidemia.

The subjects were divided into four groups depending on the presence or absence of hypertension and dyslipidemia, and the mean SBPs and DBPs during gestational weeks 12–42, the second