A survey on the measurement of blood pressure in pregnant women and management of hypertensive disorders of pregnancy by the Japan Society for the Study of Hypertension in Pregnancy (JSSHP)

Hirotada Suzuki, Kenjiro Takagi, Kanji Tanaka, Atsuhiro Ichihara, Hiroyuki Seki, on behalf of the Japan Society for the Study of Hypertension in Pregnancy (JSSHP)

Aim: A questionnaire survey was conducted by the scientific committee of the Japan Society for the Study of Hypertension in Pregnancy (JSSHP) to clarify whether the measurement of blood pressure in pregnant women and management of hypertensive disorders of pregnancy differ between obstetricians.

Methods: We distributed anonymous questionnaires to 624 members of the JSSHP by mail in May 2019. Valid responses were obtained from 206 obstetricians. The majority of obstetricians used an automatic sphygmomanometer to screen for hypertension in clinical settings. Home blood pressure measurements were used by 97% of obstetricians to diagnose white coat hypertension. However, blood pressure measurements performed by many obstetricians in clinical and non-clinical settings did not comply with standards for non-pregnant adults. Furthermore, blood pressure goals in women with hypertensive disorders of pregnancy varied among obstetricians.

Conclusions: In Japan, an automatic sphygmomanometer in clinical settings and home blood pressure measurements in non-clinical settings are commonly used in practice for pregnant women. However, obstetricians may need to be re-educated on how to perform correct blood pressure measurements in these settings. Further evidence is needed to establish appropriate blood pressure goals in pregnant women with hypertensive disorders of pregnancy.

Introduction

Methods of blood pressure measurement in pregnant women have changed in recent years. Mercury sphygmomanometers had been widely used, but the production and import/export of mercury-containing equipment in Japan will be banned from 2021 in view of the Minamata Convention on Mercury. Therefore, non-mercury sphygmomanometers will replace mercury-based equipment moving forward.1) Home blood pressure (HBP) measurements are becoming more widespread among pregnant women in Japan. A number of guidelines refer to the use of HBP measurements in the management of hypertension in pregnancy in non-clinical settings.2,3) The definition and classification of hypertensive disorders of pregnancy...
(HDP) were revised in 2018 by the Japan Society for the Study of Hypertension in Pregnancy (JSSHP) and the Japan Society of Obstetrics and Gynecology (JSOG), with the addition of chronic hypertension (CH) as a new classification.\(^4\) Extensive evidence forms the basis for how to measure blood pressure and manage hypertension in non-pregnant individuals, and guidelines on hypertension in Japan have proposed suitable and reliable devices, methods for measuring blood pressure in clinical and non-clinical settings, and the management of hypertension based on appropriate evidence.\(^1\) However, appropriate devices for measuring office blood pressure and HBP in pregnant women have not yet been established, there is currently no reference value for HBP in pregnant women, and only limited information is available on the measurement of blood pressure and management of hypertension in pregnancy.\(^1,2,5–15\)

Blood pressure variations occur throughout the different stages of gestation due to progressive adaptations by the maternal cardiovascular system. HDP may develop rapidly and progressively and quickly deteriorate, in contrast to hypertension in the non-pregnant state. Thus, the diagnosis and management of hypertension differ between pregnant and non-pregnant women. Devices and methods for diagnosing hypertension in pregnant women have not yet been established, with a focus on devices used and decision-making based on office blood pressure and HBP.

The present nationwide questionnaire survey aimed to clarify whether the method of measuring blood pressure in pregnant women and managing HDP differ between obstetricians.

**Methods**

We distributed anonymous self-administered questionnaires to 624 members (obstetricians) of the JSSHP by mail between May 7, 2019 and May 31, 2019, and answer sheets were sent back to Jichi Medical University. We asked questions regarding the characteristics of respondents, as well as blood pressure measurements in clinical settings, HBP measurements in non-clinical settings, and blood pressure goals for hypertension in pregnancy. Data are presented as number (percent) or median (interquartile range). We did not perform statistical testing for comparisons between groups in this study. Data were processed using EZR (R version 3.4.1).

The present study was approved by the Institutional Ethics Committee of Jichi Medical University (approval number: rin-dai-18-188). JSSHP members agreed to complete the questionnaire survey by checking a box on the answer sheet.

**Results**

**Respondent characteristics**

Responses were received from 218 of 624 JSSHP members, among whom 207 were obstetricians (33.2%) and 11 were not (1.7%). After excluding one answer sheet due to insufficient responses, the remaining 206 answer sheets from obstetricians were analyzed. Median (interquartile range) age was 44 years (range: 38–53). The distribution of affiliations was as follows: general perinatal medical centers (37.7%), regional perinatal centers (36.3%), general hospitals (16.7%), and clinics (9.3%).

**Blood pressure measurements in clinical settings**

Automatic sphygmomanometers, both automatic and mercury sphygmomanometers, and other devices were used by 93.7, 5.3, and 1.0% of obstetricians, respectively. Thus, the majority of obstetricians used automatic sphygmomanometers to screen for hypertension in pregnant women in clinical settings.

1) **How many times do you measure blood pressure in one office visit?**

When the first blood pressure value was within the normal range (<140/90 mmHg), measurement frequencies were once, twice, until stable, and other by 89.3, 6.3, 3.4, and 1.0% of obstetricians, respectively (Figure 1A; white bar). When the first blood pressure value was ≥ 140/90 mmHg, measurement frequencies were twice, until stable, once, and other by 54.8, 40.3, 1.5, and 3.4% of obstetricians, respectively (Figure 1A; black bar). These results indicate that office blood pressure was measured only once in cases showing normal blood pressure, but repeatedly when the first measurement suggested hypertension.

2) **How do you select the blood pressure value to use for the assessment?**

Among obstetricians (n = 113) who measured blood pressure twice, the final blood pressure value selected was the lowest, highest, final, both, average, and other by 62.8, 11.5, 8.9, 7.1, 6.2, and 3.5% of obstetricians, respectively (Figure 1B; white bar). When the first blood pressure value was ≥ 140/90 mmHg, measurement frequencies were twice, until stable, once, and other by 54.8, 40.3, 1.5, and 3.4% of obstetricians, respectively (Figure 1B; black bar). These results indicate that office blood pressure was measured only once in cases showing normal blood pressure, but repeatedly when the first measurement suggested hypertension.

3) **What is the difference between blood pressure that is considered to be stable when you measure blood pressure until it stabilizes on one occasion?**

Differences between blood pressure values considered to
be stable were < 10 mmHg, < 15 mmHg, no determination, < 5 mmHg, and other by 50.0, 31.3, 6.2, 3.7, and 8.8% of obstetricians, respectively.

4) How do you diagnose hypertension in clinical settings?
Hypertension was diagnosed based on the confirmation of blood pressure ≥ 140/90 mmHg on two occasions, one occasion, and other by 56.6, 40.9, and 2.5% of obstetricians, respectively. However, even among obstetricians who answered that they confirmed blood pressure on two occasions, many adjusted the number of occasions according to the blood pressure value (Figure 2). When we asked about the time needed between two occasions to diagnose hypertension with blood pressure levels of 140–159/90–109 mmHg, the percentage of obstetricians selecting two intervals of ≥ 5 minutes was the highest (63.6%), whereas none selected a diagnosis even on one occasion. In contrast, 45.3% of obstetricians answered that even one measurement of 160–179/110–119 mmHg was sufficient to diagnose hypertension, while 70.1% answered one measurement of ≥ 180/120 mmHg was sufficient. These results suggest that the majority of obstetricians performed only one measurement to diagnose hypertension in clinical settings.

5) How is white coat hypertension diagnosed when hypertension is detected in clinical settings in the first trimester?
White coat hypertension was diagnosed using HBP measurements, HBP measurements and consulting with internal medicine doctors, both HBP measurements and ambulatory blood pressure monitoring, no distinction, only consulting with internal medicine doctors, and other by 80.0, 12.6, 4.4, 1.5, 0.5, and 1.0% of obstetricians, respectively. This suggests that the majority of obstetricians (97%) used HBP to diagnose white coat hypertension.

HBP measurements in non-clinical settings
Body regions used for blood pressure measurements in non-clinical settings were unspecified, upper arm, and wrist according to 51.2, 47.8, and 1.0% of obstetricians, respectively.
1) What is the cut-off value for office blood pressure to initiate HBP measurements?
Cut-off values of office systolic blood pressure (SBP) to initiate HBP measurements in pregnant women of ≥ 140 mmHg, ≥ 130 mmHg, ≥ 135 mmHg, ≥ 125 mmHg, and ≥ 120 mmHg were selected by 39.9, 37.8, 20.2, 1.5, and 0.5% of obstetricians, respectively (Figure 3A; white bar). Cut-off values of office diastolic blood pressure (DBP) to initiate HBP measurements in pregnant women of ≥ 90 mmHg, ≥ 80 mmHg, ≥ 85 mmHg, ≥ 100 mmHg, ≥ 75 mmHg, and ≥ 70 mmHg were selected by 43.0, 30.6, 23.8, 1.6, 0.5, and 0.5% of obstetricians, respectively (Figure 3A; black bar). These results suggest that HBP measurements were initiated at nearly hypertensive levels (≥ 135/85 mmHg) by most obstetricians. Approximately 33% of obstetricians considered the initiation of HBP measurements at an elevated blood pressure (≥ 130/80 mmHg).

2) Do you have any high-risk HDP cases considered for the initiation of HBP measurements other than high office blood pressure?
Risk factors for HDP have been reported.16,17 In the present study, 73.7% of obstetricians initiated HBP measurements in high-risk HDP cases irrespective of office blood pressure levels. Risk factors for initiating HBP measurements were a previous history of HDP, obesity, renal disease, and elderly pregnancy, and these were selected by 96, 21.9, 19.9, and 16.6% of obstetricians, respectively (Figure 4). In the majority of women with a previous history of HDP, HBP measurements were considered useful for detecting the recurrence of HDP during pregnancy.

3) How many measurements do you recommend?
Measurements were recommended on two occasions each day, one occasion each day, three occasions each day, no determination, four occasions each day, and other by 80.5, 13.7, 3.4, 1.0, 0.5, and 1.0% of obstetricians, respectively. Nearly 90% of obstetricians recommended blood pressure measurements on at least two occasions each day in pregnant women in non-clinical settings. Measurements were recommended once, twice, no determination, and three times per occasion by 74.7, 20.8, 3.5, and 1.0% of obstetricians, respectively.
4) How do you select the final blood pressure value when measuring twice per occasion?
The final blood pressure value used after two consecutive measurements was the lowest value, average of the two, highest value, and other by 39.0, 29.3, 29.3, and 2.4% of obstetricians, respectively, suggesting that the value used varied among obstetricians.

5) What is the diagnostic cut-off value for diagnosing hypertension using HBP in pregnant women?
There is currently no evidence-based diagnostic cut-off value for diagnosing hypertension using HBP in pregnant women. Therefore, each obstetrician used their own cut-off value for hypertension based on HBP. Cut-off values used for SBP were ≥140 mmHg, ≥135 mmHg, and ≥130 mmHg by 69.2, 20.0, and 8.7% of obstetricians, respectively (Figure 3B; white bar). Cut-off values used for DBP were ≥90 mmHg, ≥85 mmHg, ≥80 mmHg, and ≥100 mmHg by 68.9, 21.8, 6.5, and 2.2% of obstetricians, respectively (Figure 3B; black bar). Our findings suggest that the most commonly used cut-off value was ≥140/90 mmHg, although ≥135/85 mmHg is commonly used for non-pregnant individuals in non-clinical settings.

6) How do you diagnose hypertension using HBP in non-clinical settings?
Hypertension was diagnosed using HBP in non-clinical settings based on the confirmation of high blood pressure on two occasions, from an average of 5–7 days, and on one occasion by 53.5, 31.6, and 23.5% of obstetricians, respectively. Thus, many obstetricians selected blood pressure values measured on two different occasions to diagnose hypertension in pregnant women.

Blood pressure goals for CH with/without organ disorders before/after 20 weeks of gestation, and for GH or PE
The questionnaire also inquired about blood pressure goals for HDP, together with upper and lower target values for SBP and DBP.

The upper target of SBP was <140 mmHg for 51.0, 49.0, and 41.5% of women with CH before 20 weeks of gestation, CH after 20 weeks of gestation, and GH...
or PE, respectively, and the upper target was <160 mmHg for 19.8, 22.2, and 31.6%, respectively (Figure 5A). The upper target of DBP was <90 mmHg for 51.0, 49.2, and 43.3% of women with CH before 20 weeks of gestation, CH after 20 weeks of gestation, and GH or PE, respectively, and the upper target was <110 mmHg for 16.8, 19.8, and 27.8%, respectively (Figure 5A). The lower target for SBP was ≥120 mmHg for 28.4, 26.9, and 24.7% of women with CH before 20 weeks of gestation, CH after 20 weeks of gestation, and GH or PE, respectively, and the lower target was for DBP was ≥80 mmHg for 19.9, 20.3, and 17.7%, respectively (Figure 5B).

In this survey, blood pressure goals for CH, GH, and PE varied among obstetricians. Most obstetricians (87.4%) did not change the upper and lower targets for CH before and after 20 weeks of gestation based on organ disorder status. In addition, 76.6% of obstetricians did not change the upper and lower targets for CH, GH, and PE after 20 weeks of gestation.

**Discussion**

The present study is the first nationwide survey on devices and methods for blood pressure measurement in pregnant women and blood pressure control in pregnant women with HDP. The majority of obstetricians used an automatic sphygmomanometer to screen for hypertension in pregnant women in clinical settings. HBP measurements were used by 97% of obstetricians to diagnose white coat hypertension. However, the methods used for blood pressure measurements in clinical and non-clinical settings by many obstetricians did not comply with standards used for non-pregnant adults. Blood pressure goals for women with CH, GH, or PE also varied among obstetricians.

1. **Blood pressure measurements in clinical settings**

   Automatic blood pressure measurements were widely used (99%) in clinical settings and are considered an alternative to mercury-based blood pressure measurements. For instance, the International Society for the Study of Hypertension in Pregnancy (ISSHP) guidelines allow the use of a liquid-crystal sphygmomanometer and automatic sphygmomanometer. However, it is important to note that some types of automatic sphygmomanometers show lower values than true values in women with PE.

   Four factors related to measurements and evaluations...
H. Suzuki et al.

The findings of the present study were consistent with previous reports showing that none of the measurements complied with recommendations in clinical guidelines for non-pregnant women. However, inconsistencies in measurement methods and evaluation of blood pressure affect diagnostic accuracy. In non-pregnant women, blood pressure generally approaches its true value with repeated measurements, and blood pressure is measured on at least two different occasions because it easily fluctuates. Similar measurements and evaluations are recommended for pregnant women. Therefore, obstetricians may need to be re-educated on correct methods for blood pressure measurements in clinical settings.

The majority of obstetricians in the present study performed only one measurement in a hypertensive emergency. Japanese medical guidelines recommend that the diagnosis of hypertension in clinical settings must be based on measurements on at least two different occasions at least 4 hours apart. The ISSHP guidelines recommend an interval of a few hours for less severe hypertension, and an interval of within 15 minutes for severe hypertension. HDP may deteriorate and progress more rapidly than hypertension in the non-pregnant state, and severe hypertension in pregnant
women quickly leads to serious adverse maternal outcomes, such as eclampsia and cerebral hemorrhage, as well as adverse fetal outcomes. The results of this survey may reflect the intentions of obstetricians to diagnose and treat severe hypertension as soon as possible. Therefore, ideal intervals for blood pressure measurements and the number of measurements per occasion in pregnant women with very high blood pressure may differ from those in non-pregnant individuals.

2. HBP measurements in non-clinical settings

Approximately 50% of obstetricians in the present survey designated the upper arm type device as appropriate for HBP measurements. The Japanese medical guidelines recommend the upper arm type device in non-clinical settings. Although the wrist type device is easy to use, blood pressure values vary with dorsiflexion or extension of the palm. The wrist type device is less accurate than the upper arm type device because the deviation of blood pressure values increases as the cuff position moves away from the right atrium. Therefore, the upper arm type device is recommended for HBP measurements in non-clinical settings.

Only one questionnaire survey on the measurement and evaluation of blood pressure in pregnant women was conducted at the regional level in Japan in 2013. In that survey by Oishi et al., as well as the present survey, the following information was obtained: a) use of HBP in non-clinical settings, b) indications for HBP in non-clinical settings, and c) number of measurements per day for HBP.

Regarding the use of HBP in non-clinical settings, HBP monitoring was introduced by 80% of obstetrical clinics/hospitals in 2013, and by 97% of obstetricians in the present study in 2019. The utilization rate in obstetrical settings was similar to that by the internal medicine field in Japan (94.6%). Furthermore, the recommendation rate of HBP measurements for pregnant women with a previous history of HDP increased from 14–24% in 2013 to approximately 70% in 2019. Therefore, HBP measurements in non-clinical settings are being more widely used in Japanese obstetrical settings.

In the present study, HBP measurements were commonly used when office blood pressure in pregnant women was ≥ 135/85 mmHg and for high-risk HDP cases. A previous study reported that a blood pressure of ≥ 130/80 mmHg was a high-risk factor for the later occurrence of HDP (relative risk: 2.37). The odds ratio of PE developing again in women with a previous history of PE is reported to be very high. Therefore, HBP measurements serve as an important tool for the rapid detection of HDP.

With respect to the number of HBP measurements each day in non-clinical settings, measurements on two occasions each day (in the morning and evening) according to Japanese medical guidelines were common in 2013 (75–100%) and 2019 (80.5%). However, in the present survey, three factors related to measurements and evaluations (number of measurements per occasion, final blood pressure value, and method used to diagnose hypertension) did not comply with the JSH 2019 guidelines or clinical practice guidelines by the JSSHP committee for blood pressure measurements in non-clinical settings. The JSH 2019 and the Society of Obstetricians and Gynecologists of Canada (SOGC) 2014 Guidelines recommend two measurements per occasion, while the JSSHP 2015 Guidelines recommend one to three measurements per occasion. The JSH 2019 Guidelines recommend an average of two measurements to obtain a final blood pressure value in principle, whereas the JSSHP 2015 Guidelines provide no recommendations. The JSH Guidelines and JSSHP Guidelines recommend the use of the average blood pressure measured for 5–7 days or 3–7 days, respectively, to diagnose hypertension using HBP in non-clinical settings. The number of HBP measurements per occasion and the final blood pressure value used have not yet been established, even for non-pregnant women. In the evaluation of HBP, an average of 5 days or more was previously reported to be desirable for assessing antihypertensive effects in non-pregnant women. Similar to blood pressure measurements in clinical settings, measurements and evaluations of HBP for pregnant women in non-clinical settings need to be unified. The reason why measurements and evaluations of HBP in non-clinical settings differed among obstetricians may be due to a general lack of evidence for HBP measurements in pregnant women.

A cut-off value of ≥ 140/90 mmHg (66.3%) was used by the majority of obstetricians in this study to diagnose hypertension in non-clinical settings. However, the cut-off value varied among obstetricians. The reason why the same cut-off value for hypertension in clinical settings was adopted for the diagnosis of hypertension using HBP in non-clinical settings may be because normal reference ranges for blood pressure using HBP measurements in pregnant women have not yet been established. Although the JSSHP committee recommended a cut-off value of 135/85 mmHg, which is the same value for hypertension in non-pregnant individuals in non-clinical settings, there is currently limited evidence to support the use of this value in pregnant women. A survey conducted by Mikami et al. indicated that HBP values in non-clinical settings equivalent to an office blood pressure of 140/90 mmHg were 120.8/83.5, 126.0/85.2, and 136.3/89.3 mmHg in the first, second, and third trimesters, respectively. The cut-off value for hypertension using HBP in non-clinical settings may be lower than 135/85 mmHg.
mmHg before the third trimester. Thus, further studies are needed on the diagnosis of hypertension in pregnant women using HBP in non-clinical settings.

3. Blood pressure goals for GH, PE, and CH
Approximately 40% of obstetricians in the present survey used blood pressure goals of < 140 mmHg for SBP and < 90 mmHg for DBP in pregnant women with GH or PE, which do not comply with the Best Practice Guide of HDP 2015 set forth by the JSSHP. This might be attributed to the lack of information currently available on blood pressure goals in women with GH or PE. In the CHIPS trails for CH and GH, severe hypertension was less frequent in pregnant women in a tightly controlled group (target DBP, 85 mmHg) than in those in a less tightly controlled group (target DBP, 100 mmHg), and the prognosis of infants did not change. Therefore, blood pressure goals in pregnant women with CH or GH of < 140 mmHg for SBP and < 90 mmHg for DBP may be reasonable. Recommended target blood pressure ranges for hypertension in pregnancy vary by country: 110–140/80–85 mmHg for HDP in the ISSHP, < 160/110 mmHg for PE in the ACOG, and < 155–160/90–100 mmHg, with mean blood pressure decreases within 15–20% for GH/PE in the JSSHP.

Based on the results of the present survey, we propose three improvements to current obstetrical practices and research: 1) educate obstetricians on appropriate methods for measuring office blood pressure and HBP; 2) select a normal reference value for HBP based on evidence from HBP monitoring in a nationwide pregnant cohort study; and 3) accumulate evidence on blood pressure goals in pregnant women with CH, GH, and PE.

This study has some limitations. First, the response rate was low (34.5% of all JSSHP members). Second, the questionnaire survey was delivered only to main members of the JSSHP. Therefore, the results may not accurately reflect current practices. Finally, the present survey did not reveal current practices by internal physicians managing CH in pregnant women.

In the present nationwide survey conducted in Japan, the majority of obstetricians used an automatic sphygmomanometer to screen for hypertension in pregnant women in clinical settings. HBP measurements were used by 97% of obstetricians to diagnose white coat hypertension. However, the methods used for blood pressure measurements by many obstetricians in clinical and non-clinical settings did not comply with the standards used in non-pregnant adults. Blood pressure goals in women with CH, GH, or PE varied among obstetricians. These findings suggest the need for obstetricians to be re-educated on correct methods for blood pressure measurements in clinical and non-clinical settings. The accumulation of further evidence will be needed to establish appropriate blood pressure goals in women with HDP by collaborative efforts among internal medicine doctors and obstetricians.

Acknowledgments
This survey was funded as an academic project by the research expenses of the JSSHP. We are grateful to Dr. Akihide Ohkuchi (Department of Obstetrics and Gynecology, Jichi Medical University School of Medicine, Tochigi, Japan) for reviewing the draft of the manuscript. The authors thank all participating institutions involved in the survey for their valuable contributions.

Conflict of interest
The authors declare that they have no competing interests.

Informed consent for reporting
Obtained.

References
1. Umemura S, Arima H, Arima S, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). Hypertens Res. 2019; 42: 1235–1481.
2. Takagi K, Yamasaki M, Nakamoto O, et al. A review of best practice guide 2015 for care and treatment of hypertension in pregnancy. Hypertens Res Pregnancy. 2015; 3: 65–103.
3. ACOG Practice Bulletin No. 203: Chronic Hypertension in Pregnancy. Obstet Gynecol. 2019; 133: e26-e50.
4. Watanabe K, Matusbara K, Nakamoto O, et al. Committee Report: Outline of the new definition and classification of “Hypertensive Disorders of Pregnancy (HDP)”; a revised JSSHP statement of 2005. Hypertens Res Pregnancy. 2018; 6: 33–37.
5. Iwama N, Oba MS, Satoh M, et al.; BOSHI Study Group. Association of maternal home blood pressure trajectory during pregnancy with infant birth weight: the BOSHI study. Hypertens Res. 2020. doi:10.1038/s41440-020-0416-2.
6. Ohkuchi A, Hirashima C, Arai R, et al. Temporary hypertension and white coat hypertension in the first trimester as risk factors for preeclampsia. Hypertens Res. 2019; 42: 2002–2012.
7. Metoki H, Satoh M, Murakami T. Accumulation of evidence regarding home blood pressure during pregnancy is necessary. Hypertens Res. 2017; 40: 635–636.
8. Mikami Y, Takai Y, Era S, et al. Provisional criteria for the diagnosis of hypertension in pregnancy using home blood pressure measurements. Hypertens Res. 2017; 40: 679–684.
9. Iwama N, Metoki H, Okhubo T, et al.; BOSHI Study Group. Maternal clinic and home blood pressure measurements during pregnancy and infant birth weight: the BOSH study. Hypertens Res. 2016; 39: 151–157.
10. Inoue M, Tsuchihashi T, Hasuo Y, et al. Salt intake, home blood pressure, and perinatal outcome in pregnant women. Circ J. 2016;
Survey of blood pressure in pregnancy

80: 2165–2172.
11. Ishikuro M, Obara T, Metoki H, et al. Differences between clinic and home blood pressure measurements during pregnancy. J Hypertens. 2015; 33: 1492–1493.
12. Ishikuro M, Obara T, Metoki H, et al. Parity as a factor affecting the white-coat effect in pregnant women: the BOSHI study. Hypertens Res. 2015; 38: 770–775.
13. Ishikuro M, Obara T, Metoki H, et al. Blood pressure measured in the clinic and at home during pregnancy among nulliparous and multiparous women: the BOSHI study. Am J Hypertens. 2013; 26: 141–148.
14. Metoki H, Ohkubo T, Obara T, et al.; BOSHI Study Group. Daily serial hemodynamic data during pregnancy and seasonal variation: the BOSHI study. Clin Exp Hypertens. 2012; 34: 290–296.
15. Metoki H, Ohkubo T, Watanabe Y, et al.; BOSHI Study Group. Seasonal trends of blood pressure during pregnancy in Japan: the babies and their parents’ longitudinal observation in Suzuki Memorial Hospital in Intrauterine Period study. J Hypertens. 2008; 26: 2406–2413.
16. Duckitt K, Harrington D. Risk factors for pre-eclampsia at antenatal booking: systematic review of controlled studies. BMJ. 2005; 330: 565.
17. Bartsch E, Medcalf KE, Park AL, Ray JG; High Risk of Pre-eclampsia Identification Group. Clinical risk factors for pre-eclampsia determined in early pregnancy: systematic review and meta-analysis of large cohort studies. BMJ. 2016; 353: i1753.
18. Brown MA, Magee LA, Kenny LC, et al., on behalf of the International Society for the Study of Hypertension in Pregnancy (ISSHP). The hypertensive disorders of pregnancy: ISSHP classification, diagnosis & management recommendations for international practice. Pregnancy Hypertens. 2018; 13: 291–310.
19. Natarajan P, Shennan AH, Penny J, Halligan AW, de Swiet M, Anthony J. Comparison of auscultatory and oscillometric automated blood pressure monitors in the setting of preeclampsia. Am J Obstet Gynecol. 1999; 181: 1203–1210.
20. Lo C, Taylor RS, Gamble G, McCowan L, North RA. Use of Automated home blood pressure monitoring in pregnancy: Is it safe? Am J Obstet Gynecol. 2002; 187: 1321–1328.
21. Nouwen E, Snijder M, van Montfrans G, Wolf H. Validation of the omron M7 and microlife 3BTO-A blood pressure measuring devices in preeclampsia. Hypertens Pregnancy. 2012; 31: 131–139.
22. Kobayashi M, Obara T, Ohkubo T, et al. Practice and awareness of physicians regarding casual-clinic blood pressure measurement in Japan. Hypertens Res. 2010; 33: 960–964.
23. Fagard RH, Staessen JA, Thijs J. Prediction of cardiac structure and function by repeated clinic and ambulatory blood pressure. Hypertension. 1997; 29: 22–29.
24. Kikuya M, Chonan K, Imai Y, Goto E, Ishii M, Research Group to Assess the Validity of Automated Blood Pressure Measurement Devices in Japan. Accuracy and reliability of wrist-cuff devices for self-measurement of blood pressure. J Hypertens. 2002; 20: 629–638.
25. Oishi M, Tanaka K, Ishihara K, Iino K, Yokoyama Y, Mizunuma H. Results of a questionnaire survey on blood pressure management in hypertensive disorders of pregnancy in Aomori prefecture, Japan. Hypertens Res Pregnancy. 2017; 5: 7–12.
26. Obara T, Ohkubo T, Fukunaga H, et al. Practice and awareness of physicians regarding home blood pressure measurement in Japan. Hypertens Res. 2010; 33: 428–434.
27. Lie RT, Rasmussen S, Brunborg H, Gjessing HK, Lie-Nielsen E, Irgens LM. Fetal and maternal contributions to risk of pre-eclampsia: population based study. BMJ. 1998; 316: 1343–1347.
28. Magee LA, Pels A, Helewa M, Rey E, von Dadelszen P, Canadian Hypertensive Disorders of Pregnancy (HDP) Working Group. Diagnosis, evaluation, and management of the hypertensive disorders of pregnancy. Pregnancy Hypertens. 2014; 4: 105–145.
29. Imai Y, Ohkubo T, Hozawa A, et al. Usefulness of home blood pressure measurements in assessing the effect of treatment in a single-blind placebo-controlled open trial. J Hypertens. 2001; 19: 179–185.
30. Magee L, von Dadelszen P, Rey E, et al. Less-tight versus tight control of hypertension in pregnancy. N Engl J Med. 2015; 372: 407–417.