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ORIGINAL ARTICLE

Breastfeeding leads to lower blood pressure in 7-year-old Japanese children: Tohoku Study of Child Development

The article has been corrected since Advance Online Publication, and a corrigendum is also printed in this issue.

Miki Hosaka[1], Kei Asayama[1,2], Jan A Staessen[2,3], Takayoshi Ohkubo[1,4], Katsuhisa Hayashi[5,6], Nozomi Tatsuta[7,8], Naoyuki Kurokawa[7], Michihiro Satoh[1], Takanao Hashimoto[9], Takuo Hirose[1], Taku Obara[8], Hirohito Metoki[8], Ryusuke Inoue[10], Masahiro Kikuya[1], Kunihiko Nakai[7,8], Yutaka Imai[1] and Hiroshi Satoh[7]

This study investigated the association between breastfeeding and both self-measured home blood pressure (HBP) and conventional blood pressure (CBP) in 7-year-old Japanese children. We obtained data pertaining to breastfeeding and blood pressure for 377 mother–offspring pairs from the Tohoku Study of Child Development, which is a prospective birth cohort study. Information on breastfeeding and other factors were obtained from parental questionnaires during the follow-up period. Based on the duration of breastfeeding as a major source of nutrition, mother–offspring pairs were divided into short-term (mean, 5.1 months) and long-term (mean, 11.3 months) breastfeeding groups. At the age of 7 years (84.4 ± 1.8 months), each child's blood pressure was measured. The HBP in the long-term breastfeeding (LBF) group (92.9 mm Hg systolic/55.1 mm Hg diastolic) was significantly lower ($P = 0.006/0.04$) than in the short-term breastfeeding group (94.7/56.4 mm Hg); however, there were no significant differences in the CBP measurements between the short- and LBF groups. Using multiple regression analysis, the duration of breastfeeding (greater than 8 months) was more strongly associated with HBP ($P = 0.008/0.05$) than with CBP ($P = 0.4/0.9$). Furthermore, the adjusted R-squared values for HBP (0.25/0.12) tended to be higher than those for CBP (0.07/0.03). These findings were independent of the birth weight. In conclusion, breastfeeding has a protective effect against elevated blood pressure even in young children, and subtle, but important, differences were precisely detected by self-measurements performed at home.
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Keywords: breastfeeding; child; home blood pressure; infant nutrition; self-measurement

INTRODUCTION

Hypertension is the most important risk factor for cardiovascular disease in adults.[1–4] Likewise, hypertension during childhood can have unhealthy consequences. The tracking of blood pressure (BP) has previously been reported from infancy to childhood.[5] A significant association between BP and left ventricular hypertrophy has also been reported in 14-year-old children.[6] Therefore, the evaluation of BP from childhood onward is important.

In adults, self-measurement of BP at home (that is, home blood pressure; HBP) has been recognized as a useful tool for the accurate diagnosis and treatment of hypertension.[7,8] Similarly, in children and adolescents, the long-term reproducibility of HBP is superior to that of conventional BP (CBP).[9] However, children's BP, as stated in several hypertension guidelines,[10] is primarily based on CBP, and little attention has been paid to HBP in children.

Breastfeeding is an unparalleled means of providing optimal nutrients for the healthy growth and development of infants.[11] Breast milk has important benefits for the mother as well as the child, and the duration of breastfeeding is associated with a lower prevalence of metabolic syndrome in a dose-dependent manner in

[1]Department of Planning for Drug Development and Clinical Evaluation, Tohoku University Graduate School of Pharmaceutical Sciences, Sendai, Japan; [2]Studies Coordinating Centre, Division of Hypertension and Cardiovascular Rehabilitation, Department of Cardiovascular Diseases, University of Leuven, Leuven, Belgium; [3]Department of Epidemiology, Maastricht University, Maastricht, The Netherlands; [4]Department of Public Health, Shiga University of Medical Science, Otsu, Japan; [5]Department of Cancer Molecular Biology, Tohoku University Graduate School of Medicine, Natori, Japan; [6]Division of Cancer Chemotherapy, Miyagi Cancer Center Research Institute, Natori, Japan; [7]Department of Environmental Health Sciences, Tohoku University Graduate School of Medicine, Sendai, Japan; [8]Department of Development and Environmental Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan; [9]Department of Clinical Pharmacology and Therapeutics, Tohoku University Graduate School of Pharmaceutical Sciences, Sendai, Japan and [10]Department of Medical Informatics, Tohoku University Graduate School of Medicine, Sendai, Japan
Correspondence: Dr K Asayama, Department of Planning for Drug Development and Clinical Evaluation, Tohoku University Graduate School of Pharmaceutical Sciences, 6-3 Aramaki-aza-aoba, Sendai 980-8578, Japan.
E-mail: kei@asayama.org
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adults who were breastfed as infants.[12] Furthermore, adults who were breastfed as infants have lower BMIs and higher high-density lipoprotein cholesterol levels than adults who were not breastfed as infants.[13] It has been reported in systematic reviews and meta-analyses that breastfeeding is protective against elevated CBP and against being overweight or obese later in life.[14–17] Breastfed infants also grow more slowly during infancy than bottlefed infants and, consequently, breastfeeding might have protective effects against the risk of obesity later in childhood.[18] However, the available information about the association between breastfeeding and CBP is inconsistent,[13,16,19] and no studies have used HBP measurements. The purpose of this study was to investigate the association between breastfeeding and both HBP and CBP in young children.

METHODS

Study design

The Tohoku Study of Child Development (TSCD) is a prospective birth cohort study investigating the health and development of children. The TSCD has been carried out in the Tohoku district of Japan, and details of the TSCD have been described previously.[20,21] From January 2001 until September 2003, a total of 687 pregnant women were enrolled in the TSCD. Women were eligible for inclusion in the study if they had no severe diseases, such as thyroid dysfunction, hepatitis, immune deficiency, malignant tumors or mental diseases; had not undergone *in vitro* fertilization; and spoke Japanese as their native language. A total of 599 babies fulfilled the inclusion criteria, which included the absence of congenital anomalies or severe diseases, a singleton birth at term (36–42 weeks of gestation) with birth weight of more than 2400 g (Figure 1). Maternal consent was required for participation in this study. Of the 599 mother–offspring pairs originally recruited, 53 were lost to follow-up and 546 participated in a follow-up examination. By 31 March 2011, the current status of the 454 children at 7 years of age and their mothers was surveyed (84-month survey). We excluded 77 children from analysis because either their CBP or their HBP was unavailable ($n=20$), their HBP in the morning was measured fewer than 3 days ($n=33$), the mothers were taking antihypertensive medication during the survey ($n=3$), or not all required characteristics or outcomes at the 84-month survey were available for analysis ($n=21$). Therefore, the population of this study consisted of 377 children and an equal number of mothers. The study was performed only after obtaining written informed consent and approval from the Ethics Committee of Tohoku University Graduate School of Medicine.

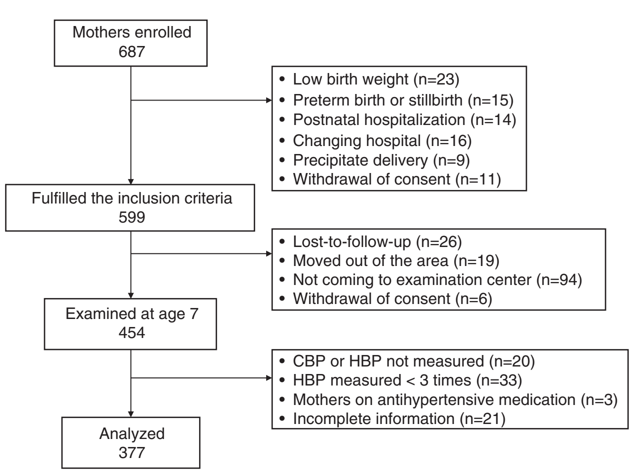

Figure 1 Flowchart of study participants. CBP, conventional blood pressure; HBP, home blood pressure.

Anthropometric measurements and other information

Information on the mothers' characteristics, including birth date, smoking and drinking habits during pregnancy, parity and education, was collected by self-administered questionnaires at enrollment or 4 days after delivery. Information on the mothers' neonatal characteristics during pregnancy was obtained from medical records before their discharge from the hospital. The heights and weights of the children at 7 years of age were measured at the 84-month survey using a KS-502Gp automatic analyzer (Kansai Seiki Co., Ltd., Kusatsu, Japan) while the subjects wore light indoor clothes and no shoes.

Feeding data

Information about the duration of breastfeeding was obtained from parental questionnaires during the infant's age of 18 or 30 months. In the questionnaires, the written text inquired about the duration of breastfeeding, asking: (1) how long was breastfeeding a major source of nutrition for the child, and (2) when was breastfeeding for the child discontinued. We defined the former as how long breastfeeding was used as a major source of nutrition and the latter as the time at which breastfeeding was stopped. If the information could not be obtained at that time for any reason, we asked the same question again at the infant's age of 42 and 84 months. We divided the study participants and children into two groups according to the median duration of breastfeeding. This approach yielded a short-term breastfeeding (SBF) group (less than 8 months) and a long-term breastfeeding (LBF) group ($\geqslant$8 months).

BP measurement and criteria

The mothers' and children's CBP and HBP at the 84-month survey were both measured using the OMRON *HEM-7080IC* (Omron Healthcare Co., Ltd., Kyoto, Japan), a device based on the cuff-oscillometric method that generates a digital display of both the systolic BP (SBP) and diastolic BP (DBP) values. The device used in the present study is equivalent to the OMRON *HEM-705IT* and has been validated.[21,22] The device automatically stores up to 350 readings in its memory, and we directly downloaded the BP readings to a computer from the device without any measurement bias. An appropriate arm cuff was selected for each child and mother based on arm circumference. The CBP was measured by trained survey staff. The BP measurements were performed once on mothers and children in a seated position after resting for at least 2 min. The study subjects were also instructed and trained how to measure their HBP, and they were asked to take their own measurements for 2 weeks. Their HBP was measured once in the morning before breakfast, in the sitting position, within 1 h after awaking and after 2 min or more of rest. They recorded their measurements for 2 weeks, as specified by the Japanese guidelines for HBP measurement.[10] Each child's BP was measured with the mother's assistance. Although many subjects measured their HBP twice or more per occasion, we used the first value from each measurement in our analysis to exclude individual selection bias. HBP was defined as the mean of all measurements. The mean number of days with HBP readings available for analysis was 12.5. In the present analysis, we set the criteria for hypertension based on a HBP$\geqslant$135/85 mm Hg, based on the Japanese Society of Hypertension Guidelines for the Management of hypertension.[10] Based on the consensus statement by the Japan Society for the Study of Hypertension in Pregnancy,[23] gestational hypertension and preeclampsia were defined as the 'new onset of BP of at least 140/90 mm Hg after the 20th week of gestation in women with no history of hypertension, renal or cardiovascular diseases, and with no clinical or laboratory features of preeclampsia,' and the 'new onset of hypertension after 20 weeks gestation with proteinuria,' respectively. Women were classified as having a history of pregnancy-induced hypertension when they had gestational hypertension or preeclampsia.

Statistical analyses

All data are expressed as the mean ± s.d. unless otherwise stated. We calculated the BMI for children at the 84-month survey using the following formula: weight (kg)/height (m)^2. The variables for the characteristics of the study participants and the children's outcomes at the 84-month survey were compared using a Fisher's exact test or a Wilcoxon rank-sum test. An analysis of covariance was followed by Tukey's multiple comparison test adjusted for sex, birth weight and BMI in the 84-month survey. The child's exact age at the 84-month survey was used to examine the BP differences between the two categories that were based on the duration of breastfeeding as a major source of nutrition. Spearman rank-correlation coefficients were calculated to determine the correlation between the BP and breastfeeding information. A stepwise multiple regression analysis was used to examine the influence of the duration of breastfeeding and other covariates on child's CBP and HBP levels. For the children, the factors included birth weight, gestational age, sex and the age and BMI at the time of the 84-month survey. For the mothers, the factors included maternal SBP at the 84-month survey, parity, smoking habits during pregnancy, drinking habits during pregnancy, hypertension defined by HBP, history of pregnancy-induced hypertension and education level. The data are presented as the mean ± s.d. Statistical significance was established at $P<0.05$. All statistical calculations were performed using SAS software (version 9.13, SAS Institute Inc., Cary, NC, USA).

RESULTS

Of the original cohort of 599 children at age seven and their mothers, 377 were included in the current analysis. There were no significant differences in gestational age, birth weight, birth height, rate of females and parity between the 377 children who did participate and 222 those who did not participate in the current analysis. By contrast, participating mothers had a significantly higher level of education than non-participating mothers (>13 years; 76.9 *vs.* 55.4% $P<0.0001$).

Table 1 displays the characteristics of the study participants and the children's outcomes at the 84-month survey, which was divided into two groups according to the median duration of breastfeeding (that is, SBF and LBF). The birth weight was significantly lower in the SBF group (mean 3032.4 g) than in the LBF group (mean 3104.1 g). The duration of breastfeeding as the major source of nutrition and the time at which breastfeeding stopped was 5.1 and 16.5 months, respectively, in the SBF group, and 11.3 and 18.5 months, respectively, in the LBF group. Maternal variables, anthropometric status and CBP were not significantly different between the two groups. However, the average HBP in the LBF group (92.9/55.1 mm Hg) was significantly lower than the average HBP in the SBF group (94.7/56.4 mm Hg) ($P=0.006$ for SBP and $P=0.04$ for DBP).

The relationships between the duration of breastfeeding and the children's BP measurements are displayed in Table 2. When the BP measurements of the male and female children were analyzed separately (or together), there were no significant differences in CBP between the LBF and SBF groups. A significantly higher diastolic HBP and a tendency to have a lower systolic HBP were observed in the females in the SBF group compared with those in the LBF group. Similarly, the systolic HBP in the males was significantly higher in the SBF group than in the LBF group. We found a significant relationship between the duration of breastfeeding and gender for diastolic CBP ($P=0.045$).

The correlations between the duration of breastfeeding and the children's CBP or HBP values are displayed in Table 3. Weak but significantly negative correlations were observed between the duration of breastfeeding as a major source of nutrition and children's HBP (partial $r=-0.13$ for SBP and -0.13 for DBP; $P=0.01$ for SBP and 0.01 for DBP) and between the duration of breastfeeding and systolic CBP (partial $r=0.11$; $P=0.03$). We observed no significant relationship between the time when breastfeeding was stopped and the children's BP.

Table 4 displays the results of the stepwise multiple regression analysis with the duration of breastfeeding as a major source of nutrition (more than 8 months or less than 8 months) included in the models. Although there were no significant associations between the duration of breastfeeding as a major source of nutrition and CBP, the duration of breastfeeding as a major source of nutrition was significantly related to lower systolic HBP at age seven ($P=0.008$). The children's BMIs at the 84-month survey were also associated with all of the BP information ($P\leqslant 0.0001$). Maternal smoking status during pregnancy influenced the diastolic HBP in the 7 year olds. Systolic HBP was significantly associated with both gender and maternal systolic HBP at the 84-month survey. Diastolic HBP was marginally associated with the children's age in months at the 84-month survey but not with gender. Birth weight and other variables were not selected in all models. The adjusted R-squared values were 0.07/0.03 (systolic/diastolic) for CBP and 0.25/0.12 for HBP (Table 4).

Table 1 Characteristics of study participants and children's status at 84-month survey by breastfeeding duration[a]

Variables	*Shorter breast-feeding duration*[b]	*Longer breast-feeding duration*[c]	P-*value*
Children			
Number of subjects (*n*)	186	191	—
Girls (%)	50.5	44.5	0.3
Gestational age (week)	39.5 ± 1.3[d]	39.6 ± 1.2	0.8
Birth weight (g)	3032 ± 335	3104 ± 345	0.04
Birth height (cm)	48.9 ± 1.8	49.2 ± 1.8	0.2
The duration of breastfeeding as a major source of nutrition (month)	5.1 ± 1.8	11.3 ± 3.0	<0.0001
The time at which breastfeeding was stopped (month)	16.5 ± 11.0	18.5 ± 7.1	<0.0001
Mothers			
Age at delivery (years old)	31.6 ± 4.4	32.0 ± 3.9	0.3
Smoking during pregnancy (%)	9.7	4.7	0.07
Drinking during pregnancy (%)	32.3	31.9	>0.9
No previous pregnancies (%)	54.3	50.3	0.5
Education ⩾13 years (%)	79.1	77.7	0.8
With a job (%)	54.5	55.6	0.8
Income ⩾3 million yen (%)	21.7	27.0	0.3
Hypertension (%)	4.3	3.1	0.6
PIH (%)	9.7	6.3	0.3
Children's status at 84-month survey			
Age (month old)	84.4 ± 1.8	84.3 ± 1.8	0.5
Weight (kg)	23.2 ± 3.2	22.8 ± 2.8	0.3
Height (cm)	120.5 ± 4.9	119.8 ± 4.5	0.2
BMI (kg m^{-2})	15.9 ± 1.5	15.8 ± 1.3	0.7
Conventional SBP (mm Hg)[e]	92.2 ± 8.9	91.2 ± 9.6	0.3
Conventional DBP (mm Hg)	55.7 ± 8.9	55.6 ± 9.6	>0.9
Conventional heart rate (b.p.m.)	79.9 ± 10.5	80.6 ± 10.4	0.4
Home SBP (mm Hg)	94.7 ± 6.6	92.9 ± 6.6	0.006
Home DBP (mm Hg)	56.4 ± 5.9	55.1 ± 5.7	0.04
Home heart rate (b.p.m.)	85.0 ± 7.6	84.1 ± 7.9	0.3

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; PIH, pregnancy-induced hypertension; SBP, systolic blood pressure.
[a]Differences between groups were analyzed using Fisher's exact test or the Wilcoxon rank-sum test except for blood pressure.
[b]The duration of breastfeeding as a major source of nutrition less than 8 months.
[c]The duration of breastfeeding as a major source of nutrition 8 months or more.
[d]Mean ± s.d. (all such values).
[e]Conventional and home measurements were analyzed by using ANCOVA adjusted for sex, birth weight, children's BMI and age at the 84-month survey.

We performed further comparisons to examine the differences in CBP between the 268-member, once-measured group and the 109-member, twice-measured group. There were no significant differences, even though the number of measurements were different (SBP: 93.0 mm Hg *vs.* 93.0 mm Hg, $P=0.9$; DBP: 57.1 mm Hg *vs.* 56.5 mm Hg, $P=0.6$).

DISCUSSION

This is the first study to examine the associations between children's HBP and breastfeeding and to report a significant relationship between the duration of breastfeeding as a major source of nutrition and children's HBP. Based on this prospective birth cohort, we established that a longer duration of breastfeeding as a major source of nutrition resulted in a lower BP in 7-year-old children. This association was stronger for HBP than for CBP.

Breastfeeding has been shown to have many benefits for children, including reduced risks of infection, obesity and cardiovascular disease,[13] in addition to good mother–infant bonding[24,25] and reduced early sodium intake. In Japan, the mean postpartum content of sodium in breast milk during days 90–180 and 181–365 are 10.7 ± 6.9 mg per 100 ml and 11.6 ± 6.1 mg per 100 ml, respectively,[26] whereas the amount of sodium in modified milk powder is 140 mg g^{-1}. Thus, the mean sodium concentration in formula milk (13 g of powder per 100 ml) is generally 18.2 mg per 100 ml.[27] Although the content of formula milk has become increasingly similar to that of breast milk in recent years, it is undeniable that the accumulated sodium intake in formula-fed infants is greater than in breastfed infants. In addition to sodium intake, it has been reported that breastfeeding could influence BP via a variety of mechanisms such as altering glucose and lipid metabolism.[15]

In several studies, the associations between breastfeeding and BP were inconsistent.[15,19,28] Wilson *et al.*[29] reported that 301 children (6.9–10.0 years old) who were exclusively bottlefed had a significantly higher SBP than those who were partially or exclusively breastfed. Although our results support these findings, the previous study might contain a selection bias because BP was not measured for 90 children who were dropped from the subanalysis.[29] In contrast to the previous study, we used an automated cuff-oscillometric device to eliminate observer bias, whereas the previous study used a random zero sphygmomanometer.[29] In addition, the children's age remained within a narrow range in our current study (84.4 ± 1.8 months), which enabled us to emphasize that age difference had little effect on our findings. Furthermore, to the best of our knowledge, all previous studies were based on CBP measurements. The long-term reproducibility of HBP is superior to that of CBP not only in adulthood[30] but also in childhood.[9] In the present study, the association between breastfeeding and HBP was more clearly observed than the association between breastfeeding and CBP, indicating that HBP measurement is a useful tool to detect subtle but important differences, even in young children.

On the basis of multiple regression analysis, birth weight was not associated with BP in 7-year-old children. It has been reported that birth weight is inversely associated with BP in both childhood and adult life.[31,32] In Japanese children, a lower birth weight is

Table 2 Comparison of children's blood pressure by breastfeeding duration according to sex

Variables	*Shorter breastfeeding duration*[a]	*Longer breastfeeding duration*[b]	*P-value*[c]
Girls			
Number of subjects (*n*)	94	85	—
Conventional SBP (mm Hg)	91.9 ± 9.9[d]	90.6 ± 10.4	0.3
Conventional DBP (mm Hg)	56.8 ± 9.7	54.8 ± 8.9	0.2
Conventional heart rate (b.p.m.)	82.4 ± 10.7	83.2 ± 9.8	0.7
Home SBP (mm Hg)	93.7 ± 7.0	91.6 ± 7.1	0.05
Home DBP (mm Hg)	56.3 ± 6.0	54.2 ± 5.8	0.02
Home heart rate (b.p.m.)	87.4 ± 6.9	86.0 ± 7.1	0.2
Boys			
Number of subjects (*n*)	92	106	—
Conventional SBP (mm Hg)	92.4 ± 7.8	91.7 ± 9.0	0.6
Conventional DBP (mm Hg)	54.5 ± 7.9	56.3 ± 10.2	0.2
Conventional heart rate (b.p.m.)	77.4 ± 9.7	78.4 ± 10.5	0.5
Home SBP (mm Hg)	95.7 ± 5.9	94.0 ± 6.0	0.048
Home DBP (mm Hg)	56.5 ± 5.8	55.9 ± 5.7	0.5
Home heart rate (b.p.m.)	82.5 ± 7.5	82.5 ± 8.2	0.9

Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Duration of breastfeeding as a major source of nutrition less than 8 months.
[b]Duration of breast feeding as a major source of nutrition 8 months or more.
[c]Adjusted for birth weight, children's BMI and age at 84-month survey.
[d]Mean ± s.d. (all such values).

Table 3 Spearman's rank-correlation coefficients between duration for breastfeeding and children's BP

	Time at which breastfeeding was stopped				*Duration of breastfeeding as a major source of nutrition*			
Measurement variables	*Crude*	*P-value*	*Sex-, birth weight-, BMI-, age- adjusted*	*P-value*	*Crude*	*P-value*	*Sex-, birth weight-, BMI-, age- adjusted*	*P-value*
Conventional SBP (mm Hg)	0.0007	>0.9	−0.01	0.8	−0.07	0.2	−0.11	0.03
Conventional DBP (mm Hg)	0.03	0.6	0.003	>0.9	−0.01	0.8	−0.04	0.4
Conventional heart rate (b.p.m.)	0.007	0.9	0.01	0.8	0.03	0.6	0.01	0.9
Home SBP (mm Hg)	0.03	0.5	0.06	0.3	−0.10	0.049	−0.13	0.01
Home DBP (mm Hg)	−0.01	0.9	0.05	0.3	−0.10	0.07	−0.13	0.01
Home heart rate (b.p.m.)	−0.002	>0.9	0.007	0.9	−0.05	0.3	−0.03	0.6

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 4 Stepwise multiple regression analysis of children's blood pressure and covariates[a]

Selected variables	*β*	P-*value*	*Partial* R^2	*Adjusted* R^2
Conventional SBP (mm Hg)				0.07
Children's factors				
Breastfeeding (over 8 months)[b]	−0.83	0.4	0.003	
BMI (1 kg m $^{-2}$)[c]	1.78	<0.0001	0.073	
Conventional DBP (mm Hg)				0.03
Children's factors				
Breastfeeding (over 8 months)[b]	0.08	0.9	0.000	
BMI (1 kg m $^{-2}$)[c]	1.31	0.0001	0.039	
Home SBP (mm Hg)				0.25
Children's factors				
Breastfeeding (over 8 months)[b]	−1.59	0.008	0.017	
Sex (girl)	−1.97	0.001	0.022	
BMI (1 kg m $^{-2}$)[c]	1.85	<0.0001	0.185	
Maternal factors				
Home SBP (10 mm Hg)[c]	1.17	0.0002	0.029	
Smoking during pregnancy (yes)	−2.27	0.051	0.007	
Parity (yes)	0.98	0.1	0.005	
Home DBP (mm Hg)				0.12
Children's factors				
Breastfeeding (over 8 months)[b]	−1.11	0.053	0.011	
Age (1 month old)[c]	−0.31	0.054	0.009	
BMI (1 kg m $^{-22}$)[c]	0.93	<0.0001	0.062	
Maternal factors				
Home SBP (10 mm Hg)[c]	1.10	0.0003	0.033	
Smoking during pregnancy (yes)	−2.80	0.01	0.016	

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Birth weight, gestational age, drinking during pregnancy, hypertension defined by HBP, past history of PHI and maternal education level were not selected in any models.
[b]Duration of breastfeeding as a major source of nutrition.
[c]Children's BMI, age and maternal home SBP were collected at the 84-month survey.

independently associated with increases in BP during childhood.[33] However, environmental growth factors, such as breastfeeding, were not taken into account in previous studies. To the best of our knowledge, there has been no study that evaluated the concurrent influences of environmental growth factors and perinatal factors (for example, birth weight) on children's BP. Although the number of our subjects was small, and there may be a Type II error (that is, the probability of erroneously failing to reject the null hypothesis), the results indicated that breastfeeding more strongly influenced the BP of 7-year-old children than birth weight. Therefore, a child's growth environment is very important the child's future health. Both perinatal factors and growth environmental factors should be considered simultaneously when investigating the causes of elevated BP in children.

Children in the SBF group had significantly lower birth weight than those in the LBF group (Table 1), likely originating from factors such as smoking during pregnancy. Although the difference was not statistically significant (Table 1), mothers in the SBP group tended to smoke more during pregnancy than those in the LBF group, which might have resulted in the differences in the children's birth weights. However, it is also a reasonable assumption that some of the smoking mothers would terminate breastfeeding early to restart smoking or to prevent side effects of smoking while breastfeeding. As we do not have data to determine the reasons that the mothers terminated breastfeeding, further investigation is needed.

The mothers participating in the present study were more highly educated than the non-participating mothers. One of the limiting factors in prolonged breastfeeding is the employment status (that is, higher educated women are more often employed). Although no significant differences between the SBF group and LBF group were observed for the mothers' employment status or annual income (Table 1), other socioeconomic factors should be taken into account in future investigations.

Despite the significant results, some limitations should be considered when interpreting our results. The mechanisms for the association between breastfeeding and the lower BP remain unclear, and this could not be determined based on our study design. We used a CBP measurement once because only 109 of the 377 mother–offspring pairs measured their CBP twice consecutively. However, further comparison between these 109 subjects and the other 268 showed little difference, suggesting that the measurement times of the CBP might not have an important role in the outcome of our results. Furthermore, the breastfeeding information was subjective and obtained from parental questionnaires. We do not have accurate data on either the duration of exclusive breastfeeding or information about the infants' consumption of solid foods. Although 8 months as the median breastfeeding duration as a major source of nutrition would be reasonable in Japanese children,[34] our findings might not be representative for other ethnic groups. Participants could not be divided into two groups (that is, breastfed and non-breastfed) because there were only two mothers who exclusively used formula for feeding. As children who were exclusively formula-fed would have a higher BP than breastfed children, further research into the association between breastfeeding and children's BP should be conducted. Nevertheless, a significant relationship between breastfeeding and HBP was observed, suggesting that HBP is a reliable tool to evaluate health status and might predict future cardiovascular risk.

In conclusion, there was a significant inverse association between children's BP and the duration of breastfeeding as a major source of nutrition, and the findings were more clearly observed when HBP was used for BP measurements instead of CBP. Our results suggest that breastfeeding has a protective effect against elevated BP during childhood, but there may not be a need to breastfeed exclusively to reap the protective effects on BP later in life. Our findings can be generalized to healthy Japanese children. Furthermore, subtle but important differences could be precisely detected using HBP, even in young children. Breastfeeding has a strong influence on 7-year-old children's BP, even after taking into account other possible confounding factors in relation to the growth environment and perinatal status.

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