

Short Communication

Breast-feeding and hospitalization for asthma in early childhood: a nationwide longitudinal survey in Japan

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Abstract

Objective: Whether or not breast-feeding is protective against asthma among children is still controversial. Therefore, we examined the effects of breast-feeding on hospitalization for asthma in early childhood.

Design: Secondary data analyses of a nationwide longitudinal survey of children in Japan ongoing since 2001, with results collected from 2001 to 2004. We used logistic regression models to evaluate the associations of breast-feeding with hospitalization for asthma in children between the ages of 6 and 42 months, adjusting for children's factors (sex, day-care attendance and presence of older siblings) and maternal factors (educational attainment and smoking habit).

Setting: All over Japan.

Subjects: Term singleton children with information on feeding practices during infancy (n 43 367).

Results: After adjusting for maternal factors and children's factors, exclusive breast-feeding at 6–7 months of age was associated with decreased risk of hospitalization for asthma in children. The adjusted odds ratio was 0.77 (95 % CI 0.56, 1.06). One-month longer duration of breast-feeding was associated with a 4 % decreased risk of hospitalization for asthma (OR = 0.96; 95 % CI 0.92, 0.99).

Conclusions: The protective effects of breast-feeding on hospitalization for asthma were observed in children between the ages of 6 and 42 months.

Keywords
Breast-feeding
Asthma
Child

Although breast-feeding has long-term benefits for children's health such as prevention of overweight/obesity and type 2 diabetes and improvement of cognitive function⁽¹⁾, the protective effect of breast-feeding on asthma in childhood still remains controversial^(2–11). Two meta-analyses^(4,5) and a recent study in New Zealand⁽⁶⁾ reported that breast-feeding continued to be associated with decreased risk of asthma in children after cessation of breast-feeding. However, a large-scale randomized trial⁽⁷⁾ and several observational studies^(8–11) found no effect or even an increased risk of asthma. The Japanese Pediatric Guideline for Food Allergy concluded that evidence was insufficient that exclusive breast-feeding had more preventive effects on allergy than partial breast-feeding⁽¹²⁾.

In the present study, we evaluated the associations between breast-feeding and hospitalization for asthma in early childhood (i.e. between the ages of 6 and 42 months) by using data from a nationwide longitudinal survey in Japan. We also examined the dose–response relationship between the duration of breast-feeding and children's hospitalization for asthma.

Materials and methods

Study participants

We extracted the data from the Longitudinal Survey of Babies in the 21st Century conducted by the Japanese

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Ministry of Health, Labour and Welfare. The survey was targeted at all families whose babies were born between 10–17 January and 10–17 July 2001, all over Japan ($n = 53\,575$)⁽¹³⁾. Baseline questionnaires were mailed to the targeted families when children were 6 months of age and were returned by 47 015 families (87.8% response rate). Follow-up questionnaires were annually sent to the families who responded at baseline. The data were also linked individually to birth records from vital statistics of Japan. A detailed description of the survey is available elsewhere⁽¹⁴⁾.

In the present study, we targeted children who were followed until the fourth survey (i.e. between the ages of 6 and 42 months). We restricted study participants to children born after 37 gestational weeks and those who were singleton births, because of the potential influence of prematurity and multiple births on children's health⁽¹⁵⁾. This resulted in excluding 2418 and 976 children. Children with missing information on infant feeding practices ($n = 742$) were also excluded. Among eligible children ($n = 43\,367$), 2761, 2038 and 1677 children were lost to follow-up at the second, third and fourth surveys, respectively. Finally, 1686 children were excluded due to missing information on hospitalization, leaving 35 215 children for analyses.

Infant feeding practices

The first survey included questions on infant feeding practices at age 6 months to determine whether children had been breast-fed, fed colostrum only or never breast-fed. The duration of breast-feeding was then queried. In the present study, we combined the categories of 'never breast-fed' and 'colostrum only' into a category of 'formula feeding only' because the number was small in the category of 'never breast-fed' and the duration of feeding colostrum was short. We made the categories of 'partial breast-feeding' and 'exclusive breast-feeding' by combining queries on breast-feeding and formula feeding. We further divided the category of 'partial breast-feeding' into three categories based on the duration of breast-feeding. We do not know when children started being partially breast-fed. Although the first survey was conducted at age 6 months, children breast-fed up to 7 months were included due to the timing of the response. Finally, we had five categories for infant feeding practices as follows: formula feeding only; partial breast-feeding (breast-feeding for 1–2 months, 3–5 months and 6–7 months)⁽¹⁴⁾; and exclusive breast-feeding at 6–7 months of age.

Children's hospitalization for asthma

We used hospitalization as our health outcome for three reasons. First, it is likely to be reported correctly by families⁽¹⁶⁾. Second, children's hospitalization is used as a marker of the disease severity⁽²⁾. Third, hospitalization may be a more valid outcome for children than hospital visit, because Japan has good access to hospitals for everyone but a medical doctor's judgement is necessary for

hospitalization. A history of hospitalization was queried in the second, third and fourth surveys (i.e. parental report of doctor's diagnosis). The question was whether or not children had been hospitalized during the past 12 months. Subsequent questions ascertained hospitalization for specific causes including asthma. We thus considered as cases children who were hospitalized for asthma at least once between the ages of 6 and 42 months.

Covariates

We selected the following characteristics as potential confounding factors. Maternal educational attainment was obtained in the second survey. We classified the original eight categories into four as follows: junior high school or others; high school; junior college (2 years) or vocational school; and university (4 years) or higher. Maternal smoking habit was ascertained at the first survey. Children's sex and parity were listed in the birth record. The information on parity (i.e. the number of deliveries) was used as proxy for the presence of older siblings. Persons who usually took care of children were asked about in the first survey, and we assumed children being taken care of by nursery teachers as attending day care.

Statistical analysis

To evaluate the impact of loss to follow-up, we first compared baseline characteristics between eligible children, children included in the analyses and those who were lost to follow-up between the first and fourth surveys.

We used logistic regression models to estimate crude odds ratios for the associations of infant feeding practices with children's hospitalization for asthma using the category of 'formula feeding only' as a reference (model 1). Next, we adjusted for maternal factors (i.e. educational attainment and smoking habit; model 2). We then additionally adjusted for children's factors (i.e. sex, day-care attendance and presence of older siblings) in the final model (model 3). Furthermore, instead of using the five infant feeding categories, we examined a dose–response relationship between breast-feeding duration (i.e. 0 months, 1 month, 2 months, 3 months, 4 months, 5 months and 6–7 months) and children's hospitalization for asthma, adjusting for the same set of covariates.

In sensitivity analyses, we further adjusted for paternal annual income (as a continuous variable) in addition to the same set of covariates in model 3 to examine the potential impacts from familial socio-economic status as suggested in a previous study⁽¹⁷⁾. Furthermore, we performed the same analyses excluding asthma cases at the second survey (i.e. between the ages of 6 and 18 months), because diagnosing asthma could be difficult at an earlier age.

All confidence intervals were calculated at the 95% level. The statistical software package STATA SE version 12 was used for all analyses.

The study was approved by the Institutional Review Board of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences (number 881).

Results

Table 1 shows the baseline characteristics of eligible children at the first survey, children in the analyses and those who were lost to follow-up between the first and fourth surveys. Children who were lost to follow-up were more likely than the eligible children to have been formula-fed and to have mothers who smoked.

Table 2 shows the demographic characteristics of children included in the analyses according to infant feeding practices. Children who had been exclusively breast-fed at 6–7 months of age were more likely to have mothers with a higher academic attainment and who were non-smokers than those who had been formula-fed. In addition, children who had been exclusively breast-fed at 6–7 months of age were less likely to attend day care and were more likely to have older siblings.

Table 3 shows the results for the associations between infant feeding practices and children's hospitalization for asthma between the ages of 6 and 42 months. After adjusting for the covariates, the protective associations were marginally significant in models 2 and 3. The adjusted OR was 0.77 (95% CI 0.56, 1.06) for exclusive breast-feeding at 6–7 months of age in the final model (model 3). One-month longer duration of breast-feeding was associated with a 4% decreased risk of hospitalization for asthma (OR = 0.96; 95% CI 0.92, 0.99).

In the sensitivity analyses, even after we further adjusted for paternal income in addition to the covariates in model 3, the main findings for the associations with hospitalization due to asthma did not change substantially (data not shown). When we conducted the analysis with the same covariates in model 3 excluding the outcome at the second survey, the estimates were still protective but less precise. The OR for exclusive breast-feeding at 6–7 months of age was 0.88 (95% CI 0.61, 1.26). The dose–response relationship turned to be marginally significant (OR = 0.97; 95% CI 0.93, 1.01).

Discussion

We examined the effects of breast-feeding on children's hospitalization for asthma between the ages of 6 and 42 months using a large Japanese nationwide data set. We found that exclusive breast-feeding at 6–7 months of age was associated with decreased risk of hospitalization for asthma. Moreover, we observed a dose–response relationship between breast-feeding duration and hospitalization for asthma. These protective associations did not change substantially in the sensitivity analyses.

A past study in Japan suggested that exclusive breast-feeding was associated with increased risk of asthma among children⁽¹⁰⁾. By contrast, a recent study in New Zealand showed that exclusive breast-feeding protected against asthma up to 6 years of age⁽⁶⁾. These inconsistencies may be derived from variations in study designs and settings (e.g. children's age, the duration of exclusive breast-feeding, different environments surrounding children, residual confounding or reverse causation). From a

Table 1 Baseline characteristics of eligible children, children in the analyses and children lost to follow-up between the first and fourth surveys, Longitudinal Survey of Babies in the 21st Century, Japan

	Eligible children (<i>n</i> 43 367)		Children included in the analyses (<i>n</i> 35 215)		Children lost to follow-up until 4th survey (<i>n</i> 6466)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Sex						
Boys	22 364	51.6	18 186	51.6	3351	51.8
Girls	21 003	48.4	17 029	48.4	3115	48.2
Presence of older siblings						
None	21 467	49.5	17 380	49.4	3241	50.1
≥1	21 900	50.5	17 835	50.7	3225	49.9
Maternal smoking habit						
No	35 613	82.1	29 916	85.0	4313	66.7
Yes	7515	17.3	5158	14.7	2072	32.0
Missing	239	0.6	141	0.4	81	1.3
Day-care attendance						
No	41 678	96.1	33 955	96.4	6098	94.3
Yes	1689	3.9	1260	3.6	368	5.7
Infant feeding practices						
Formula feeding only	2597	6.0	1920	5.5	544	8.4
Partial breast-feeding, breast-feeding duration						
1–2 months	8586	19.8	6401	18.2	1834	28.4
3–5 months	8615	19.9	6884	19.6	1409	21.8
6–7 months	14 048	32.4	11 933	33.9	1604	24.8
Exclusive breast-feeding at 6–7 months of age	9521	22.0	8077	22.9	1075	16.6

Table 2 Demographic characteristics of children included in the analyses by infant feeding practices (*n* 35 215), Longitudinal Survey of Babies in the 21st Century, Japan

	Formula feeding only (<i>n</i> 1920)		Partial breast-feeding, breast-feeding duration						Exclusive breast-feeding at 6–7 months of age (<i>n</i> 8077)	
	<i>n</i>	%	1–2 months (<i>n</i> 6401)		3–5 months (<i>n</i> 6884)		6–7 months (<i>n</i> 11 933)		<i>n</i>	%
			<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Sex										
Boys	1011	52.7	3325	52.0	3427	49.8	6332	53.1	4091	50.7
Girls	909	47.3	3076	48.1	3457	50.2	5601	46.9	3986	49.4
Presence of older siblings										
No	959	50.0	3116	48.7	3604	52.4	6451	54.1	3250	40.2
≥1	961	50.1	3285	51.3	3280	47.7	5482	45.9	4827	59.8
Maternal smoking habit										
No	1391	72.5	4591	71.7	5614	81.6	10 860	91.0	7460	92.4
Yes	515	26.8	1780	27.8	1241	18.0	1029	8.6	593	7.3
Missing	14	0.7	30	0.5	29	0.4	44	0.4	24	0.3
Day-care attendance										
No	1825	95.1	6070	94.8	6538	95.0	11 515	96.5	8007	99.1
Yes	95	5.0	331	5.2	346	5.0	418	3.5	70	0.9
Maternal educational attainment										
University or higher	116	6.0	530	8.3	847	12.3	2116	17.7	1456	18.0
Junior college	618	32.2	2259	35.3	2873	41.7	5446	45.6	3718	46.0
High school	1012	52.7	3182	49.7	2890	42.0	4066	34.1	2696	33.4
Junior high school or others	163	8.5	396	6.2	239	3.5	252	2.1	163	2.0
Missing	11	0.6	34	0.5	35	0.5	53	0.4	44	0.5

Table 3 Associations of infant feeding practices with hospitalization for asthma in children between the ages of 6 and 42 months (*n* 35 215), Longitudinal Survey of Babies in the 21st Century, Japan

Infant feeding practice	Asthma cases		Model 1 (<i>n</i> 35 215)		Model 2 (<i>n</i> 34 902)		Model 3 (<i>n</i> 34 902)	
	<i>n</i>	%	OR	95% CI	OR	95% CI	OR	95% CI
Formula feeding only (<i>n</i> 1920)	57	3.0	1	Ref.	1	Ref.	1	Ref.
Partial breast-feeding, breast-feeding duration								
1–2 months (<i>n</i> 6401)	171	2.7	0.90	0.66, 1.22	0.91	0.67, 1.23	0.90	0.66, 1.23
3–5 months (<i>n</i> 6884)	156	2.3	0.76	0.56, 1.03	0.80	0.59, 1.10	0.82	0.60, 1.12
6–7 months (<i>n</i> 11 933)	239	2.0	0.67	0.50, 0.90	0.75	0.56, 1.01	0.76	0.56, 1.03
Exclusive breast-feeding at 6–7 months of age (<i>n</i> 8077)	164	2.0	0.68	0.50, 0.92	0.77	0.56, 1.05	0.77	0.56, 1.06

Model 1: no adjustment was performed.

Model 2: maternal factors (educational attainment and smoking habit) were adjusted for.

Model 3: children's factors (sex, day-care attendance and presence of older siblings) in addition to maternal factors were adjusted for.

perspective of mechanisms to prevent asthma, children may receive benefits from excluding infant formula, foods or other drinks containing potential allergenic factors as well as from consuming anti-inflammatory, nutritional or other elements in breast milk^(6,18–20).

A major strength of the present study is that we used a large nationally representative sample of children^(6,7,10,11). In addition, the response rate at baseline was very high (i.e. 87.8%), which strengthens the validity of our findings. The data on duration of breast-feeding should be accurate because the information on feeding practices was collected at when the children's age was 6–7 months.

An important limitation of the present study is that we do not examine the maternal or children's history of allergy. Although influence by maternal history of allergy is conflicting^(4,21,22), a meta-analysis suggested that breast-feeding

was protective for asthma in early childhood irrespective of maternal allergy adjustment⁽⁴⁾. Moreover, maternal or children's history of allergy was found to affect decisions regarding breast-feeding⁽²³⁾, which may attenuate the protective associations of breast-feeding with asthma among children if those at higher risk of asthma because of familial history of allergy or children's eczema are more likely to be breast-fed.

We have the following weakness on the breast-feeding information. First, we could not evaluate the effect of breast-feeding beyond 6–7 months of age. Second, we could not ascertain through the questionnaire whether children were given any liquids or solid foods until age 6 months, although weaning is recommended to be started at 5–6 months of age in Japan⁽²⁴⁾. Thus, predominantly breast-fed children may be included in the category of

'exclusive breast-feeding', resulting in the underestimation of the present result.

Medical doctors may have difficulty in diagnosing asthma for young children⁽¹⁵⁾. Although children who had severe asthma are unlikely to be diagnosed as respiratory tract infections, children with asthma may have been misdiagnosed as respiratory tract infections but not as asthma. In addition, children who had wheezing due to respiratory tract infections could be misdiagnosed as asthma. These misclassifications, however, would be non-differential, moving the effect estimates toward the null. In the present study, we conducted sensitivity analysis excluding asthma cases between the ages of 6 and 18 months, and the estimates were still protective.

Furthermore, the loss of participant children from the first survey to the fourth survey should be considered. As shown in Table 1, children who were lost to follow-up were less likely to have been breast-fed and more likely to have mothers who smoked, compared with the eligible children. Such a differential loss would underestimate the protective effects of breast-feeding on hospitalization for asthma.

Conclusion

In conclusion, we found beneficial effects of breast-feeding on hospitalization for asthma in early childhood.

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