

Association of active and passive smoking with allergic disorders in pregnant Japanese women: baseline data from the Osaka Maternal and Child Health Study

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Background: Evidence remains inconclusive as to whether smoking is a risk factor for allergic disorders in adults.

Objective: To investigate the relationship between active and passive smoking exposure and allergic disorders in pregnant Japanese women.

Methods: This cross-sectional study included 1,002 pregnant women. Participants were classified as having asthma after the age of 18 years if they had used an asthma medication at any time after reaching the age of 18 years. Current atopic eczema and allergic rhinitis (including cedar pollinosis) were defined as being present if participants had received any drug treatment during the previous 12 months. Adjustment was made for age; gestation; parity; family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income; education; and the mite antigen level in house dust.

Results: Current smoking, but not environmental tobacco smoke exposure, was independently related to an increased prevalence of asthma after the age of 18 years (adjusted odds ratio [OR], 2.66; 95% confidence interval [CI], 1.30–5.38). A significant positive association of current passive smoking exposure at home (adjusted OR, 1.89; 95% CI, 1.10–3.30) and at work (adjusted OR, 2.50; 95% CI, 1.29–4.76) with the prevalence of current allergic rhinitis was observed, whereas no measurable association with active smoking exposure was found. Neither active nor passive smoking was statistically significantly related to the prevalence of current atopic eczema.

Conclusions: These findings suggest that active smoking and environmental tobacco smoke exposure may increase the likelihood of asthma and allergic rhinitis, respectively, in pregnant Japanese women.

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INTRODUCTION

Although many epidemiologic studies^{1–16} have investigated a possible association between exposure to tobacco smoke and allergic disorders, evidence remains inconclusive as to

whether smoking is a risk factor for allergic disorders, especially in adults. A prospective study¹ in Swedish adults showed that current and former smoking presented significant risk factors for self-reported asthma compared with nonsmok-

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ing. The National Population Health Survey in Canada demonstrated that the incidence of asthma was not related to smoking status in males and females 12 years and older, although a significant positive association between smoking and asthma was observed among females who had pets at home.² The Nurses' Health Study found that current smokers were at lower risk for asthma than women who had never smoked and that the risk of asthma in past smokers was initially elevated but decreased as the time since they quit smoking increased.³ The healthy smoker effect may have concealed true increases in the risk of asthma in relation to smoking in that study, however. Few epidemiologic studies^{4-6,15,16} have reported a relationship between smoking habits and atopic eczema and allergic rhinitis in adults.

On the other hand, limited epidemiologic studies^{5,6,17-21} have examined the relationship between exposure to environmental tobacco smoke (ETS) and allergic disorders in adults. A cross-sectional study¹⁷ in Swiss adults who had never smoked found that passive smoking exposure at home or at work was significantly associated with an increased prevalence of physician-diagnosed asthma, with evidence of a dose-dependent increase with hours per day of exposure. There was no measurable relationship between exposure to ETS and allergic rhinitis in cross-sectional studies in Switzerland¹⁷ and Singapore⁶ or in the European Community Respiratory Health Survey.²¹

In view of the scarcity of epidemiologic information regarding the relationship between exposure to smoking and allergic disorders in Japan, we analyzed baseline data from the Osaka Maternal and Child Health Study to investigate the effects of active and passive smoking on the prevalence of asthma, atopic eczema, and allergic rhinitis in pregnant Japanese women using a cross-sectional design. In pregnant women, a significant positive association between active, but not passive, smoking and total serum IgE levels was reported in a previous study,²² whereas spousal smoking was significantly positively related to maternal total IgE levels in France.²³

METHODS

Study Population

The Osaka Maternal and Child Health Study is an ongoing prospective cohort study that investigates preventive and risk factors for maternal and child health problems, such as allergic disorders and postpartum depression. The Osaka Maternal and Child Health Study consists of a baseline survey completed by pregnant women and several postnatal follow-up surveys. In Japan, when women become pregnant, they notify the municipality of the domicile of the conception and the municipality provides them with a maternal and child health handbook. Eligible women were those who became pregnant in Neyagawa City, which is 1 of the 44 municipalities in Osaka Prefecture, a metropolis in Japan with a total population of approximately 8.8 million. Between November 1, 2001, and March 31, 2003, all pregnant women received a set of leaflets explaining the study, an application form, and a self-addressed and stamped return envelop along with the

maternal and child health handbook from the Neyagawa City government. Research technicians asked all of the eligible women to participate in this study by telephone, excluding pregnant women who had already returned the application form to the data management center. Of the 3,639 eligible women, 627 (17.2%) in Neyagawa City took part in this study. Eight pregnant women who did not live in Neyagawa City but who had become aware of the study at an obstetric clinic before August 2002 decided by themselves to participate in this study. Also, there were 77 participants who received explanations regarding the Osaka Maternal and Child Health Study from public health nurses in 6 other municipalities between August 1, 2002, and March 31, 2003. Between October 1, 2002, and March 31, 2003, 290 participants were recruited from a university hospital and 3 obstetric hospitals in 3 other municipalities; these women were recommended for participation in the Osaka Maternal and Child Health Study by an obstetrician. Finally, a total of 1,002 pregnant women gave their fully informed consent in writing and completed a baseline survey. The ethics committees of the Osaka City University School of Medicine and the Osaka Prefectural Institute of Public Health approved this study.

Measurements

In the baseline survey, each participant filled out a set of 2 self-administered questionnaires, put a passive diffusion sampling tube on her clothes for 24 hours on a usual day to measure concentrations of nitrogen dioxide and formaldehyde, and collected 2 dust samples from a 1-m² area of the bedclothes and flooring for 1 minute using a vacuum cleaner fitted with a collection apparatus. Participants then mailed these materials to the data management center. Research technicians completed missing or illogical data by telephone interview.

One of the self-administered questionnaires elicited information on age; gestation; parity; indoor domestic pets; family income; education; personal history of asthma, atopic eczema, and allergic rhinitis; family history of asthma, atopic eczema, and allergic rhinitis; smoking habits; and passive smoking exposure. Current asthma, atopic eczema, and allergic rhinitis (including cedar pollinosis) were defined as being present if participants had been treated with medications at some time in the previous 12 months, although data on the types of medications and the duration of their use were not available. Participants were classified as having asthma after the age of 18 years if they had used an asthma medication at any time after reaching the age of 18 years. A family history of asthma, atopic eczema, and allergic rhinitis (including cedar pollinosis) was considered to be present if 1 or more parents or siblings of the study participant had manifested any of these allergic disorders.

Antigen levels from extracts of fine dust fractions were measured using a double-antibody sandwich enzyme-linked immunosorbent assay using a soluble antigen prepared from whole *Dermatophagoides farinae* mite bodies as a reference standard and were expressed as antigen equivalent in micro-

grams per square meter of surface area (Mitey checker; Shinto Fine Co Ltd, Osaka, Japan).^{24,25} Antigen levels were semiquantitatively classified with scores of $-$ ($<2 \mu\text{g}/\text{m}^2$), $\pm$ ($5 \mu\text{g}/\text{m}^2$), $+$ ($10\text{--}15 \mu\text{g}/\text{m}^2$), and $++$ ($>35 \mu\text{g}/\text{m}^2$). In the present study, we used only antigen levels in the sample collected from the bedclothes because the correlation between antigen levels from the bedclothes and flooring was almost collinear (Spearman correlation coefficient = 0.54; $P < .0001$). The other instrument was a validated self-administered diet history questionnaire. Data regarding diet and concentrations of formaldehyde and nitrogen dioxide were not used in this study.

Statistical Analysis

Multiple logistic regression analysis was used to estimate adjusted odds ratios (ORs) and their 95% confidence intervals (CIs) for allergic disorders relative to active and passive smoking exposure. The analysis of the effects of ETS exposure at home and at work on allergic disorders was based only on the 697 participants who had never smoked. Age; gestation; parity; family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income; education; and the mite antigen level in house dust were selected a priori as potential confounding factors. Cigarette smoking was classified into 3 categories (never, former, and current), pack-years of smoking into 3 categories (none, 0.1–4.9, and ≥ 5.0), passive smoking at home into 3 categories (never, former, and current), pack-years of passive smoking at home into 3 categories (none, 0.1–4.9, and ≥ 5.0), passive smoking at work into 3 categories (never, former, and current), years of passive smoking at work into 3 categories (none, 1–5, and ≥ 6), age into 2 categories (<30 and ≥ 30 years), gestation into 2 categories (<18 and ≥ 18 weeks), parity into 2 categories (0 and ≥ 1), family income into 3 categories ($<\text{¥}4,000,000$, $\text{¥}4,000,000\text{--}5,999,999$, and $\geq \text{¥}6,000,000$ per year), education into 3 categories (<13 , 13–14, and ≥ 15 years), and dust mite antigen levels into 3 categories ($-$, $\pm$, and $+$ or $++$). To examine whether the prevalence increased with smoking status, trend of association was evaluated using a logistic regression model assigning scores to the levels of the independent variable. Two-sided $P < .05$ was considered statistically significant. All computations were performed using a software package (SAS version 8.2; SAS Institute Inc, Cary, NC).

RESULTS

The prevalences of asthma, atopic eczema, and allergic rhinitis (including cedar pollinosis) in the previous 12 months were 2.1%, 5.7%, and 14.1%, respectively, in 1,002 pregnant women. Regarding asthma, we were more interested in associations with asthma after the age of 18 years, which had a prevalence of 4.7%, than those with current asthma because the prevalence of current asthma was too low to have substantial statistical power. Of the 47 participants with asthma after the age of 18 years, 21 (44.7%) had received drug treatment for asthma between birth and the age of 12 years. Also, between birth and the age of 12 years, 52.6% of

participants currently with atopic eczema had received drug treatment for atopic eczema, and 10.6% of those with current allergic rhinitis had received drug treatment for rhinitis. Table 1 gives the distribution of selected factors in the 1,002 participants. The mean participant age was 29.8 years. Approximately 50% of the women were enrolled by the 17th week of gestation and had a parity of 1 or more. Many more participants had a family history of allergic rhinitis than a family history of asthma or atopic eczema. High mite antigen levels of $10 \mu\text{g}/\text{m}^2$ or more were observed in 27% of participants.

Table 2 presents crude and adjusted ORs and 95% CIs in relation to active smoking status in 1,002 pregnant women. Compared with never smoking, current smoking was independently associated with a 2.7-fold increased prevalence of asthma after the age of 18 years, whereas former smoking was not measurably related to the prevalence of asthma after the age of 18 years after adjustment for age; gestation; parity; family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income; education; and the mite antigen level in house dust. A clear exposure-related relationship between cigarette smoking status and the prevalence of asthma after the age of 18 years was observed ($P = .007$ for linear trend). A significant increased crude prevalence of asthma after the age of 18 years was found for smokers with 0.1 or more pack-years, showing a clear dose-response association with cumulative consumption of cigarettes. In the

Table 1. Distribution of Selected Factors in 1,002 Pregnant Women, Osaka Maternal and Child Health Study, Japan

Factor	Patients, No. (%)
Age, y	
<30	473 (47.2)
≥ 30	529 (52.8)
Gestation, wk	
<18	508 (50.7)
≥ 18	494 (49.3)
Parity of ≥ 1	513 (51.2)
Family history of asthma	101 (10.1)
Family history of atopic eczema	138 (13.8)
Family history of allergic rhinitis	429 (42.8)
Indoor domestic pets (cats, dogs, birds, or hamsters)	114 (11.4)
Family income, ¥/y*	
<4,000,000	301 (30.0)
4,000,000–5,999,999	403 (40.2)
$\geq 6,000,000$	298 (29.7)
Education, y	
<13	323 (32.2)
13–14	413 (41.2)
≥ 15	266 (26.6)
Mite antigen level in house dust†	
$-$	436 (43.5)
$\pm$	297 (29.6)
$+$ or $++$	269 (26.9)

*US \$1 = ¥104.

†See the "Measurements" subsection for definitions of the antigen levels.

Table 2. Crude and Adjusted ORs and 95% CIs for Allergic Disorders in Relation to Smoking Status in 1,002 Pregnant Women, Osaka Maternal and Child Health Study, Japan

	Prevalence, No./total No. (%)	OR (95% CI)	
		Crude	Adjusted*
Asthma after age 18 y			
Cigarette smoking			
Never	23/697 (3.3)	1.00	1.00
Former	7/121 (5.8)	1.80 (0.70–4.09)	1.44 (0.54–3.44)
Current	17/184 (9.2)	2.98 (1.54–5.69)	2.66 (1.30–5.38)
<i>P</i> for linear trend	NA	.0009	.007
Pack-years of smoking			
None	23/697 (3.3)	1.00	1.00
0.1–4.9	11/143 (7.7)	2.44 (1.12–5.02)	2.16 (0.95–4.66)
≥5.0	13/162 (8.0)	2.56 (1.23–5.09)	2.10 (0.96–4.43)
<i>P</i> for linear trend	NA	.004	.03
Current atopic eczema			
Cigarette smoking			
Never	45/697 (6.5)	1.00	1.00
Former	7/121 (5.8)	0.89 (0.36–1.90)	1.02 (0.40–2.31)
Current	5/184 (2.7)	0.41 (0.14–0.94)	0.41 (0.14–1.03)
<i>P</i> for linear trend	NA	.06	.11
Pack-years of smoking			
None	45/697 (6.5)	1.00	1.00
0.1–4.9	5/143 (3.5)	0.53 (0.18–1.23)	0.52 (0.17–1.28)
≥5.0	7/162 (4.3)	0.65 (0.27–1.39)	0.78 (0.30–1.79)
<i>P</i> for linear trend	NA	.18	.36
Current allergic rhinitis			
Cigarette smoking			
Never	97/697 (13.9)	1.00	1.00
Former	21/121 (17.4)	1.30 (0.76–2.14)	1.24 (0.71–2.10)
Current	23/184 (12.5)	0.88 (0.53–1.42)	0.98 (0.57–1.62)
<i>P</i> for linear trend	NA	.83	.91
Pack-years of smoking			
None	97/697 (13.9)	1.00	1.00
0.1–4.9	22/143 (15.4)	1.13 (0.67–1.83)	1.18 (0.68–1.98)
≥5.0	22/162 (13.6)	0.97 (0.58–1.57)	1.01 (0.58–1.69)
<i>P</i> for linear trend	NA	.97	.85

Abbreviations: CI, confidence interval; NA, not applicable; OR, odds ratio.

*Based on multiple logistic regression controlling for age (<30 and ≥30 years); gestation (<18 and ≥18 weeks); parity (0 and ≥1); family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income (<¥4,000,000, ¥4,000,000–5,999,999, and ≥¥6,000,000 per year); education (<13, 13–14, and ≥15 years); and mite antigen level in house dust (–, ±, and + or ++).

multivariate model, however, the positive association with 0.1 to 4.9 and 5.0 or more pack-years of smoking fell just short of the significance level, although the trend was statistically significant. Active smoking status and pack-years of smoking were not statistically significantly associated with the prevalence of current atopic eczema and allergic rhinitis.

Table 3 provides crude and adjusted ORs and 95% CIs for allergic disorders according to passive smoking exposure at home in the sample of 697 never-smoking pregnant women. After controlling for the potential confounding factors under study, there was no material association between passive smoking at home and the prevalence of asthma after the age of 18 years or current atopic eczema, although current passive smoking at home showed a tendency toward a positive relationship with current eczema ($P = .07$ for linear trend).

Current passive smoking at home was independently associated with an increased prevalence of current allergic rhinitis; a positive linear trend was significant ($P = .02$ for linear trend). Also, 0.1 to 4.9 pack-years of passive smoking at home were significantly related to a 1.9-fold increased prevalence of current allergic rhinitis, although the association with 5.0 or more pack-years of passive smoking at home was not statistically significant.

Results for passive smoking in the workplace are given in Table 4. Passive smoking at work was not statistically significantly associated with the prevalence of asthma after the age of 18 years and current atopic eczema. Current passive exposure to tobacco smoke in the workplace was independently associated with an increased prevalence of current allergic rhinitis, but a positive linear trend was not statisti-

Table 3. Crude and Adjusted ORs and 95% CIs for Allergic Disorders in Relation to Passive Smoking Status at Home in 697 Never-Smoking Pregnant Women, Osaka Maternal and Child Health Study, Japan

	Prevalence, No./total No. (%)	OR (95% CI)	
		Crude	Adjusted*
Asthma after age 18 y			
Passive smoking at home			
Never	5/249 (2.0)	1.00	1.00
Former	6/169 (3.6)	1.80 (0.53–6.33)	1.62 (0.46–5.88)
Current	12/279 (4.3)	2.19 (0.80–6.97)	1.90 (0.65–6.32)
<i>P</i> for linear trend	NA	.15	.26
Pack-years of passive smoking at home			
None	5/249 (2.0)	1.00	1.00
0.1–4.9	10/211 (4.7)	2.43 (0.85–7.90)	2.21 (0.74–7.43)
≥5.0	8/237 (3.4)	1.71 (0.56–5.71)	1.42 (0.44–4.95)
<i>P</i> for linear trend	NA	.39	.62
Current atopic eczema			
Passive smoking at home			
Never	13/249 (5.2)	1.00	1.00
Former	11/169 (6.5)	1.26 (0.54–2.90)	1.28 (0.53–3.05)
Current	21/279 (7.5)	1.48 (0.73–3.09)	2.02 (0.95–4.49)
<i>P</i> for linear trend	NA	.28	.07
Pack-years of passive smoking at home			
None	13/249 (5.2)	1.00	1.00
0.1–4.9	16/211 (7.6)	1.49 (0.70–3.23)	1.70 (0.76–3.84)
≥5.0	16/237 (6.8)	1.31 (0.62–2.84)	1.64 (0.74–3.72)
<i>P</i> for linear trend	NA	.49	.22
Current allergic rhinitis			
Passive smoking at home			
Never	25/249 (10.0)	1.00	1.00
Former	25/169 (14.8)	1.56 (0.86–2.82)	1.48 (0.80–2.73)
Current	47/279 (16.9)	1.82 (1.09–3.09)	1.89 (1.10–3.30)
<i>P</i> for linear trend	NA	.03	.02
Pack-years of passive smoking at home			
None	25/249 (10.0)	1.00	1.00
0.1–4.9	37/211 (17.5)	1.91 (1.11–3.32)	1.92 (1.10–3.40)
≥5.0	35/237 (14.8)	1.55 (0.90–2.71)	1.53 (0.87–2.73)
<i>P</i> for linear trend	NA	.13	.16

Abbreviations: CI, confidence interval; NA, not applicable; OR, odds ratio.

*Based on multiple logistic regression controlling for age (<30 and ≥30 years); gestation (<18 and ≥18 weeks); parity (0 and ≥1); family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income (<¥4,000,000, ¥4,000,000–5,999,999, and ≥¥6,000,000 per year); education (<13, 13–14, and ≥15 years); and mite antigen level in house dust (–, ±, and + or ++).

cally significant. No significant dose-related association was found between years of passive smoking at work and the prevalence of current allergic rhinitis.

DISCUSSION

In the analysis of baseline data from the prospective Osaka Maternal and Child Health Study among pregnant Japanese women, we found that current smoking, but not ETS exposure, was independently associated with an increased prevalence of asthma after the age of 18 years. However, a significant positive relationship between current passive smoking exposure at home and at work, but not active smoking, and the prevalence of current allergic rhinitis was observed. Neither active nor passive smoking was statistically significantly related to the prevalence of current atopic eczema.

The present findings are in agreement with previous observations^{1,7–12} in adults showing a positive association between active smoking and asthma in both sexes or in women only but at variance with other studies showing an inverse^{3,5} or no¹⁶ association. The Obstructive Lung Disease in Northern Sweden Study¹ demonstrated that between 1986 and 1992, the period under study, 78 individuals who had been smokers in 1986 developed asthma. Of those 78 individuals, 21 stopped smoking in 1992. If the smoking habits in 1992 were used as independent variables, the effect of former smoking as a risk factor for asthma would increase and the effect of current smoking would decrease compared with smoking habits in 1986.¹ In the present study, the adjusted OR for comparison of active former smoking with never

Table 4. Crude and Adjusted ORs and 95% CIs for Allergic Disorders in Relation to Passive Smoking Status in the Workplace in 697 Never-Smoking Pregnant Women, Osaka Maternal and Child Health Study, Japan

	Prevalence, No./total No. (%)	OR (95% CI)	
		Crude	Adjusted*
Asthma after age 18 y			
Passive smoking at work			
Never	11/277 (4.0)	1.00	1.00
Former	9/344 (2.6)	0.65 (0.26–1.59)	0.62 (0.23–1.58)
Current	3/76 (4.0)	0.99 (0.22–3.28)	1.12 (0.24–3.98)
P for linear trend	NA	.66	.71
Years of passive smoking at work			
None	11/277 (4.0)	1.00	1.00
1–5	6/240 (2.5)	0.62 (0.21–1.66)	0.62 (0.20–1.73)
≥6	6/180 (3.3)	0.83 (0.28–2.23)	0.82 (0.26–2.34)
P for linear trend	NA	.63	.61
Current atopic eczema			
Passive smoking at work			
Never	21/277 (7.6)	1.00	1.00
Former	21/344 (6.1)	0.79 (0.42–1.49)	0.91 (0.46–1.78)
Current	3/76 (4.0)	0.50 (0.12–1.51)	0.33 (0.07–1.09)
P for linear trend	NA	.24	.15
Years of passive smoking at work			
None	21/277 (7.6)	1.00	1.00
1–5	18/240 (7.5)	0.99 (0.51–1.90)	0.98 (0.49–1.95)
≥6	6/180 (3.3)	0.42 (0.15–1.00)	0.43 (0.15–1.09)
P for linear trend	NA	.09	.13
Current allergic rhinitis			
Passive smoking at work			
Never	39/277 (14.1)	1.00	1.00
Former	38/344 (11.1)	0.76 (0.47–1.22)	0.71 (0.43–1.17)
Current	20/76 (26.3)	2.18 (1.17–3.99)	2.50 (1.29–4.76)
P for linear trend	NA	.13	.11
Years of passive smoking at work			
None	39/277 (14.1)	1.00	1.00
1–5	28/240 (11.7)	0.81 (0.48–1.35)	0.80 (0.47–1.37)
≥6	30/180 (16.7)	1.22 (0.72–2.04)	1.21 (0.69–2.11)
P for linear trend	NA	.54	.62

Abbreviations: CI, confidence interval; NA, not applicable; OR, odds ratio.

*Based on multiple logistic regression controlling for age (<30 and ≥30 years); gestation (<18 and ≥18 weeks); parity (0 and ≥1); family history of asthma, atopic eczema, and allergic rhinitis; indoor domestic pets; family income (<¥4,000,000, ¥4,000,000–5,999,999, and ≥¥6,000,000 per year); education (<13, 13–14, and ≥15 years); and mite antigen level in house dust (–, ±, and + or ++).

having smoked was 1.44 (95% CI, 0.54–3.44), whereas the corresponding OR for current smoking was 2.66 (95% CI, 1.30–5.38), although there were only 24 women with asthma after the age of 18 years who had ever smoked. We could not evaluate the potential effects of such a self-selection bias in our results. Two cross-sectional studies^{8,9} showed a higher prevalence of asthma among former smokers than among current smokers in males but not in females. Female patients with asthma may be less likely to quit smoking than their male counterparts. In our study, a significant positive dose-response relationship between pack-years of smoking and asthma after the age of 18 years, and a significant positive association with current smoking, may provide little support for the important effect of active smoking on asthma, although the adjusted ORs for 0.1 or more pack-years of smoking were not statistically significant.

Significant positive relationships between ever-smoking and the risk of noninfectious rhinitis and between former smoking and the prevalence of allergic rhinitis among men and women were observed in a prospective cohort study in Sweden⁴ and in a cross-sectional study in Singapore,⁶ respectively. Three previous cross-sectional studies in Sweden,⁵ Norway,¹⁴ and Switzerland¹⁵ showed that the prevalence of lifetime or current allergic rhinitis was highest in nonsmokers, intermediate in former smokers, and lowest in current smokers. All of these results contradicted our results. To our knowledge, only 1 of the cross-sectional studies, the one in Norway,¹⁴ investigated whether there was an association between active smoking and atopic eczema and found none. This is compatible with the present findings.

Two cross-sectional studies^{20,21} in European countries demonstrated that ETS exposure at work or outside the home, but

not at home, was significantly associated with an increased prevalence of asthma in males and females. A cross-sectional study¹⁹ in Sweden showed that workplace ETS exposure was significantly related to methacholine challenge-positive asthma that was reported to be symptomatic at work in men but not in women. A significantly increased OR for physician-diagnosed asthma in relation to domestic exposure to ETS was found only among males in a Swedish case-referent study.¹⁸ These findings are partially consistent with the present results. Patients with asthma may have been likely to avoid ETS exposure. Also, family members in a household with patients with asthma and office coworkers of patients with asthma may have altered their smoking habits. This hypothesis would have led to an underestimation of values in our results. In addition, it may be difficult to detect a clear positive association between passive smoking exposure and asthma in a population with few patients with asthma.

The present findings are at variance with the few previous observations^{6,17,21} showing no material relationship between ETS exposure and allergic rhinitis among adults of both sexes. The prevalence of allergic rhinitis is the highest of all allergic disorders in Japan.^{26–28} Exposure to cedar pollen is likely to be ubiquitous in the entire country. In a cross-sectional study of Japanese adolescents in Osaka, there was a marginally significant positive relationship between residences facing major roads and the prevalence of allergic rhinoconjunctivitis, which suggested interactive effects between air pollutants and sensitization to cedar pollen.²⁶ Many chemical agents in ETS are known, including nicotine, carbon monoxide, benzene, formaldehyde, and acrolein.²⁰ The joint effect of cedar pollen and ETS exposure may be indicated in this study. To our knowledge, no study has evaluated the relationship between exposure to ETS and atopic eczema in adults. No statistically significant association between parental smoking and atopic eczema was observed in a cross-sectional study of Swedish children aged 3 to 15 years.⁵

The present investigation had methodological advantages in that study participants were homogeneous in terms of all being pregnant and in that we obtained detailed data on active and passive smoking, such as the duration of tobacco exposure, although objective measurements of ETS exposure, such as salivary, serum, and urine cotinine levels, were not available. A modest correlation between self-reported passive smoking and biomarkers of ETS exposure was found in previous studies, however.^{29,30} Important weaknesses of this study should be taken into account when interpreting the results. Of a total of 3,639 eligible pregnant women in Neyagawa City, only 627 (17.2%) took part in this study. We were uncertain whether there was a difference between participants and nonparticipants in Neyagawa City because data on personal characteristics, such as age, socioeconomic status, and history of allergic disorders, among the nonparticipants were not available. Regarding the remaining 375 participants, we could not calculate the participation rate because the exact number of eligible women was not available. Also, we could not compare participants with nonparticipants in the 4 col-

laborating hospitals and 6 municipalities. Our participants were not representative of pregnant Japanese women in the general population, and the present findings may not be generalized. In fact, educational levels were higher in the present study population than in the general population. According to the 2000 population census of Japan,³¹ the proportions of women aged 30 to 34 years in Osaka Prefecture with years of education of less than 13, 13 to 14, 15 or more, and unknown were 49.2%, 32.3%, 13.6%, and 4.9%, respectively. Active smoking status in our participants was likely to be the same as that in the general population, however. In a nationwide nutritional survey in 1998, percentages of never, former, and current smoking in women aged 20 to 29 years were 76.0%, 4.9%, and 19.1%, respectively.³² It was not ascertained whether our study participants represented a different group in terms of passive smoking status and the confounders being studied. Because the definition of allergic disorders was based on drug treatment, there was probably a loss of milder cases of allergic disorders. In particular, females who want to become pregnant or who are pregnant might tend to avoid drugs. Patients with asthma might be aware of the possible ill effects of smoking exposure, owing to increased bronchial reactivity, whereas individuals with atopic eczema and allergic rhinitis might not be aware of such effects. The consequence would have given rise to an overestimation of our findings regarding asthma because of differential outcome misclassification and an underestimation of the results in relation to atopic eczema and allergic rhinitis due to nondifferential outcome misclassification. The nature of the present cross-sectional study prevents conclusions from being drawn about causality. In particular, we should be more cautious about our results related to asthma after the age of 18 years compared with those related to current eczema and rhinitis with respect to temporality. Approximately 90% of individuals with allergic rhinitis had not been treated with medications when they were 12 years or younger, whereas the onset of asthma occurred in childhood in approximately half of the patients with asthma. This fact may support a causal relationship between ETS exposure and allergic rhinitis.

This is the first epidemiologic study of the relationship between active and passive smoking exposure and allergic disorders in pregnant Japanese women. Further investigations with more precise exposure and outcome measurements are required to draw a conclusion regarding whether active smoking and ETS exposure increase the likelihood of asthma and allergic rhinitis, respectively, in adults.

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