

## Prevalence and Risk Factors of Allergic Rhinitis and Cedar Pollinosis among Japanese Men

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**Background.** Although recent reports show a worldwide increase in allergic diseases during the past 10–20 years, few epidemiological studies on secular trend and the age-specific prevalence of allergic rhinitis have been carried out in Japan. We conducted a study to clarify the age-specific prevalence of allergic rhinitis and cedar pollinosis to provide baseline data for a prospective study and to investigate the association of rhinitis with both environmental and personal factors among 2,307 Japanese men.

**Methods.** Allergic rhinitis was determined from self-reported allergic rhinitis or from the seasonal symptoms of the nose. Seasonal rhinitis was defined as symptoms evoked in the subjects from February to May. Cedar pollinosis was defined as the presence of cedar-specific IgE positivity among subjects with seasonal rhinitis.

**Results.** The prevalences of allergic rhinitis, seasonal rhinitis, and cedar pollinosis were 35.5, 28.8, and 11.0%, respectively. Age was a negative risk factor for all allergic conditions. Allergic family history and residence along a main street were strong risk factors for all allergic rhinitis.

**Conclusions.** The current prevalence of each rhinitis was higher than previously reported. The risk factors were similar for each allergic rhinitis except for a past history of atopy. ©1998 American Health Foundation and Academic Press

**Key Words:** allergic rhinitis; cedar pollinosis; Japan; prevalence; risk factors.

### INTRODUCTION

Recent reports have shown a worldwide increase of allergic diseases during the past 10–20 years [1–3]. Although allergic rhinitis is a common disease in Japan

among various allergic conditions, few reports have examined the increased trend for allergic rhinitis in Japan [4,5], and there have been few epidemiological studies conducted on the age-specific prevalence of allergic rhinitis [6].

The first purpose of this study was to estimate the current age-specific prevalence of allergic rhinitis and cedar pollinosis among male subjects living in an urban area in Japan as baseline data for a prospective study. The second objective was to examine the association of allergic rhinitis and cedar pollinosis with environmental and personal risk factors.

### MATERIALS AND METHODS

The subjects of this study were recruited from the population of the Sotetsu study, which is an ongoing prospective study to examine the associations between lifestyle factors and chronic illnesses, such as coronary heart disease, diabetes mellitus, and hypertension. Details of this study have been described elsewhere [7].

The subjects of the present study consisted of 2,307 male railway employees who underwent a health examination from February to May 1995 (mean age, 41.4 years; range, 19 to 65 years). Employees of this company, which was located in the vicinity of Tokyo, are required to receive a health examination at least once a year. This health examination consists of anthropometric measurements, urinalysis, blood pressure measurement, and physicians' interviews. The questionnaire about allergic rhinitis was distributed to the employees a few days before the examination and was collected at the time of the physicians' interviews. Missing data were filled in by the physicians at the interview, insofar as was possible.

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The questionnaire consisted of eight major questions about allergic conditions: "Have you ever suffered from allergic rhinitis?" (current, past, or never); "Have you ever been diagnosed as having an allergic disease, such as asthma, atopic dermatitis, drug rush, etc.?" (If yes, what?); "Have any of your relatives suffered from allergic diseases?" (If yes, who suffered from?); "Are you living near a factory or along a main street?" (factory or street); "What are your symptoms (sneezing, rhinorrhea, blocked nose, eye itching, watery eyes)?" (grade 1 to 5); and "When are your symptoms evoked?" (January to December, perennial, or vasomotoric). Although the last question required an answer only from subjects who had self-reported allergic rhinitis, several subjects who had responded with never had allergic rhinitis also responded to this question.

#### *Criteria of Allergic Rhinitis and Cedar Pollinosis*

Allergic rhinitis was defined on the basis of either of the following two criteria: (1) the subjects who reported current allergic rhinitis other than vasomotoric rhinitis ( $n = 775$ ) and (2) the subjects who did not report allergic rhinitis and who had nasal symptoms not attributable to the common cold and vasomotoric reaction ( $n = 45$ ). In order to validate the symptoms as allergy and not the common cold, all of the subjects with self-reported and/or with any symptoms were checked by means of a review of the medical records and/or by a personal telephone interview. Among the subjects with allergic rhinitis, those whose symptoms were evoked during the months from February to May were defined as seasonal rhinitis ( $n = 664$ ; 651 from the self-reported rhinitis and 13 from the seasonal symptoms only).

Among the subjects with allergic rhinitis, 358 permitted blood sampling in order to test for allergen-specific IgE antibodies. Cedar pollen, grass pollen, house dust, mites, and mold were examined by the FEIA (fluoroenzyme immunoassay) method (CAP RAST FEIA Kit; Pharmacia and Upjohn, Tokyo) in an external laboratory (Health Research Institute, Yokohama), and 14 persons were not examined for cedar-specific IgE antibody. The allergen-specific IgE was classified into seven groups (0–6), and a score of 2 or more (antibody  $\geq 0.35$  U<sub>A</sub>/ml) was regarded as positive for the antigen. Among 344 subjects, 286 were cedar-specific IgE positive, and 253 of these had nasal symptoms evoked from February to May. Cedar pollinosis was defined as a score of 2 or more for cedar pollen and nasal symptoms evoked during the months of pollination of cedar ( $n = 253$ ; mean age, 39.6 years; range, 20 to 60 years).

#### *Environmental and Personal Risk Factors*

Atopic past history was defined as positive when the subjects had previously suffered from bronchial asthma and/or atopic dermatitis. Allergic family history was

positive when he had one or more relatives who had suffered from any allergic diseases. Residential conditions (near a factory or along a main street) were used as environmental factors.

Other confounding factors, such as smoking status (current or non), alcohol use (current or non), and protein intake (frequencies of meat and egg intake of three or more times per week or not), were obtained from another routine questionnaire.

#### *Statistics*

The subjects were classified into four groups (<30, 30–39, 40–49,  $\geq 50$  years of age), and age-specific prevalences for allergic rhinitis and cedar pollinosis were calculated. As the subjects examined for IgE showed more serious symptoms of the nose or eyes than the individuals who were not examined ( $P < 0.0001$ ), in order to avoid overestimation the minimum value was used as the estimated prevalence, based on the assumption that the nonexamined subjects did not have cedar pollinosis.  $\chi^2$  tests were carried out in order to evaluate the differences in categorical data.  $P$  for trend with aging was calculated by means of the Mantel–Haenszel extended test. Multiple logistic regression analysis was employed in order to evaluate the associations of allergic rhinitis, seasonal rhinitis, and cedar pollinosis with environmental and personal risk factors. All computations were based on the use of the Statistical Analysis System, which is a statistical software package [8]. A  $P$  value less than 0.05 in the two-tailed test was defined as significant.

## RESULTS

The characteristics of the study population are shown in Table 1. Roughly equal numbers of persons appeared in each age stratum except for the youngest stratum. Sneezing and rhinorrhea were more frequent than the other three symptoms. Two hundred fourteen (9.3%) subjects had a past history of allergic conditions, such as asthma and atopic dermatitis, and 932 (40.4%) had a family history of allergy among parents, children, and/or siblings.

Allergic rhinitis was more common among the younger subjects (<40 years of age) (Table 2). Those with a personal or family history of allergic conditions were more likely to show allergic rhinitis than those without any allergic history. These two factors were significantly associated with allergic rhinitis independent of other variables. Although subjects who lived near a factory had a significantly ( $P < 0.05$ ) higher prevalence of allergic rhinitis than those who did not in the univariate analysis, the significance was eliminated after adjustment for other variables. Furthermore, individuals who lived along a main street had significantly ( $P = 0.001$ ) higher prevalences than those who did not

**TABLE 1**

Characteristics of the Subjects: Male Employees of a Railway Company ( $n = 2,307$ ), 1995

| Variables                       | Number | Proportion (%) |
|---------------------------------|--------|----------------|
| Age (years)                     |        |                |
| <30                             | 420    | 18.2           |
| 30–39                           | 602    | 26.1           |
| 40–49                           | 625    | 27.1           |
| ≥50                             | 660    | 28.6           |
| Self-reported allergic rhinitis |        |                |
| Yes                             | 795    | 34.5           |
| Symptoms <sup>a</sup>           |        |                |
| Sneezing                        | 810    | 35.1           |
| Rhinorrhea                      | 822    | 35.6           |
| Blocked nose                    | 736    | 31.9           |
| Eye itching                     | 747    | 32.4           |
| Watery eye                      | 531    | 23.0           |
| Past history of atopy           |        |                |
| Yes                             | 214    | 9.3            |
| Allergic family history         |        |                |
| Yes                             | 932    | 40.4           |
| Factory <sup>b</sup>            |        |                |
| Near                            | 222    | 9.6            |
| Main street <sup>c</sup>        |        |                |
| Along                           | 512    | 22.2           |

<sup>a</sup> The number of positive responses to each question does not match the number of self-reported positive allergic rhinitis cases, because several subjects who were not cases of self-reported allergic rhinitis answered this question.

<sup>b</sup> Missing data were excluded ( $n = 13$ ).

<sup>c</sup> Missing data were excluded ( $n = 13$ ).

and this association persisted after additional adjustment. The associations between seasonal rhinitis and risk factors were similar to those of allergic rhinitis except for a past history of atopy, which was not associated with seasonal rhinitis whether adjusted for or not.

The positive proportion of cedar pollen was very high among the IgE tests (83.1%). The age-specific estimated prevalence of cedar pollinosis ranged from 7.9 to 13.3%, and the individuals ages 50 years or more had a significantly lower risk compared with the youngest population. Family history and residence along a main street remained significant after adjustment for age, smoking status, alcohol use, meat and egg intake, and other variables shown in Table 3.

The associations of cedar pollinosis with other allergens are shown in Table 4. Compared with cedar pollen, there were lower levels of positivity observed for each allergen. The highest proportion of cedar pollinosis was found among grass pollen-positive people (79.3%).

## DISCUSSION

### Allergic Rhinitis

The prevalence of allergic rhinitis cited in the previous literature has varied according to race and age of

the subjects, criteria of allergic rhinitis, and the year of the research. Unfortunately, criteria for allergic rhinitis have not been established for the purpose of epidemiological research. Several studies have used self-reported symptoms as criteria for allergic rhinitis [9–12]. On the other hand, other studies have used a combination of symptoms and laboratory/clinical examinations, such as serum IgE levels, eosinophils in nasal discharge, and skin tests [4,6,13–15]. In the present study, we used self-reported data, which were validated by a review of the medical records or telephone interviews, as the criteria for allergic rhinitis.

For children, the prevalence of allergic rhinitis was from 13 to 25%, according to a self-reported questionnaire conducted in Japan [13,14]. For university students, Nakamura [4] reported the prevalence to be 32.5% in a cohort study based on self-reported symptoms only. Wuthrich et al. [6] showed several prevalences of allergic rhinitis: the prevalence of self-reported allergic rhinitis (including hay fever) was 17.9 and 18.3%, respectively. The prevalence of atopic rhinitis (rhinitis symptoms associated with atopy) was 13.5%, and the prevalence for current hay fever varied between 9.1% (questionnaire answers and a positive skin-prick test to at least one pollen), 11.2% (questionnaire answers and presence of atopy), and 14.2% (questionnaire answer only). Compared with these previous findings, our results (35.5%) showed a high prevalence of allergic rhinitis. Kihara et al. [15] used strict criteria, which were (1) positivity for 3 or 4 items among nasal symptoms (rhinorrhea, sneezing, nasal obstruction, and sense of slight fever) and (2) positivity for both eye itching and watery eyes. Based on these criteria, they obtained a prevalence of 4.8% among the male inhabitants of Oshima island who were ages 14 years or older. Even if we used the same criteria, the prevalence was higher among our subjects than on Oshima island (16.8% versus 4.8%, respectively).

Several explanations for the discrepancy between our result and those of others can be raised. In previous reports, the Japanese showed a higher prevalence of allergic rhinitis than Caucasians [3–5,13–15]. Racial differences may have an influence on the prevalence. However, our prevalence was higher than that of other studies in Japan. Our high response rate (100%) and complete validation check of the symptoms to distinguish them from the common cold may have contributed to the precision of diagnosis of allergic rhinitis and pushed up the prevalence to the higher level.

We also found that age-specific prevalence of allergic rhinitis decreased with increasing age (Table 2). Several reasons have been proposed by previous researchers, such as change in the home environment (Japanese style to Western style), westernization of the diet (increased frequency of protein intake), air pollution, and so on [1,2]. Although the frequencies of egg and meat

TABLE 2

Prevalence, Adjusted Odds Ratios (ORs),<sup>a</sup> and 95% Confidence Intervals (95% CIs) of Allergic and Seasonal Rhinitis: Male Employees of a Railway Company ( $n = 2,307$ ), 1995

| Variables                   | No. of allergic/seasonal rhinitis cases | Prevalence and <i>P</i> value of allergic/seasonal rhinitis (%) | OR of allergic/seasonal rhinitis (95% CI) |
|-----------------------------|-----------------------------------------|-----------------------------------------------------------------|-------------------------------------------|
| Age (years)                 |                                         |                                                                 |                                           |
| < 30                        | 185/141                                 | 44.0/33.6                                                       | Reference                                 |
| 30–39                       | 257/206                                 | 42.7/34.2                                                       | 1.05 (0.81, 1.38)/1.12 (0.85, 1.49)       |
| 40–49                       | 213/182                                 | 34.1/29.1                                                       | 0.71 (0.53, 0.93)/0.85 (0.64, 1.14)       |
| ≥50                         | 165/135                                 | 25.0/20.5                                                       | 0.44 (0.33, 0.59)/0.51 (0.37, 0.69)       |
| <i>P</i> value <sup>b</sup> |                                         | 0.001/0.001                                                     |                                           |
| Past history of atopy       |                                         |                                                                 |                                           |
| Yes                         | 108/72                                  | 50.5/33.6                                                       | 1.49 (1.10, 2.01)/0.98 (0.71, 1.34)       |
| No                          | 712/592                                 | 34.0/28.3                                                       | Reference                                 |
| <i>P</i> value              |                                         | 0.001/0.10                                                      |                                           |
| Allergic family history     |                                         |                                                                 |                                           |
| Yes                         | 447/358                                 | 48.0/38.4                                                       | 2.46 (2.05, 2.95)/2.18 (1.80, 2.63)       |
| No                          | 373/306                                 | 27.1/22.3                                                       | Reference                                 |
| <i>P</i> value              |                                         | 0.001/0.001                                                     |                                           |
| Factory <sup>c</sup>        |                                         |                                                                 |                                           |
| Near                        | 93/76                                   | 41.9/34.2                                                       | 1.23 (0.91, 1.66)/1.22 (0.89, 1.65)       |
| Non                         | 720/582                                 | 34.7/28.1                                                       | Reference                                 |
| <i>P</i> value              |                                         | 0.03/0.05                                                       |                                           |
| Main street <sup>d</sup>    |                                         |                                                                 |                                           |
| Along                       | 214/180                                 | 41.8/35.2                                                       | 1.38 (1.11, 1.71)/1.45 (1.16, 1.80)       |
| Non                         | 603/481                                 | 33.9/27.0                                                       | Reference                                 |
| <i>P</i> value.             |                                         | 0.001/0.001                                                     |                                           |

Note. *P* values were calculated by means of the  $\chi^2$  test.

<sup>a</sup> Adjustment for smoking status, alcohol use, frequency of meat and egg intake, and the variables on the table.

<sup>b</sup> Mantel–Haenszel extended test.

<sup>c</sup> Missing data were excluded ( $n = 13$ ).

<sup>d</sup> Missing data were excluded ( $n = 13$ ).

intake among younger (<40 years of age) and older ( $\geq 40$  years of age) persons are indeed different ( $\chi^2 = 27.6$ ,  $P < 0.001$  and  $\chi^2 = 259$ ,  $P < 0.001$ , respectively), the oldest subjects showed a significantly lower risk of allergic rhinitis after adjustment for dietary factors. The subjects who lived along a main street showed a significantly higher risk, and this finding supports the previously reported association between automobile exhaust and allergic rhinitis [5,16]. We cannot comment on the shift toward a Western lifestyle since we do not have sufficient data at present.

### Cedar Pollinosis

We defined cedar pollinosis as seasonal rhinitis with cedar pollen-specific IgE positivity (score  $\geq 2$ ). Although the most common allergen of allergic rhinitis is dust in the United Kingdom [8] or grass pollen in Switzerland [6], the proportion of cedar-specific IgE positivity was extremely high in our population (83.1%). There are few reports, to our knowledge, that have discussed the association between cedar-specific IgE and allergic rhinitis in Asian countries, except for Japan [4]. Cedar pollinosis may be a domestic disease in Japan, and the prevalence of cedar pollinosis may be of no interest to

other countries. However, cedar pollen may play an important part in increasing allergic conditions, hence it is important to estimate the prevalence of cedar pollinosis.

Several explanations can be raised for the high proportion of cedar-specific IgE positivity. The blood-sampled population was recruited from subjects with seasonally evoked nasal symptoms, which are important clinical characteristics of cedar pollinosis. Accordingly, this sampling bias may have increased the proportion of positive subjects. The frequency of exposure to cedar pollen may have increased in Japan, because the government encouraged the planting of cedar trees for the construction of housing after World War II.

The minimum prevalence of cedar pollinosis (11.0%) is higher than previously reported, except for the studies among young subjects [4,14]. The actual prevalence of cedar pollinosis may be higher than our estimated prevalence. Cedar pollinosis, as well as seasonal rhinitis, was significantly associated with age, allergic family history, and residence along a main street. On the other hand, other allergic rhinitis, which was not caused by cedar pollen, was associated with allergic personal and family history (adjusted OR = 3.55 and

**TABLE 3**

Prevalence, Adjusted Odds Ratios (ORs),<sup>a</sup> and 95% Confidence Intervals (95% CIs) of Cedar Pollinosis: Male Employees of a Railway Company (*n* = 2,307), 1995

| Variables                | No. of cases examined for IgE/No. of cedar-specific IgE positive cases/No. of cedar pollinosis cases | Age-specific prevalence <sup>b</sup> | Adjusted OR (95% CI) |
|--------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------|
| Age (years)              |                                                                                                      |                                      |                      |
| <30                      | 69/61/50                                                                                             | 11.9                                 | Reference            |
| 30–39                    | 106/91/80                                                                                            | 13.3                                 | 1.19 (0.79, 1.81)    |
| 40–49                    | 96/77/71                                                                                             | 11.4                                 | 0.86 (0.56, 1.33)    |
| ≥50                      | 73/57/52                                                                                             | 7.9                                  | 0.51 (0.32, 0.81)    |
| Past history of atopy    |                                                                                                      |                                      |                      |
| Yes                      | 52/42/31                                                                                             | —                                    | 1.48 (0.94, 2.31)    |
| Allergic family history  |                                                                                                      |                                      |                      |
| Yes                      | 200/171/146                                                                                          | —                                    | 2.77 (2.09, 3.67)    |
| Factory <sup>c</sup>     |                                                                                                      |                                      |                      |
| Near                     | 42/33/33                                                                                             | —                                    | 1.31 (0.85, 2.02)    |
| Main street <sup>d</sup> |                                                                                                      |                                      |                      |
| Along                    | 93/80/71                                                                                             | —                                    | 1.53 (1.11, 2.10)    |

<sup>a</sup> Adjustment for smoking status, alcohol use, frequency of meat and egg intake, and the variables on the table.

<sup>b</sup> Age-specific prevalence was defined as the proportion of the number of the cedar pollinosis cases divided by the age-specific total population.

<sup>c</sup> Missing data were excluded (*n* = 13).

<sup>d</sup> Missing data were excluded (*n* = 13).

3.62, respectively). Interestingly, there was no relationship between other allergens and residence along a main street.

The present study had several advantages compared with those previously reported (as mentioned above). On the other hand, there were several limitations. Our study subjects were Japanese males only, and we cannot generalize our findings to other race, sex, and age groups. The estimated prevalence of cedar pollinosis was calculated from sampling data, not from allergic subjects. However, at the very least, the actual prevalence of cedar pollinosis is 7.9 to 13.3% or more. Sampling bias cannot be neglected in the associations between cedar pollinosis and risk factors. However, risk factors of cedar pollinosis were similar to those of seasonal rhinitis and we believe there was only a minimal effect of sampling bias on the results of this research. This study was cross-sectional and the causality of each variable was beyond our scope to investigate.

**TABLE 4**

Numbers of the Subjects Who Were Examined for IgE for Each Allergen, Who Were Positive for Each Allergen, and Who Were Positive for Cedar Pollen Additionally and Numbers of Cedar Pollinosis

| Allergen     | Examined/positive for allergen/positive for cedar pollen/cedar pollinosis |
|--------------|---------------------------------------------------------------------------|
| Grass pollen | 315/82/75/65                                                              |
| House dust   | 351/85/71/55                                                              |
| Mites        | 349/101/83/65                                                             |
| Molds        | 304/23/18/18                                                              |

In conclusion, age-specific prevalences of allergic rhinitis, seasonal rhinitis, and cedar pollinosis were from 25.0 to 44.0%, 20.5 to 34.2%, and 7.9 to 13.3%, respectively. They appeared to decrease with increasing age. Family history of allergic conditions and residence along a main street were strongly related to all forms of allergic rhinitis.

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#### REFERENCES

1. Sibbald B, Strachan DP. Epidemiology of rhinitis. In: Busse NW, Holgate ST, editors. *Asthma and rhinitis*. Boston: Blackwell Sci., 1995:32–43.
2. Wüthrich B. Epidemiology of the allergic diseases: are they really on the increase? *Int Arch Allergy Appl Immunol* 1989;90:3–10.
3. Nakagomi T, Itaya H, Tominaga T, Yamaki M, Hisamatsu S, Nakagomi O. Is atopy increasing? *Lancet* 1994;343:121–2.
4. Nakamura S. Investigation into the frequency of cases Japanese cedar pollinosis among university students in the year of freshmen and fourth-grade [in Japanese]. *Arerugi [Jpn J Allergol]* 1993;42:101–6.
5. Ishizaki T, Koizumi K, Ikemori R, Ishiyama Y, Kushibiki E. Studies of prevalence of Japanese cedar pollinosis among the residents in a densely cultivated area. *Ann Allergy* 1987;58:265–70.
6. Wüthrich B, Schindler C, Leuenberger P, Ackermann-Liebrich U, and the SAPALDIA team. Prevalence of atopy and pollinosis in the adult population of Switzerland (SAPALDIA study). *Int Arch Allergy Immunol* 1995;106:149–56.

7. Sakurai Y, Teruya K, Shimada N, Wakabayashi K, Umeda T, Honjo S, et al. Relationship between weight change in young adulthood and the risk of NIDDM: the Sotetsu study. *Diabetes Care* 1997;20:978–82.
8. SAS Institute, Inc. SAS/STAT user's guide, release 6.03. Cary (NC): SAS Institute, 1988.
9. Ng TP, Tan WC. Epidemiology of allergic rhinitis and its associated risk factors in Singapore. *Int J Epidemiol* 1994;23:553–8.
10. Brodar I, Higgins MW, Mathews KP, Keller JB. Epidemiology of asthma and allergic rhinitis in a total community, Tecumseh, Michigan. III. Second survey of the community. *J Allergy Clin Immunol* 1974;53:127–38.
11. Sibbald B, Rink E. Epidemiology of seasonal and perennial rhinitis: clinical presentation and medical history. *Thorax* 1991;46:895–901.
12. Barbee RA, Halonen M, Kaltenborn WT, Burrows B. A longitudinal study of respiratory symptoms in a community population sample. *Chest* 1991;99:22–6.
13. Hori T, Ohyama H. A study on childhood pollinosis (2nd report): an epidemiological examination of pollinosis among junior high school students in Matsukawa town, Nagano prefecture [in Japanese]. *Arerugi [Jpn J Allergol]* 1986;35:1022–7.
14. Mori A. Sensitization and onset of Japanese cedar pollinosis in children [in Japanese]. *Arerugi [Jpn J Allergol]* 1995;44:7–15.
15. Kihara N, Adachi T, Fujinaga H, Ogawa R, Koseki T, Himeno T, et al. Investigation of *Cryptomeria japonica* pollinosis in Izu-Oshima [in Japanese]. *Arerugi [Jpn J Allergol]* 1995;44:609–17.
16. Tamura K, Ono M, Murakami M, Takahashi H, Sairenchi T, Tamiya N, et al. Yearly changes and geographical distribution of allergic rhinitis morbidity estimated from records of the National Health Insurance [in Japanese]. *Nihon Koshu Eisei Zasshi [Jpn J Public Health]* 1993;39:135–9.