Several studies have shown that certain pets increase the risk for asthma or other allergic diseases.1–5 In particular, furry pets have been associated with rhinitis and wheezing, and these animals can also provoke allergic reactions.5 Some surveys have found that wheezy children were more likely to own a furry pet than non-wheezy children.3,4 However, other surveys have failed to show these associations.3,6,7 Therefore, it remains unclear whether exposure to pets including hamsters is related to allergic symptoms.

Recently, there has been a notably sharp increase in the number of people who keep hamsters. Among people who kept pets in 1997, 20% kept hamsters.8 Some clinical reports have suggested that asthma or respiratory symptoms are causally associated with keeping hamsters and other pets.8–14 Respiratory symptoms in asthma patients who had kept hamsters disappeared after the hamsters were removed.8,9 However, few large population-based studies have been conducted that have explored the association between hamsters and respiratory symptoms relating to allergic respiratory disorders.

Received June 14, 2004, and accepted October 26, 2004.

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The aim of the present study was to investigate the association of pets, especially hamsters, with allergy-related respiratory symptoms in a large-size population-based study.

Study population
We used data from the cross-sectional survey done in Saitama prefecture, which has a total population of 7 million. In the survey, a stratified-cluster proportional sampling technique was adopted. Initially, 100 areas were randomly selected from 5 administration districts of Saitama prefecture in proportion to their population size.

A lay away plan was used to recruit the households. At the community center in each area, trained interviewers started visiting the closest households to deliver the questionnaires, and afterward collected them during the period of August 1 to 20, 2002. If a household declined to participate in this study, the interviewer moved to the neighboring households until 30 households (15 detached houses and 15 other dwelling types, such as apartments) were recruited. Thus the total sample was made up of 3,000 households.

Questionnaires
Two questionnaires were developed for the survey. One dealt with household conditions and included questions about pets and the residential environment. The other dealt with the health status and lifestyle of the individual residents. If a family member could not answer the questionnaires for any reason, another family member was to be interviewed instead. The questionnaire regarding pets asked, "Do you have pets?" and then, if 'yes', the next multiple-choice question was "What kind of pets do you have: dog, cat, cage bird and/or hamster?" The residential environment questionnaire inquired about the indoor and outdoor environments. The indoor environment questions included exposure to environmental tobacco smoke, type of flooring (carpet or other) and the presence of moisture condensation in summer and winter. Outdoor environment questions dealt with the structural type of the house (wooden or concrete, detached or apartment), and proximity to heavy traffic, a shopping district, a residential district, or a farm. These types of exposures were selected based on reports of previous studies that demonstrated an increased risk of respiratory or allergy symptoms in some of these settings.15-24

Individual residents were asked "Whether you had experienced respiratory symptoms (wheezing and/or breathlessness and/or bad cough) in the last 12 months." In addition, information regarding sex, age, and smoking habits were obtained by the detailed questionnaire.

Statistical analysis
The Statistical Package for the Social Sciences (SPSS®) version 11.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for all analyses. The number of subjects included in the individual analyses varied slightly due to some missing data.

The association between respiratory symptoms and the characteristics were evaluated by the chi-squared test. Statistical significance is reported at three levels: p<0.05, p<0.01 and p<0.001. A logistic regression analysis was performed to compute adjusted odds ratios with 95% confidence intervals. Age, sex, smoking habits and residential environments were used as confounding factors in the model.

We received responses from 2,368 households containing 7,395 individuals, ranging in age from under 1 to 95 years. The response rate was 78.9%. However, some households refused to participate in the study or were excluded because their members were absent. Thus the rate quoted above does not include the number of those households in the numerator. Table 1 shows the demographic characteristics, smoking status, pet-ownership status, and the prevalence of respiratory symptoms. Of all individuals, 5,059 (68.0%) reported having a pet, and a hamster was kept by 319 individuals (4.3%).

Respiratory symptoms were reported by 1,065 respondents (14.4%). The relationships between respiratory symptoms and respondents’ home environments and pet ownership are displayed in Table 2. The prevalence rate of respiratory symptoms was higher in males than in females (p<0.01), and was also higher in individuals less than 20 years of age or over 60 years of age.

Table 1. Characteristics of the study population.

|                  | n   | (%) |
|------------------|-----|-----|
| Total            | 7395|     |
| Sex              |     |     |
| Male             | 3656| (49.4) |
| Female           | 3730| (50.5) |
| Age (year)       |     |     |
| <10              | 1037| (14.0) |
| 10-19            | 853 | (11.5) |
| 20-29            | 856 | (11.6) |
| 30-39            | 1325| (17.9) |
| 40-49            | 997 | (13.5) |
| 50-59            | 974 | (13.2) |
| 60-69            | 799 | (10.8) |
| 69+              | 546 | ( 7.4) |
| Smoking status   |     |     |
| Current smokers  | 1844| (24.9) |
| Ex-smokers       | 2634| (35.6) |
| Pets*            |     |     |
| No pets          | 2336| (31.6) |
| Dogs             | 947 | (12.8) |
| Cats             | 456 | ( 6.2) |
| Cage birds       | 232 | ( 3.1) |
| Hamsters         | 319 | ( 4.3) |
| Prevalence of respiratory symptoms | 1065 | (14.4) |

*: A multiple-choice question was used to ask the kind of pet(s).
Table 2. The prevalence of "respiratory symptoms": relation to home environment exposures and other questionnaire.

|                          | Respiratory symptoms | Prevalence % | P value |
|--------------------------|----------------------|--------------|---------|
| **Sex**                  |                      |              |         |
| Male                     | 15.7 (572/3635)      | <0.01        |         |
| Female                   | 13.3 (493/3709)      | 0.001        |         |
| **Age (year)***          |                      |              |         |
| <20                      | 17.9 (337/1881)      | <0.001       |         |
| 20-59                    | 12.4 (513/4137)      | 0.001        |         |
| 60+                      | 16.2 (215/1331)      | 0.001        |         |
| **Smoking status**       |                      |              |         |
| Current smoker           |                      |              |         |
| Yes                      | 16.3 (299/1831)      | <0.01        |         |
| No                       | 13.8 (759/5483)      | 0.001        |         |
| Environmental exposure to tobacco smoke\* | | | |
| Yes                      | 13.8 (394/2860)      | n.s.         |         |
| No                       | 13.9 (364/2621)      | 0.001        |         |
| **Present house**        |                      |              |         |
| Indoor environments      |                      |              |         |
| Carpet                   |                      |              |         |
| Yes\*                    | 14.9 (724/4871)      | n.s.         |         |
| No                       | 13.7 (341/2481)      | 0.001        |         |
| Moisture condensation (in summer) | | | |
| Yes                      | 17.2 (59/343)        | n.s.         |         |
| No                       | 14.4 (934/6503)      | 0.001        |         |
| Moisture condensation (in winter) | | | |
| Yes                      | 15.2 (880/5788)      | <0.001       |         |
| No                       | 11.4 (147/1295)      | 0.001        |         |
| **Pets**                 |                      |              |         |
| Yes\*                    | 15.8 (368/2328)      | <0.05        |         |
| No                       | 13.9 (693/4981)      | 0.001        |         |
| **Outdoor environments** |                      |              |         |
| Residence Structure      |                      |              |         |
| Wooden house             | 13.6 (498/3670)      | <0.05        |         |
| Concrete and other       | 15.4 (549/3570)      | 0.001        |         |
| Type                     |                      |              |         |
| Detached                 | 13.4 (531/3975)      | <0.01        |         |
| Apartment                | 15.8 (534/3377)      | 0.001        |         |
| Living environment       |                      |              |         |
| Residential district     | 13.4 (723/5381)      | <0.001       |         |
| Close to something\*     | 17.5 (261/1495)      | 0.001        |         |

* : The age was divided into three intervals (<20 years, 20-59 years, 60+ years).
\*: Analysis was performed for data of never smokers.
\*: Included using carpet only and others.
\*: Dog, cat, caged bird, hamster, others.
\*: Close to shopping district, heavy traffic, or farm.
In this large-size population survey using a stratified-cluster proportional sampling technique, we found that exposure to hamsters was significantly associated with self-reported respiratory symptoms, while exposure to dogs, cats or birds was not associated with respiratory symptoms. This association remained significant after adjusting for a number of potential risk factors, including indoor environment (environmental tobacco smoke, moisture condensation, or carpet use) and outdoor environment (wooden or concrete structure, detached house or apartment, and proximity to heavy traffic, a shopping district, a residential district and/or a farm).

As a note of caution, extending our findings to the relationship between pets and specific allergic disorders, including bronchial asthma, may not be appropriate, as the subjective scale used could have led to misclassification when discriminating symptoms caused by allergic disorders from those caused by non-allergic conditions. However, a previous study found that self-reported respiratory symptoms were well discriminated from those of asthma diagnosed by physicians.25 Having said that, the relationship between respiratory symptoms and allergies in adults seemed to be less significant than that in children, because non-allergic respiratory diseases, such as chronic obstructive pulmonary diseases, are more prevalent in adults.

### Table 3. The association between pet ownership and the prevalence of respiratory symptoms.

| Pets     | Yes/Total | Prevalence (%) | P value |
|----------|-----------|----------------|---------|
| Dogs     | Yes       | 25/945         | 13.2    | n.s.    |
|          | No        | 932/6371       | 14.6    |         |
| Cats     | Yes       | 66/454         | 14.5    | n.s.    |
|          | No        | 994/6882       | 14.4    |         |
| Cage birds | Yes    | 38/231         | 16.5    | n.s.    |
|          | No        | 1021/7097      | 14.4    |         |
| Hamsters | Yes       | 68/319         | 21.3    | <0.001  |
|          | No        | 989/7003       | 14.1    |         |

### Table 4. Adjusted odds ratios and their 95% confidence intervals for pet exposure and relation to self-reported respiratory symptoms, controlling for age, sex, smoking habits, and residential environments.

| Pets     | Odds ratio | 95% confidence interval |
|----------|------------|-------------------------|
| Dogs     | 0.99       | 0.79-1.24               |
| Cats     | 1.07       | 0.79-1.45               |
| Birds    | 1.07       | 0.72-1.58               |
| Hamsters | 1.57       | 1.18-2.10               |

*: The age was divided into three intervals (<20 years, 20-59 years, and 60+ years).
Some previous studies have reported that respiratory symptoms or allergic sensitization were associated with exposure to hamsters. However, these studies did not consider other potential confounding factors such as residential environment, and they surveyed only symptomatic outpatients. Since our study took these factors into account, this allowed us to generalize our finding of an association between hamster raising and respiratory symptoms to the general population.

In our study, allergy-related respiratory symptoms were significantly related to the keeping of hamsters, but not to the keeping of dogs or cats. Several explanations may account for this finding. First, the difference in respiratory symptoms between hamsters and other pets could be caused by a selective bias in favor of having pets. Some studies have reported that parents of allergic children tend not to acquire pets. It is widely believed that having pet dogs or cats can induce allergic symptoms, so people with allergic symptoms are likely to avoid keeping these pets. On the other hand, the hamster is a new, popular pet whose sales have increased in the last 10 years in Japan. Therefore, hamster owners might not realize that hamsters play an important role in the development of allergic or respiratory symptoms. Thus, they are less likely to give up hamster ownership, even though they have respiratory symptoms.

A second explanation for the difference in respiratory symptoms between hamsters and other pets may relate to differences in exposure to particular animals as pets in early life. Exposure to pet-attributable allergens in early life can inhibit the development of allergic symptoms. Some studies have indicated that early exposure to dog fur or cat fur has a protective effect against allergic sensitization and asthma. Because dogs and cats have been popular pets for a very long time, the inhibiting effect against allergic symptom development may be increased. In contrast, hamster ownership only became popular during the 1990s, so there is little chance of early life exposure or long-term exposure to hamsters. Therefore, keeping pet hamsters might cause respiratory symptoms because the inhibiting anti-allergic effect associated with dogs and cats does not occur.

Finally, people without dogs or cats may still be exposed to dog or cat fur. It has been reported that antibodies for a component of cat fur have been found in the inhabitants of an island without cats. Because dogs or cats are kept both indoors and outdoors, people without these pets are often exposed to them in public spaces, and might acquire some protective effects against allergic symptoms caused by fur. In contrast, hamsters are mostly kept indoors. Thus, there is little opportunity to come in contact with hamsters, and so to induce the protective immunological effects.

This study has several limitations. First, the number of households in which member(s) refused to participate or were absent at the first visit was not available. Therefore, the real response rate could be lower than the above reported rate. The proportion of single households in this study (7.1%) is apparently lower than that in Saitama prefecture in Census 2000 (23.1%). Thus, we most likely failed to collect sufficient data from people who live alone. However, respiratory symptoms were not associated with household composition, and therefore the above problem may not have influenced the results. Second, some items of the questionnaire, such as "close to something" and "heavy traffic," were insufficient to allow conclusions to be drawn regarding quantitative determination of causality. Third, the time and duration of keeping pets was not considered in this analysis. Thus, the possibility exists that some subjects already had respiratory symptoms before acquiring their pets.

Further examination will be required to determine the causal relationship and underlying mechanisms between hamster ownership and allergic symptoms.

In conclusion, after adjusting for some potential environmental risk factors, we found that the keeping of hamsters is associated with an increased risk of respiratory symptoms based on a large-sized population-based survey in Saitama prefecture. Thus, our results imply a positive association between hamster keeping and respiratory symptoms caused by allergic disorders, as has been suggested by observations in clinical settings. Due to the cross sectional design of this study, further studies are needed to clarify whether the relationship between hamster keeping and respiratory symptoms is causal.

We thank officers of the Department of Health and Human Services Center of Saitama Prefectural Government for their assistance. This research is a part of The Saitama Prefectural Allergy Study.
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