Waseda Studies in Social Sciences, Vol. 9, No. 2 (Dec. 2008)

NOTE

Gendered Determinants of Allergies in Japanese Families

Hiroshi Kojima

Introduction

In many developed societies allergies among children are on the increase. Epidemiological surveys on primary school children conducted in Western Japan during the past two decades show similar tendencies. The prevalence of bronchial asthma, allergic rhinitis and conjunctivitis, and hay fever is on the increase while that of atopic eczema has slightly decreased. At the same time, the age at first contraction of asthma has declined and the correlation with the family member's allergies has become stronger, but the regional differentials and the correlation with population density and air pollution have disappeared (Nishima 2004). While epidemiological studies on determinants of allergies, with geographical and age limitations, are more often found, almost no social statistical studies have been conducted in Japan. The Japanese General Social Survey conducted in 2002 (JGSS-2002) asked respondents whether or not they themselves and their family members have different kinds of allergies and offers the nation-wide information on allergies.

This is a preliminary analysis of the JGSS-2002 micro-data on the determinants of allergies (atopic eczema, hay fever, asthma, food allergy and either kind of allergies) reported by respondents about their family members, drawing on logistic regressions with and without contextual variables. In the contextual analysis, the micro-data have been linked to the community-level macro-data from statistical data base at the Statistics Bureau's web site (http://www.stat.go.jp) and the Pollutant Release and Transfer Register (PRTR) indicators offered at the web site of the Organization for Research and Communication on Environmental Risk of Chemicals (http://www.ecochemi.jp/PRTR2005/prtr-index.html). Due to the preliminary nature and the lack and inconsistent results of past Japanese studies, no hypotheses have been constructed in advance. This is also an extension of the author's past studies (Kojima 2005a 2005b, 2006) with an emphasis on gender differences and family members.

Data and Method

Since the detailed information on the JGSS-2002 is available in the code book (Osaka University of Commerce and University of Tokyo, 2004) and at the JGSS web-site of Osaka University of Commerce (Daishodai) (http://www.jgss.daishodai.ac.jp/english/eframe/englishtop.html), only a brief introduction will be given here. The JGSS-2002 is a nation-wide survey with a sample of 5,000 men and women aged 20-89 from 341 enumeration districts (2,953 usable cases). It has a similar content as the GSS in the US and other GSS-type surveys in Europe, asking about general social attitudes and behaviors as well as demographics. The dependent variables derive from Question 32 in the JGSS-2002, asking respondents whether or not they themselves and their family members have any of the four kinds of allergies (atopic eczema, hay fever, asthma or food allergy) or none. In this study only the allergies of family members have been analyzed. But the respondent's contraction of allergies has been used to control for common genetic and/or environmental factors in this analysis of allergy contraction by family members.

Independent variables derive from the JGSS-2002, the Statistics Bureau's 2004 municipality data base and the 2003 PRTR indicators for each 2004 municipality. The JGSS-2002 variables for individual characteristics include demographic traits (sex, age, marital status and number of each type of siblings), socio-economic traits (education and occupation), behavioral traits (frequency of washing, cleaning, dinner with all the family, exercise and the use of public transportation, the purchase of organic vegetables, drinking and smoking, the number of trauma during the last five years, work week, weekly working hours, daily TV-watching hours and the affiliation with religion. The JGSS-2002 variables for micro-level environmental characteristics include household size, house area and type, the existence of fearful spot to walk at night in the neighborhood, urban-rural residence, region, urban-rural residence at age 15, region at age 15 and survey company branch.

On the other hand, independent variables for the respondent's community of residence, which were calculated from information in the Statistics Bureau's data base, include various kinds of proportions in the population, incidence rates per population, numbers or monetary values per person and numbers or monetary values per square kilometer based on the combination of aggregate statistics. Independent variables of five PRTR indicators include 1) Non-Pesticide Air Pollutant Risk to Humans, 2) Non-Pesticide Water Pollutant Risk to Humans, 3) Non-Pesticide Water Pollutant Risk to Aquatic Biosphere, 4) Pesticide Use Risk to Humans, and 5) Pesticide Use Risk to Biosphere. They had been calculated with different weights for toxicity from the 2003 PRTR data from the Ministry of Environment by the Organization for Research

Table 1 Determinants of Family Members' Allergies Reported by Married Respondents Living with Children: Both Sexes Aged 20–69

Indep Var	Category	Eczema	Hay Fever	Asthma	Food Allergy	Either
(Constant)		−0.434***	−0.242***	−3.113***	−6.013***	−1.109**
Sex	Female	0.218	0.092	−0.304	−0.310	−0.152
Age	20–29	0.450	−0.713*	0.307	1.469**	−0.075
	30–39	0.180	−0.421#	0.896**	0.679	−0.057
	40–49	0.334	0.020	0.644*	−0.089	0.056
	50–59	−0.145	0.002	0.116	0.438	−0.052
Sib Size	1 sibs	0.346	0.093	−0.258	−0.799	0.052
	2 sibs	−0.252	0.202	−0.106	−0.501#	0.038
Education	Senior High	0.551*	0.643***	−0.190	−0.109	0.326*
	Junior Coll	0.624*	0.783**	−0.034	0.279	0.552**
	University	1.151***	0.808***	−0.480	0.244	0.296
Occupation	Prof/Man	−0.266	−0.171	−0.247	−0.529	−0.144
	Sales	−0.433	−0.091	−0.282	−0.413	−0.238
	Service	0.089	−0.176	−0.293	0.246	−0.017
	Manual	−0.229	−0.029	−0.110	−0.386	−0.011
	Agric	−0.325	−0.312	−0.439	−0.539	−0.174
	No Work	−0.099	−0.324	−0.453	−0.270	−0.285
HH Size	4 persons	1.225***	0.612***	0.232	0.589*	0.662***
	5 persons	1.043***	0.544**	0.866**	1.300**	0.528**
	6 persons+	1.407***	0.721***	1.294***	1.874***	0.961***
House Area	$<50m^2$	−0.438	−0.307	−0.219	0.361	−0.140
	$50–99m^2$	0.293	−0.047	0.139	0.410	0.104
	$100–149m^2$	0.179	−0.131	0.020	0.201	0.048
House Type	Collective	0.387	0.087	0.316	0.344	0.109
Neighbor	Fearful Spot	0.145	0.261*	0.157	0.024	0.213#
City Type	Metropolitan	0.102	−0.037	0.475	0.126	−0.098
	Other City	0.270	0.136	0.409#	0.402	0.066
Region	Hok/Tohoku	0.208	−0.662#	0.351	1.696*	0.018
	Kanto	−0.114	0.105	0.110	1.504**	0.331
	Kinki	0.338	−0.218	0.074	0.394	0.078
	Chu–Shikoku	−0.049	−0.703	0.421	0.465	−0.222
	Kyushu	−0.177	−0.601	0.988	1.426#	−0.060
Residence at 15	Large City	−0.372	0.085	−0.143	0.209	0.046
	Medium City	−0.170	−0.174	−0.061	0.085	−0.064
	Other City	−0.114	−0.223	−0.359	−0.046	−0.235
Region at 15	Hok/Tohoku	0.125	0.100	0.496	−0.924	0.118
	Kanto	−0.178	0.078	−0.056	−1.203*	−0.314
	Kinki	−0.582	−0.268	−0.073	0.606	−0.366
	Chu–Shikoku	−0.011	0.132	−0.704	0.076	0.094
	Kyushu	−0.227	−0.020	−0.905	−0.578	−0.216
Washing	Everyday	0.722*	−0.188	−0.021	−0.277	0.221
	Several/wk	0.506#	−0.628*	0.005	0.169	−0.087
Cleaning	Everyday	−0.051	0.329#	−0.129	0.761*	0.115
	Several/wk	0.084	0.120	−0.233	0.172	0.078
Fam Dinner	Everyday	−0.227	0.086	0.167	−0.271	−0.157
Exercise	Several/wk	−0.157	0.292#	−0.383	0.319	0.167
	Once/wk	−0.080	−0.172	0.035	−0.125	−0.211
Pub Transp	Frequent	0.176	−0.037	0.291	0.107	0.055
Org Veget	Non–Buyer	0.048	−0.106	0.513#	−0.185	−0.089
Alcohol	Everyday	0.081	0.104	−0.391#	0.125	−0.020
	Non–Drinker	−0.111	0.057	0.225	0.544#	0.016
Cigarette	Smoker	0.133	0.294#	−0.043	−0.596	0.151
	Past Smoker	0.232	0.333#	−0.124	−0.248	0.164
Trauma in last 5 years	Once	−0.115	0.094	−0.122	0.780*	0.000
	Twice+	0.243	0.185	0.057	1.099***	0.127
Work d /wk	6 days+	0.177	−0.108	−0.103	−0.369	−0.212
Work h /wk	60 hours+	−0.242	0.161	0.448	0.822#	0.411#
TV h /day	6 hours+	−0.724*	−0.281	−0.026	−1.319*	0.107
Religion	Invididual	0.258	0.282	−0.162	−1.377*	0.152
	Family	0.264	0.081	0.341	0.229	0.019
Respondent's Allergies	Eczema	1.775***	0.283	0.523	0.648	1.444***
	Hay Fever	0.236	1.605***	0.020	0.884***	1.075***
	Asthma	1.051***	0.561*	1.854***	0.611	1.308***
	Food Allergy	0.713*	0.332	0.797*	3.059***	1.034***
−2 LL Ratio		259.5***	331.2***	166.2***	213.3***	282.7***
N		1737	1737	1737	1737	1737
Frequency (%)		17.7	29.0	11.0	6.0	53.1

(Source) JGSS-2002 micro-data.

(Note) #$p<0.10$, *$p<0.05$, **$p<0.01$, ***$p<0.001$.

and Communication on Environmental Risk of Chemicals, Yokohama National University. In the contextual analysis the logistic regression with stepwise selection has been applied to micro-data attached with community-level data. The cases for the analyses were limited to married respondents aged below 70 (20-69) living with children to avoid the possible biases due to the heterogeneity among older respondents.

Results

A. Basic Model

(1) Atopic Eczema

Table 1 shows the results of the basic model with a predetermined set of individual-level independent and control variables and without community-level contextual variables for respondents of both sexes. It reveals that gender has no significant effects on either kind of allergies contracted by family members, while the reported prevalence of either kind of allergies at the bottom of the following two tables tends to be lower among female respondents. According to Column 1, the reported prevalence of atopic eczema of family members is significantly increased by completion of senior high school or higher level, household size of 4 or larger and frequent washing, while it is significantly decreased only by TV watching for 6 hours or more per day. The positive effects of education may show those on reporting or recognition rather than on actual incidence. The positive effects of household size may show those of number of children rather than house crowing. The positive effects of frequent washing may show either reverse causation or possible harmful effects of detergents. The negative effects of long hours of TV watching may show reverse causation, but they can also show those caused by the reduction of stress through TV watching together by respondents and their family members, considering that the same variable has a negative effect on food allergy.

Column 1 of Tables 2 and 3 shows the results for male and female respondents, which show relatively large gender differences in the effect of each independent variable on atopic eczema of family members. According to Column 1 of Table 2 for male respondents, ages 40-49, completion of senior high school or university, household size of 4 or larger, fearful spot in the neighborhood have significant and positive effects, while medium city residence at age 15, one trauma during the last 5 years and TV watching of 6 hours or more have significant and negative effects. Male respondents in their 40s may be more likely to have children at prime age of allergies. The effect of fearful spot in the neighborhood may show the effects of physical environment or the reflection of stress held by male respondents.

According to Column 1 of Table 3 for female respondents, completion of senior high school or higher, household size of 4 or larger, washing everyday, 2 or more trau-

Table 2 Determinants of Family Members' Allergies Reported by Married Respondents Living with Children: Males Aged 20–69

Indep Var	Category	Eczema	Hay Fever	Asthma	Food Allergy	Either
(Constant)		−3.852***	−2.545***	−0.346***	−6.083***	−0.611
Sex	Female	—	—	—	—	—
Age	20–29	0.930	−1.009#	1.202#	3.007**	−0.127
	30–39	0.517	−1.206**	0.750	2.002*	−0.311
	40–49	0.925*	−0.270	1.470**	0.656	0.194
	50–59	0.019	−0.161	0.882*	1.480#	−0.011
Sib Size	1 sibs	0.592	0.345	−0.737	−1.304	0.529
	2 sibs	−0.402	0.130	−0.394	−1.800**	−0.124
Education	Senior High	0.770*	0.876**	−0.618	0.385	0.355
	Junior Coll	0.783	0.902*	−0.396	0.878	0.757#
	University	1.596***	1.106***	−0.747	0.136	0.548#
Occupation	Prof/Man	−0.454	0.036	−0.581	−0.704	−0.296
	Sales	−0.643	0.143	−1.334*	−0.725	−0.347
	Service	0.132	−0.438	−0.849	1.015	0.032
	Manual	−0.043	0.031	−0.239	−0.917	0.060
	Agric	−1.674	−0.673	0.826	0.059	−0.010
	No Work	0.443	−0.488	−0.729	−1.635	−0.358
HH Size	4 persons	1.039***	0.633**	−0.148	0.679	0.533*
	5 persons	0.838*	0.721*	0.895*	0.421	0.297
	6 persons+	0.665#	0.937***	0.768#	2.759***	0.631*
House Area	$<50m^2$	−0.773	−0.693	−0.442	1.675#	−0.704#
	$50–99m^2$	0.420	−0.030	0.762*	1.074	0.274
	$100–149m^2$	0.179	−0.138	0.273	0.677	0.156
House Type	Collective	0.198	0.416	−0.215	0.388	0.376
Neighbor	Fearful Spot	0.447*	0.222	0.494#	0.712	0.415*
City Type	Metropolitan	0.413	0.163	0.828	0.481	0.101
	Other City	0.482	0.400#	1.142**	0.605	0.468*
Region	Hok/Tohoku	−0.412	−0.712	0.889	1.333	−0.102
	Kanto	−0.802	−0.168	0.515	−0.209	−0.112
	Kinki	0.382	0.040	1.587#	−1.853	0.177
	Chu-Shikoku	−0.774	−1.468*	1.532	−1.664	−0.947
	Kyushu	−1.127	−0.651	3.152**	−0.065	−0.463
Residence at 15	Large City	−0.691	0.198	0.242	−0.303	0.034
	Medium City	−0.922**	−0.114	−0.179	−1.342#	−0.519*
	Other City	−0.292	−0.080	−0.621#	−0.114	−0.334
Region at 15	Hok/Tohoku	0.545	0.298	0.303	−1.508	0.270
	Kanto	0.199	0.454	−0.592	−0.191	−0.052
	Kinki	−0.863	−0.386	−1.628#	2.025	−0.756
	Chu-Shikoku	0.348	0.593	−1.763	1.725	0.842
	Kyushu	0.508	0.138	−2.703**	0.974	0.263
Washing	Everyday	0.684	−0.178	0.972#	−1.302#	0.218
	Several/wk	0.556	−0.670#	0.408	0.053	−0.192
Cleaning	Everyday	−0.140	−0.242	−0.958*	1.097	−0.427#
	Several/wk	−0.067	−0.240	−0.673#	0.712	−0.215
Fam Dinner	Everyday	−0.276	−0.021	0.267	−0.107	−0.146
Exercise	Several/wk	−0.341	0.478#	−0.019	−0.451	0.107
	Once/wk	−0.046	−0.158	−0.168	0.020	−0.395
Pub Transp	Frequent	0.388	−0.217	−0.413	1.242#	0.268
Org Veget	Non-Buyer	−0.156	−0.004	0.661*	−0.258	0.020
Alcohol	Everyday	0.191	0.410*	−0.708*	0.872#	0.140
	Non-Drinker	−0.366	0.453	−0.790	1.577*	−0.048
Cigarette	Smoker	−0.222	0.278	−0.344	−2.557***	−0.185
	Past Smoker	−0.213	0.354	−0.227	−0.888#	−0.083
Trauma in last 5 years	Once	−0.487#	−0.019	−0.470	0.829	−0.241
	Twice+	−0.080	0.216	−0.427	−0.279	−0.103
Work d /wk	6 days+	0.218	0.134	−0.055	−0.619	0.040
Work h /wk	60 hours+	−0.301	0.223	0.482	1.042#	0.477#
TV h /day	6 hours+	−1.197#	0.271	−0.435	−1.102	−0.241
Religion	Invididual	−0.027	0.008	−1.577*	−0.825	−0.332
	Family	0.361	−0.198	0.447	0.804	−0.140
Respondent's Allergies	Eczema	1.352**	0.229	0.484	2.678***	1.450**
	Hay Fever	−0.383	1.595***	−0.003	−0.404	1.015***
	Asthma	0.095	0.346	1.654**	0.040	1.106*
	Food Allergy	1.717***	0.155	1.463**	4.262***	1.243*
−2 LL Ratio		153.1***	174.3**	124.7***	167.8***	148.1***
N		821	821	821	821	821
Frequency (%)		17.7	29.6	11.1	6.0	54.8

(Source) JGSS-2002 micro-data.
(Note) #p<0.10, *p<0.05, **p<0.01, ***p<0.001.

ma during the last 5 years and individual religion have significant and positive effects on atopic eczema of family members, but no independent variables have significant and negative effects. The effect of religion may reflect reverse causation. The positive effects of trauma among both sexes may reflect its effects through heavy stress for themselves and their family members. While respondents' contraction of atopic eczema, asthma and food allergy has positive effects on atopic eczema of family members, the effects of respondents' contraction of allergies differ by gender. Male respondents' atopic eczema and food allergy have positive effects on atopic eczema of family members while female respondents' atopic eczema, hay fever and asthma have positive effects.

(2) Hay Fever

Column 2 of Table 1 for respondents of both sexes shows that the reported prevalence of hay fever among family members is significantly increased by completion of senior high school or higher level, household size of 4 or larger, fearful spot in the neighborhood, cleaning everyday, exercise of several times per week, present and past smoking, while it is significantly decreased by ages 20-39, residence in Hokkaido and Tohoku Regions, and washing of several times per week. The positive effect of frequent cleaning may reflect reverse causation or more exposure to pollen of conifer trees. Exercise may also increase the chance to be exposed to pollen if family members do it together with respondents or as often as respondents and/or if the respondent brings in pollen from outside, while residence in Hokkaido and Tohoku Regions may reduce it. The negative effects of ages 20-39 may reflect the fact that children start contracting hay fever around the age of 10. While the respondent's smoking may decrease his/her own contraction of hay fever, it increases the contraction of hay fever by his/her family members.

However, Column 2 of Tables 2 and 3 for respondents of each gender shows different effects of each independent variable on hay fever of family members and even opposing effects of drinking every day between male and female respondents. According to Column 2 of Table 2 for male respondents, completion of senior high school or higher level, household size of 4 or larger, residence in non-metropolitan cities, exercise of several times per week and drinking everyday have positive effects on hay fever of family members, while ages 20-39, residence in Chu-Shikoku Region and washing of several times per week have negative effects. The positive effects of non-metropolitan residence may suggest that factories of heavy and chemical industries tend to be located in these cities and less strict anti-pollution measures may be found in these cities than metropolitan cities, while these effects are not found among female respondents, which makes it difficult to interpret. The opposing effects of drinking everyday between respondents of each gender also make it difficult to interpret.

Table 3 Determinants of Family Members' Allergies Reported by Married Respondents Living with Children: Females Aged 20–69

Indep Var	Category	Eczema	Hay Fever	Asthma	Food Allergy	Either
(Constant)		−4.801***	−2.350**	−0.312***	−8.244***	−1.714**
Sex	Female	—	—	—	—	—
Age	20–29	0.046	−0.309	−0.728	1.366	−0.049
	30–39	−0.242	−0.026	1.112*	−0.412	0.033
	40–49	−0.213	0.225	0.387	−1.689*	−0.055
	50–59	−0.305	0.044	−0.434	−0.887	−0.093
Sib Size	1 sibs	0.128	0.062	0.138	−1.294	−0.311
	2 sibs	−0.176	0.272	0.107	−0.313	0.150
Education	Senior High	0.639*	0.561*	−0.020	−0.120	0.268
	Junior Coll	0.823*	0.659*	−0.031	0.601	0.461
	University	1.195*	0.544	−0.177	1.013	0.007
Occupation	Prof/Man	−0.122	−0.516	0.175	−0.057	0.012
	Sales	−0.173	−0.540	0.640	−0.562	−0.127
	Service	−0.122	−0.160	−0.387	−0.470	−0.144
	Manual	−0.350	−0.068	−0.097	−0.572	−0.042
	Agric	0.312	0.190	−1.970#	−12.343&	−0.068
	No Work	−0.201	−0.472#	−0.516	−0.338	−0.375
HH Size	4 persons	1.354***	0.584*	0.348	0.783	0.721***
	5 persons	1.197***	0.431	0.739#	1.952***	0.655**
	6 persons+	2.004***	0.534#	1.610***	1.926**	1.177***
House Area	$<50m^2$	−0.376	−0.189	−0.270	−0.830	0.127
	$50–99m^2$	0.152	−0.049	−0.363	0.003	−0.070
	$100–149m^2$	0.155	−0.117	−0.232	0.010	−0.072
House Type	Collective	0.438	−0.136	0.644	0.758	−0.130
Neighbor	Fearful Spot	−0.189	0.323#	−0.016	−0.008	0.098
City Type	Metropolitan	−0.169	−0.338	0.110	−0.196	−0.283
	Other City	0.232	−0.160	0.040	0.613	−0.160
Region	Hok/Tohoku	0.669	−0.808	−0.040	2.374*	0.215
	Kanto	0.266	0.236	−0.133	2.280**	0.725*
	Kinki	0.263	−0.710	−0.558	0.516	−0.012
	Chu–Shikoku	0.960	−0.113	−0.272	2.110	0.543
	Kyushu	0.795	−0.431	−0.372	2.615*	0.382
Residence at 15	Large City	−0.170	0.082	−0.213	−0.014	0.105
	Medium City	0.334	−0.225	−0.057	0.353	0.261
	Other City	0.068	−0.385	−0.532	−0.267	−0.217
Region at 15	Hok/Tohoku	−0.269	−0.029	0.995	−1.143	−0.083
	Kanto	−0.336	−0.188	0.449	−1.744*	−0.525
	Kinki	−0.431	−0.066	0.761	0.882	−0.088
	Chu–Shikoku	−0.745	−0.494	−0.140	−0.821	−0.723
	Kyushu	−0.947	−0.316	0.423	−2.124#	−0.581
Washing	Everyday	1.002#	−0.059	−0.837	0.905	0.396
	Several/wk	0.370	−0.536	−0.272	0.181	0.026
Cleaning	Everyday	0.075	0.848**	0.336	1.276*	0.634**
	Several/wk	0.204	0.422	−0.131	0.227	0.379
Fam Dinner	Everyday	−0.330	0.114	0.172	−0.385	−0.198
Exercise	Several/wk	−0.161	0.156	−0.639	0.660	0.209
	Once/wk	−0.105	−0.077	0.119	1.056#	−0.022
Pub Transp	Frequent	0.079	0.060	0.815*	0.160	−0.090
Org Veget	Non–Buyer	0.111	−0.918#	−0.259	−0.426	−0.633
Alcohol	Everyday	−0.001	−0.614#	−0.438	−0.336	−0.402
	Non–Drinker	0.038	−0.183	0.553*	0.690#	−0.047
Cigarette	Smoker	0.324	0.495#	0.295	0.965#	0.517*
	Past Smoker	0.580	0.190	0.067	−2.382*	0.294
Trauma in last 5 years	Once	0.125	0.204	−0.047	1.002#	0.197
	Twice+	0.409#	0.173	0.204	1.893***	0.274
Work d /wk	6 days+	0.297	−0.495#	−0.142	0.052	−0.505*
Work h /wk	60 hours+	−0.644	−0.496	0.921	1.330	0.122
TV h /day	6 hours+	−0.599	−0.652*	0.299	−1.525#	0.245
Religion	Invididual	0.588#	0.575*	0.350	−1.780#	0.473#
	Family	0.200	0.369	0.320	−0.128	0.239
Respondent's Allergies	Eczema	2.025***	0.352	0.356	−0.802	1.599***
	Hay Fever	0.652**	1.827***	0.098	1.622***	1.190***
	Asthma	1.490***	0.697#	2.355***	1.247#	1.492**
	Food Allergy	0.317	0.516	0.292	3.483***	0.992*
−2 LL Ratio		179.0***	226.5***	136.1***	146.2***	216.0***
N		916	916	916	916	916
Frequency (%)		17.8	28.4	10.9	6.0	48.5

(Source) JGSS-2002 micro-data.

(Note) #$p<0.10$, *$p<0.05$, **$p<0.01$, ***$p<0.001$, & small number of cases.

According to Column 2 of Table 3 for female respondents, completion of senior high school or junior college, household size of 4 or 6, fearful spot in the neighborhood, cleaning everyday, current smoking and individual religion have positive effects on hay fever of family members, while no work, non-purchase of organic vegetables, drinking everyday, work week of 6 or more days and TV watching of 6 or more hours per day have negative effects. No work of female respondents suggest that they are full-time home maker, which should decrease stress for themselves and their family members and which may increase time to make efforts to decrease the amount of pollen in their house. Non-purchase of organic vegetables should reflect reverse causation. The work week of 6 or more days may mean that the respondents are self-employed, which may decrease the stress of respondents themselves and their family members. While the respondents' contraction of hay fever and asthma has positive effects on hay fever of family members among respondents of both sexes, the effect of respondent's contraction of asthma is significant only among females.

(3) Asthma

Column 3 of Table 1 for respondents of both sexes shows that the reported prevalence of asthma among family members is significantly increased by ages 30-49, household size of 5 or larger, residence in non-metropolitan cities and non-purchase of organic vegetables, while it is significantly decreased by drinking everyday. The effect of non-purchase of organic vegetables on asthma of family members is in the opposite direction to its effect on hay fever, which may suggest that the purchase of organic vegetables actually deters the incidence of asthma among family members. The negative effect of drinking everyday apparently reflects the effect among male respondents, but it is in the opposite direction to its effect on hay fever among male respondents, which is difficult to interpret. It may be related to the hereditary transmission of enzyme to dissolve alcohol, the change in the amount and composition of dinner dishes with father's alcohol consumption or the intake of alcohol vapor by family members.

Column 3 of Tables 2 and 3 for respondents of each gender shows largely different effects of each independent variable on asthma of family members and only the positive effects of household size is in common among male and female respondents. According to Column 3 of Table 2 for male respondents, ages 20-29 and 40-59, household size of 5 or larger, house area of 50-99 square meters, fearful spot in the neighborhood, residence in non-metropolitan cities, residence in Kinki or Kyushu Region, washing everyday and non-purchase of organic vegetables have positive effects on asthma of family members, while sales occupation, small city residence at age 15, residence in Kinki or Kyushu Region at age 15, cleaning everyday or several times per week, drinking everyday and individual religion have negative effects.

The positive effect of house area of 50-99 square meters, which is not too large for a family even in Japan, may suggest the possible environmental contamination or stress inside the house due to crowding. The fact that the current residence in non-metropolitan cities and Kinki or Kyushu Region and the past residence at age 15 in small cities and Kinki or Kyushu Region have opposite effects may suggest the effect of deteriorated living environment. The negative effect of sales occupation is difficult to interpret, but it may suggest that those men are more likely to be self-employed with less stressful family life. Frequent cleaning may actually reduce the prevalence of asthma among family members through the maintenance of cleaner environment inside the house.

According to Column 3 of Table 3 for female respondents, ages 30-39, household size of 5 or larger, frequent use of public transportation and non-drinking have positive effects on asthma of family members, while only agricultural occupation has a negative effect. The positive effect of frequent use of public transportation is in the opposite direction to its negative effect on female respondents' contraction of asthma possibly because the negative effect on female respondents' contraction of asthma may reflect reverse causation. The negative effect of agricultural occupation of female respondents may support the "hygiene hypothesis" based on the observation of lower prevalence of asthma among children raised in farms in the West (Bracken et al. 2002:181, Tattersfield et al. 2002:1314). While the respondents' contraction of asthma and food allergy has positive effects on asthma of family members among respondents of both sexes, the effect of respondent's contraction of food allergy is significant only among males.

(4) Food Allergy

Column 4 of Table 1 for respondents of both sexes shows that the reported prevalence of food allergy among family members is significantly increased by ages 20-29, household size of 4 or larger, residence in Hokkaido, Tohoku, Kanto or Kyushu Region, cleaning everyday, non-drinking, one or more trauma during the last 5 years and work week of 60 hours or more, while it is significantly decreased by sib size of 2, residence in Kanto Region at age 15, TV watching of 6 hours or more per day and individual religion. The positive effect of ages 20-29 is the combined results of positive effects of ages 20-59 among male respondents and negative effects of ages 30-59, but it is difficult to interpret. Perhaps, gender difference may be related to the difference in age of children and grandchildren living together due to the difference in the mean age at marriage. Regional differences may reflect the local food habits, but it is difficult to identify. The positive effect of non-drinking may reflect hereditary traits, but that of trauma and long working hours and the negative effects of TV watching and religion may suggest the effect of physical and/or mental stress of respondents, which

may be shared by children. The negative effect of sib size of 2 is difficult to interpret, but it may be related to higher proportion of co-residence with respondents' parents because it is the reflection of negative effects found among male respondents.

Column 4 of Tables 2 and 3 for respondents of each gender shows different effects of each independent variable on food allergy of family members and current smoking even has effects in the opposite direction among male and female respondents. According to Column 4 of Table 2 for male respondents, ages 20-39 and 50-59, household size of 6 or larger, house area of less than 50 square meters, frequent use of public transportation, drinking everyday or non-drinking and work week of 60 hours or more have positive effects on food allergy of family members, while sib size of 2, medium city residence at age 15, washing everyday and current and past smoking have negative effects.

The positive effects of large household size and small house size may suggest the possible environmental contamination or stress inside the house due to crowding. The positive effects of other variables also seem to be related to stress felt by male respondents and possibly his family members. The negative effects of independent variables are difficult to interpret, particularly those of smoking, but some of them may be related to less stressful family life.

According to Column 4 of Table 3 for female respondents, household size of 5 or larger, residence in Hokkaido, Tohoku, Kanto or Kyushu Region, cleaning everyday, exercise of once a week, non-drinking and one or more trauma during the last 5 years have positive effects on food allergy of family members, while ages 40-49, residence in Kanto or Kyushu Region at age 15, current and past smoking, TV watching of 6 hours or more per day, and individual religion have negative effects. The positive effects of cleaning everyday, exercise of once a week and non-drinking are difficult to interpret, but they may reflect reverse causation. While the respondents' contraction of hay fever and food allergy has positive effects on food allergy of family members among respondents of both sexes, the effect of respondent's contraction of hay fever is significant only among females. In addition, male respondents' contraction of atopic eczema has a positive effect on food allergy, while female respondents' contraction of asthma has a positive effect.

(5) Any Allergy

Column 5 of Table 1 for respondents of both sexes shows that completion of senior high school or junior college, household size of 4 or larger, fearful spot in the neighborhood and work week of 60 hours or more have significant and positive effects on either kind of allergies of family members, while no independent variables have significant and negative effects. Even those variables with significant and positive effects are fewer than in the model for each kind of allergy. This may be because

some independent variables have significant effects only on a limited number of allergies of family members and because others have significant effects in the opposite direction on different kind of allergies or among respondents of each gender.

In fact, Column 5 of Tables 2 and 3 shows different effects of each independent variable, including cleaning everyday with the effects in the opposite direction among male and female respondents. According to Column 5 of Table 2 for male respondents, household size of 4 and 6 or larger, fearful spot in the neighborhood, non-metropolitan city residence and work week of 60 hours or more have positive effects on either kind of allergies of family members, while house area of less than 50 square meters, medium city residence at age 15 and cleaning everyday have negative effects. The negative effect of small house size is not only against intuition but also unusual in the sense that it does not have a significant and negative effect on neither kind of allergies of family members while it has a significant and positive effect on food allergy. This may be related to the control of contraction of allergies by male respondents. According to Column 5 of Table 3 for female respondents, household size of 4 or larger, residence in Kanto Region, cleaning everyday, current smoking and individual religion have positive effects on either kind of allergies of family members, while only work week of 6 days or more has a negative effect. As expected, among both sexes respondents' contraction of each kind of allergies has a significant effect on either kind of allergies of family members.

B. Exploratory Contextual Model

(1) Atopic Eczema

Table 4 shows the results for the contextual model, consisting of individual-level and community-level independent variables, with stepwise selection for respondents of both sexes. It reveals that gender has no significant effects except on either kind of allergies contracted by family members possibly because of control for the respondent's own contraction of allergies. According to Column 1, the reported prevalence of atopic eczema of family members is significantly increased by residence in Hokkaido3, pharmacists per person (community-level variables), ages 40-49, completion of university, household size of 4 or larger, house area of 50-99 square meters and two or more trauma (individual-level variables) as well as the respondent's atopic eczema, asthma and food allergy (control variables), while it is significantly decreased only by residence in Fukuoka1 and TV watching of 6 hours or more per day.

While the tables are not presented here, the results for male and female respondents show relatively large gender differences in the significant effect of each selected independent variable on atopic eczema of family members. Among male respondents, residence in Miyagi1, Shizuoka1, Aichi1 or Osaka1, percentage of business

Table 4 Determinants of Family Members' Allergies Reported by Married Respondents Living with Children: Both Sexes Aged 20–69, with Contextual Variables

Indep Var	Category	Eczema	Hay Fever	Asthma	Food Allergy	Either	Either (PRTR)
(Constant)		−3.306***	−0.742	−7.344***	−7.438***	0.209	0.634
Branch of	Hokkaido3	1.428**					
Survey	Hokkaido4				2.516***		
Company	Iwate		1.891*	2.330**			
	Fukushima		1.059*				
	Saitama1					1.037**	1.184**
	Saitama2					0.742*	0.761*
	Niigata			0.905*		−0.795*	−0.811*
	Yamanashi		1.381**				
	Nagano		0.960**				
	Aichi2				2.108**		
	Osaka1				1.313**		
	Hyogo2			0.933*			
	Yamaguchi1		2.308**				
	Yamaguchi2				2.182*		
	Tokushima			2.523*			
	Fukuoka1	−1.372*					
	Saga				1.912*		
	Oita		1.494*				
	Miyazaki			1.257*			
Pesticide Use Risk to Humans		—	—	—	—	—	−8.83E-07**
% Aged <15						−6.431*	−27.789**
Child Dependency Ratio			−11.681***				
% Primary School Pupils							51.831*
% 1-person HH					5.612***		
% Elderly Family HH					14.249***		
% Employee				5.104**			
% Labor Force in Industry			4.557***				
Commuter Inflow/Outflow			−0.333**				
Doctors/km^2			0.012**				
Pharmacists/person		139.0*					
Hospitals/person						−3405.6**	−3378.3**
Clinics/person			794.6*				
Retail Shops/person			−68.219**		89.522*		
Manufactured Value/km^2			−0.00003**				
Main Street Length/km^2			−0.108**				
Recognized Crimes/person			29.179***				
Sex	Female					−0.287**	
Age	20–29				1.077*		
	30–39			0.837***	0.688*		
	40–49	0.361*	0.323*	0.610**			
Education	University	0.580***					
Occupation	No Work		−0.335*				−0.288*
HH Size	4 persons	1.311***	0.667***			0.728***	0.734***
	5 persons	1.108***	0.680***	0.748***		0.596***	0.572***
	6 persons+	1.439***	0.851***	1.203***	1.035***	0.996***	0.983***
House Area	50–99m^2	0.346*					
Neighbor	Fearful Spot		0.277*			0.232*	0.221*
Region at 15	Hok/Tohoku			0.849***			
Washing	Everyday					0.292*	
	Several/wk		−0.493**				
Cleaning	Everyday				0.473*		
Exercise	Once/wk		0.471**				
Org Veget	Non-Buyer			0.557*			
Trauma in	Once				0.709*		
last 5 years	Twice+	0.327*			0.984***		
TV h /day	6 hours+	−0.701*			−1.442*		
Respondent's	Eczema	1.767***				1.477***	1.458***
Allergies	Hay Fever		1.476***		0.820***	1.072***	1.065***
	Asthma	1.129***	0.662*	1.855***	0.807*	1.383***	1.445***
	Food Allergy	0.701*		0.980**	3.131***	1.046**	0.981**
−2 LL Ratio		217.1***	361.9***	154.6***	197.7***	268.1***	275.9***
N		1737	1737	1737	1737	1737	1737
Frequency (%)		17.7	29.0	11.0	6.0	53.1	53.1

(Sources) JGSS-2002 micro-data, Statistics for Municipalities 2004, and 2003 PRTR Indicators.

(Note) #p<0.10, *p<0.05, **p<0.01, ***p<0.001, & small number of cases.

establishments in the tertiary industry, nursing homes per person, dentists per person (community-level variables), ages 40-49, sib size of 1, completion of senior high school and university, household size of 4 or more, fearful spot in the neighborhood (individual-level variables) as well as the respondent's atopic eczema and food allergy (control variables) have significant and positive effects, while net in-migration rate, ratio of hospitals to clinics, small city residence at age 15 have significant and negative effects. Among female respondents, however, residence in Okayama (community-level variables), completion of university and household size of 4 or more (individual-level variables) as well as the respondent's atopic eczema, asthma and food allergy (control variables) have significant and positive effects on atopic eczema of family members, while kindergartens per square kilometer and percentage of population in childcare centers have significant and negative effects.

(2) Hay Fever

Column 2 of Table 4 for respondents of both sexes shows that the reported prevalence of hay fever among family members is significantly increased by residence in Iwate, Fukushima, Yamanashi, Nagano, Yamaguchi1 or Oita, percentage of labor force in the secondary industry, doctors per square kilometer, clinics per person, crimes per person, ages 40-49, household size of 4 or larger, fearful spot in the neighborhood, and exercise of once a week as well as the respondent's hay fever and asthma, while it is significantly decreased by child dependency ratio, ratio of commuter inflow to outflow, retail shops per person, value of manufactured goods per square kilometer, main street length per square kilometer, no work, and washing of several times per week. Among male respondents, residence in Yamanashi, Aichi2 or Hyogo1, percentage of business establishments in the secondary industry, students per senior high school, ages 40-59, exercise of several times per week, and drinking everyday as well as the respondent's hay fever have positive effects on hay fever of family members, while value of manufactured goods per square kilometer, main street length per square kilometer, and washing of several times per week have negative effects. Among female respondents, residence in Shiga or Yamaguchi1, percentage of labor force in the secondary industry, doctors per square kilometer, ages 40-49, household size of 4, fearful spot in the neighborhood, and cleaning everyday as well as the respondent's hay fever and asthma have positive effects on hay fever of family members, while percentage of respondents working in the municipality of residence, the percentage of commuting workers, annual amount of garbage per person, residence in Kinki Region and TV watching of 6 hours or more per day have negative effects.

(3) Asthma

Column 3 of Table 4 for respondents of both sexes shows that the reported preva-

lence of asthma among family members is significantly increased by residence in Iwate, Niigata, Hyogo2, Tokushima or Miyazaki, percentage of employees in labor force, ages 30-49, household size of 5 or larger, residence in Hokkaido or Tohoku Region at age 15, and non-purchase of organic vegetables as well as the respondent's asthma and food allergy, while no variables have significant and negative effects. Among male respondents, residence in Hokkaido2, Hokkaido5, Saitama2 or Miyazaki, department stores per person, and ages 40-49 as well as the respondent's asthma and food allergy have positive effects on asthma of family members, while only percentage of nuclear families and percentage of employers with employees in labor force have negative effects. Among female respondents, residence in Iwate or Hyogo2, percentage of employees in labor force, ages 30-49, household size of 6 or larger, residence in Hokkaido and Tohoku Regions at age 15, frequent use of public transportation and non-drinking as well as the respondent's asthma have positive effects on asthma of family members, while no independent variables have significant and negative effects.

(4) Food Allergy

Column 4 of Table 4 for respondents of both sexes shows that the reported prevalence of food allergy among family members is significantly increased by residence in Hokkaido4, Aichi2, Osaka1, Yamaguchi2 or Saga, percentage of one-person households and that of elderly family households, ages 20-39, household size of 6 or larger, cleaning everyday, non-drinking, and one or more trauma as well as the respondent's hay fever, asthma and food allergy, while it is significantly decreased only by retail shops per person and TV watching of 6 hours or more per day. Among male respondents, residence in Hokkaido4 or Saga, percentage of elderly family households, ratio of in-migrants to out-migrants, sales occupation, household size of 6 or larger, and collective housing as well as the respondent's atopic eczema and food allergy have positive effects on food allergy of family members, while only current smoking has a negative effect. Among female respondents, residence in Tochigi or Aichi2, residence in Kinki Region at age 15, cleaning everyday, two or more trauma as well as the respondent's contraction of any of four allergies have positive effects on food allergy of family members, while no independent variables have significant and negative effects.

(5) Any Allergy

Column 5 of Table 4 for respondents of both sexes shows that residence in Saitama1 or Saitama2, household size of 4 or larger, fearful spot in the neighborhood and washing everyday as well as the respondent's contraction of any of four allergies have significant and positive effects on either kind of allergies of family members, while residence in Niigata, percentage of child population, hospitals per person and females have significant and negative effects. Among male respondents, ages 40-49

and household size of 4 or larger as well as the respondent's atopic eczema, hay fever and asthma have significant and positive effects on either kind of allergies of family members, while the percentage of business establishments in commerce, no work, and house area of less than 50 square meters have significant and negative effects. Among female respondents, household size of 4 or larger and cleaning everyday as well as the respondent's contraction of any of four allergies have positive effects on either kind of allergies of family members, while percentage of family workers in labor force and hospitals per person have negative effects.

(6) Inclusion of PRTR indicators

Due to the space constraints, only the results for both sexes with significant effects of PRTR indicators on allergies of family members are presented here. Column 6 of Table 4 unexpectedly shows that 4) Pesticide Use Risk to Humans has a negative effect on the family member's contraction of either kind of allergies. This may be related to the interaction with some individual-level and community-level variables because, after the inclusion of PRTR indicators, a couple of independent variables (females and cleaning everyday) in Column 5 lose their significance while a couple of variables (percentage of population in primary school and no work) come to have significant and positive effects, suggesting possible relationship to suburban areas with higher a percentage of full-time homemakers with children. This may be also related to the differential effects of PRTR indictors on each sex. It is found that 5) Pesticide Use Risk to Biosphere has a positive effect on the male respondent's family's contraction of food allergy and that 2) Non-Pesticide Water Pollutant Risk to Humans has a positive effect on female respondent's family's contraction of atopic eczema.

Conclusion

The results show that individual-level variables (including control variables) and community-level variables (including environmental variables) have different effects on family members' contraction of allergies among respondents of each gender. But it is not always possible to interpret the effects of each variable or the gender differences in the effect. For example, the PRTR indicators have unexpected negative effects on allergies in the results of analyses for both sexes, but they have only positive effects in the results for each gender.

It may be also possible that the recognition of allergies is different in each gender because this study is based on the self-reported contraction of allergies by respondents about their family members. The direct medical information on allergies based on medical examination is preferable, but it is not easy to obtain such information in

the GSS-type surveys. This study did not include the direct information on air pollution, which could be particularly relevant to asthma, because it is not available for every community. In the prospective studies, the information for the closest municipality or the estimation by Krieging might be used when that of the particular community is lacking.

Even though this study has used ordinary logistic regressions due to its preliminary nature, the prospective studies should use the multi-level analysis (hierarchical linear model) once the variables to be included are determined. They should also examine the interactions, particularly those of the respondent's gender. However, it is difficult to select the variables to be included due to the relative lack and inconsistent results of past Japanese studies. In this sense, the results of this study are original at least in Japan and may set the ground for future studies, particularly in terms of gender differentials in determinants of allergies in the family.

Acknowledgements

The Japanese General Social Surveys (JGSS) are designed and carried out at the Institute of Regional Studies at Osaka University of Commerce in collaboration with the Institute of Social Science at the University of Tokyo under the direction of Ichiro TANIOKA, Michio NITTA, Hiroki SATO and Noriko IWAI with Project Manager, Minae OSAWA. The project is financially assisted by Gakujutsu Frontier Grant from the Japanese Ministry of Education, Culture, Sports, Science and Technology for 1999-2003 academic years, and the datasets are distributed by SSJ Data Archive, Information Center for Social Science Research on Japan, Institute of Social Science, the University of Tokyo.

References

Basagana, X, et al., 2004. "Socioeconomic Status and Asthma Prevalence in Young Adults." *American Journal of Epidemiology* 160 (2), 178-188.

Bracken, M. B., et al., 2002. "Genetic and Perinatal Risk Factors for Asthma Onset and Severity." *Epidemiological Reviews* 24 (2), 176-189.

Inaoka, Noriko, et al., 1984. "A Study on the Relationship between the Spasm of Bronchial Asthma and the Factors of Air Pollution." *Japanese Journal of Public Health* 31 (12), 625-636 (in Japanese).

Jaakkola, J. J. K., R. Piipari and M. S. Jaakkola, 2003. "Occupation and Asthma." *American Journal of Epidemiology* 158 (10), 981-987.

Johnson, C. C., et al., 2002. "Environmental Epidemiology of Pediatric Asthma and Allergy." *Epidemiological Reviews* 24 (2), 154-175.

Kojima, Hiroshi. 2005a. "Determinants of Allergies: A Preliminary Analysis of the JGSS-2002 and an Exploratory Contextual Analysis." Institute of Regional Studies, Osaka University of Commerce and Institute of Social Science, University of Tokyo (eds.), *JGSS Research Monograph Series*, Vol. 4. Higashi-Osaka, Institute of Regional Studies, Osaka University of Commerce, pp. 47-77 (in Japanese).

Kojima, Hiroshi, 2005b. "A Contextual Analysis of Allergy, Using JGSS-2002 Data." Paper presented at the 2005 Annual Meeting of the Society for Environmental Economics and Policy Studies, Waseda University, Tokyo, Oct. 9 (in Japanese).

Kojima, Hiroshi, 2006. "Contextual Analysis of Allergies in Japan, Drawing on the JGSS-2002 and the PRTR Macro-Data," A. F. Militino et al. (eds.), *International Workshop on Spatio-*

Temporal Modelling (METMA3), Pamplona, Spain, 27th, 28th, and 29th September 2006, Instituto de Estadistica de Navarra, pp. 197-201.

Ministry of the Environment (Japan), Study Group on the Interrelationship between Air Pollution and Hay Fever, 2003. "The Results of FY2002 Study on the Interrelationship between Air Pollution and Hay Fever" (in Japanese). http://www.env.go.jp/press.php3?serial=4125

Ministry of the Environment (Japan), 2004. "The Results of FY2002 Surveillance Study on Environmental Health in Relation to Air Pollution" (in Japanese). http://www.env.go.jp/press.php3?serial=5292

Nishima, Sansei, 2004. "A Study on the Measurement of Trends in Children's Bronchial Asthma and Comparative Analysis, Drawing on the Same Field and the Same Method." Organization for Environmental Regeneration (ed.) *Evaluation of Research Conducted by Organization for Environmental Regeneration: Results of 5th Cycle for FY2002 (Published in September 2003)* (in Japanese). http://www.erca.go.jp/asthma2/library/investigate/index_14.html

Osaka University of Commerce, Institute of Regional Studies, and University of Tokyo, Institute of Social Science (eds.), 2004. *Japanese General Social Surveys JGSS-2002: Basic Tables and Code Book,* Institute of Social Science, University of Tokyo (in Japanese).

Pearce, N., et al., 1998. *Asthma Epidemiology.* New York, Oxford University Press.

Pikhart, H., et al., 2000. "Outdoor Air Concentrations of Nitrogen Dioxide and Sulfur Dioxide and Prevalence of Wheezing in School Children." *Epidemiology* 11 (2), 153-160.

Statistics Bureau, MIC (Japan), 2004. "Statistics for Municipalities: 2004." http://www.stat.go.jp/data/ssds/5b.htm.

Tattersfield, A., et al., 2002. "Seminar: Asthma." *Lancet* 360, 1313-1322.

Tsunetoshi, Yoshizo, 2004. "Detailed Field Research and Analysis of Correlates on Trends in Bronchial Asthma" Organization for Environmental Regeneration (ed.) *Evaluation of Research Conducted by Organization for Environmental Regeneration: Results of 5th Cycle for FY2002 (Published in September 2003)* (in Japanese). http://www.erca.go.jp/asthma2/library/investigate/index_14.html