

Module 22: Proportions: One Sample

This module presents confidence intervals and tests of hypotheses for proportions for the situation with one random sample from a population.

Proportions

P = Population parameter, the proportion of population with characteristic

x = Number in sample with the characteristic

n = Total number in sample

$p = x/n$, the sample estimate of the proportion with the characteristic

Hypothesis tests and confidence intervals are based on the normal approximation to the binomial distribution. For the hypothesis:

$$H_0: P = P_0 \text{ vs } H_1: P \neq P_0$$

The options for the test statistic are:

$$z = \frac{p - P_0}{\sqrt{\frac{p(1-p)}{n}}}$$

$$z = \frac{p - P_0}{\sqrt{\frac{P_0(1-P_0)}{n}}}$$

$$z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}}$$

where $q = 1 - p$

Appointment-Keeping Behavior Re-Evaluated

PHILIP HERTZ, MEd, MSPH, AND PAULA L. STAMPS, MS, PhD

Abstract: Many of the traditional approaches to the problem of appointment-keeping behavior have ignored the organizational factors that may be implicated in differentially high broken appointment rates leading to an implicit assumption that low-income and ethnic minority patients will be more likely to break appointments. A case study at a Model Cities Health Center which maintains a kept appointment rate of 83

per cent examined the relationship of broken appointments to age, sex, ethnic background, and payment mechanisms. The results suggest alternative explanations for differentially high broken appointments concerning on the role of the institution in reinforcing appointment-keeping behavior. (*Am. J. Public Health* 67:1033-1036, 1977)

Broken appointment rates in ambulatory care facilities range from 14 per cent to 44 per cent. It is important to decrease the broken appointment rate as much as possible in order to provide for the best utilization of the direct care staff members. Explanations of broken appointment rates have concentrated primarily upon factors related to the patients, with emphasis placed upon demographic characteristics, such as socioeconomic status, race, age, sex, and educational levels, with other factors such as attitudes toward health care and personality factors also noted. Occasionally, additional factors have also been investigated, including the effect of weather and distance, and variables associated with the organization itself such as the appointment system, staffing patterns, and information flow in the organization. Most studies have concluded with acceptance of a primary myth which is that low-income patients do not keep appointments as well as people in middle class socioeconomic groups. This has been consistently reported by several investigators over the last ten years.¹⁻⁷ The conclusion of the relationship between low income and high broken appointments has been proposed for ambulatory care in the-bar-service settings,⁸ psychiatric care,⁹ and ambulatory care in a pre-paid setting.¹⁰ The magnitude of the differences vary, but in one of the better designed studies, Greenick contrasted appointment-keeping rates of a pre-paid group and an OEO* Community-

sive Neighborhood Health Care Program that was part of the same medical system. The broken appointment rate for the pre-paid health plan sample was 8 per cent and for the OEO health plan sample 23 per cent.¹¹

Confounding variables with low social class include age, ethnic identification, and educational levels. In general, the conclusion of most studies is that the older the patients the more likely they are to keep an appointment,^{1,2} and that members of ethnic minorities, especially Blacks and Spanish-speaking are more likely to break appointments.^{1,2,4,5,7,12} Patients with lower educational levels are generally concluded to be poorer keepers of appointments,^{1,2} although Adler's study did not confirm this relationship for psychiatric patients.⁹ Social disorganization of urban families, especially lower-income families, has also been related to poor appointment keeping behavior.¹³

All of these studies have in common the emphasis upon the failure of the patient to keep an appointment, without analyzing the organizational factors which might be responsible for reinforcing poor appointment-keeping behavior. In those studies where efforts were made to increase the kept appointment rate, some interesting observations have been made with respect to the role of the health facility in broken appointments. Three major factors can be identified as being related to appointment-keeping behavior: physician continuity, communication systems, and type of appointment system. Becker found that physician continuity, i.e., seeing the same physician each time, was positively correlated to appointment-keeping among a group of low-income, mostly Black patients.¹⁴ Increased efforts at communication, including various reminders for missed appointments, also seems to be effective in reducing the broken appointment

*Office of Economic Opportunity

Address reprint requests to Dr. Paula L. Stamps, Assistant Professor, Health Services Administration, University of Massachusetts, Amherst, MA 01003. Dr. Hertz is Administrator, Model Cities Health Center. This paper, submitted to the Journal January 18, 1977, was revised and accepted for publication April 21, 1977.

patients to see specific requested physicians had been used for some time. Postcard reminders are mailed five days prior to the appointment, by same class, when the staff deems it necessary. Home visits are made to those who break their appointments. Home visits are utilized as many of the patients do not have telephones.

Methodology and Data Collection

Data were collected for the adult medical clinics for a 12-month period of time between April 1, 1974 and March 31, 1975, on number of appointments kept and broken, sex, age, ethnic group, and payment mechanism. Chi-square was utilized at a significance level of 5 per cent to test for the existence of relationships between these variables.

The monthly data for each variable were analyzed individually, a chi-square test on the combined 12 months was calculated. There were a total of 3,172 visits recorded in the adult medical clinic during this time period.

Results

The overall kept appointment rate in the adult medical clinics during the study period was 85 per cent.

One of the 3,172 adult patient visits, 94 per cent were male and 66 per cent were female. As can be seen from Table 1, there were no significant differences in appointment-keeping behavior between males and females.

The age distribution of the population was broken into two categories using age 44 as the cut-off point. As with other studies,^{1-3,7-9} the data in Table 1 reveal a tendency for older patients to keep appointments better than younger patients. It should be added that the differences with respect

TABLE 1—Distribution of Percentage of Kept and Broken Appointments According to Selected Patient Characteristics

Characteristic	N	% Kept (N = 2,693)	% Not Kept (N = 479)
Sex ^a			
Male	1,508	85.26	14.74
Female	2,064	85.15	14.85
Age ^b			
< 44	2,566	84.66	15.34
44 +	486	90.37	9.63
Ethnicity ^c			
Puerto Rican	2,204	81.46	18.54
White	817	87.62	12.38
Black	156	93.02	6.98
Payment Mechanism ^d			
Voluntary	2,228	83.40	16.60
Non-Voluntary	944	91.98	8.02
TOTAL	3,172	84.98	15.02

^aChi = 0.04, df = 1, p = .83

^bChi = 24.48, df = 1, p = .00

^cChi = 83.04, df = 2, p = .00

^dChi = 0.06, df = 1, p = .83

to age are significant for only three months (June, October, and November), but these differences are large enough to contribute to a statistical difference over the entire 12-month period of time.

The majority of the clinic's adult patients are Puerto Rican (89 per cent), with 27 per cent of the patients classified as White and 4 per cent classified as Black. Table 1 also shows there is a statistical relationship between ethnic group membership and appointment-keeping behavior, with Puerto Ricans having a higher broken appointment rate than either the Whites or Blacks. When these data are analyzed by month, May, June, August, November, February, and March show significant differences. During the months of June and August, neither the appointment-keeping rate in bilingual health centers were present in the Health Center. Both of these periods show low rates in scheduling Spanish-speaking patients. In November, February, and March the adult clinics were changed from their regular night to other evenings and some afternoons in order to accommodate some of the schedules of the physicians. These changes were not adequately incorporated in the non-English speaking patients. The 18.5 per cent broken appointment rate among this group is compared to the 8.5 per cent broken appointment rate among Whites and the 7 per cent broken appointment rate among Blacks appears to be closely associated with these two events. The clinic's failure to fully communicate with the non-English speaking population, the erratic staffing of medical clinics, and the changes in the clinic schedule may well have contributed to the higher rate of broken appointments for the Spanish-speaking population. As can be seen from Table 1, these factors did not affect the English-speaking Black and White populations.

Sixty-five per cent of the Health Center's patient population is non-Hispanic. As can be seen from Table 1, there is no relationship between Medicaid status and appointment-keeping behavior.

In order to further clarify the relationship of ethnic status and payment mechanism, the three ethnic groups were classified by their payment mechanism. Table 2 shows that there is an association between ethnic group and kept appointments, but this is stronger among those not on Medicaid. This group possesses the same characteristics as the total clinic sample, and thus reflects the same organizational problems that have been previously cited with respect to language program.

Summary and Conclusions

The data presented suggest that the difference in the kept appointment rates of different ethnic groups does not reflect a true ethnic difference in health behavior. For the months when there was no significant difference in appointment-keeping behavior between the White and Puerto Rican populations, the appointment staff was present, and there were no changes in clinic days or medical staff. During five of the six months when such differences occurred, it was because of the absence of the bilingual appointment staff, the changes made in clinic days, and the physician

TABLE 1—Distribution of Percentage of Kept and Broken Appointments According to Selected Patient Characteristics

Patient Characteristic	N	% Kept (N = 2,603)	% Not Kept (N = 489)
Sex¹			
Male	1,109	85.39	14.61
Female	2,063	84.15	15.88
Age²			
< 45	2,603	83.00	17.00
45+	489	90.37	9.63
Ethnicity³			
Puerto Rican	2,206	81.46	18.54
White	837	91.52	8.48
Black	129	93.02	6.98
Payment Mechanism⁴			
Welfare	2,229	83.40	16.60
Non-Welfare	943	87.38	12.62
TOTAL	3,172	84.58	15.42

¹X² = 8.54; df = 1; p > .05

²X² = 24.22; df = 1; p < .05

³X² = 53.94; df = 2; p < .05

⁴X² = 8.05; df = 1; p > .05

Example of one sample hypothesis test and confidence interval

Table 1 on the following page indicates that 85.39% of the 1,109 males kept their appointments. Suppose that you had worked in this area previously and the percent of appointments kept before had always been 90% or higher. A question this raises is whether this observed rate is sufficiently different from 90% for you to think your population was different. That is, you would like to test the hypothesis:

$$H_0: P_M = 0.90 \text{ vs } H_1: P_M \neq 0.90$$

Hypothesis test for males keeping appointments

1. *The hypothesis:* $H_0: P_M = 0.90$ vs $H_1: P_M \neq 0.90$

2. *The assumptions:* Independence

3. *The α level:* $\alpha = 0.05$

4. *The test statistic:*

$$z = \frac{p - P_M}{\sqrt{\frac{p(1-p)}{n}}}$$

5. *The rejection region:* Reject $H_0: P_M = 0.90$ if z is not between ± 1.96

6. The result: $p = \frac{x}{n} = \frac{947}{1,109} = 0.85$

$$P_M = 0.90$$

$$z = \frac{p - P_M}{\sqrt{\frac{p(1-p)}{n}}}$$

$$= \frac{0.85 - 0.90}{\sqrt{\frac{(0.85)(1-0.85)}{1,109}}}$$

$$= \frac{0.85 - 0.90}{\sqrt{\frac{(0.85)(0.15)}{1,109}}} = \frac{-0.05}{\sqrt{0.000115}} = \frac{-0.05}{0.0107} = -4.66$$

7. The conclusion: Reject $H_0: P_M = 0.90$ since z is not between ± 1.96

Confidence Interval for P, with $\alpha = 0.05$

$$C = \left[p - 1.96 \sqrt{\frac{p(1-p)}{n}} < P < p + 1.96 \sqrt{\frac{p(1-p)}{n}} \right] = 0.95$$

Appointment keeping behavior for males

$$p = \frac{x}{n} = \frac{947}{1,109} = 0.85$$

$$C = \left[p - 1.96 \sqrt{\frac{p(1-p)}{n}} < P < p + 1.96 \sqrt{\frac{p(1-p)}{n}} \right] = 0.95$$

$$C = \left[0.85 - 1.96 \sqrt{\frac{(0.85)(0.15)}{1,109}} < P < 0.85 + 1.96 \sqrt{\frac{(0.85)(0.15)}{1,109}} \right] = 0.95$$

$$\text{Note: } \sqrt{\frac{(0.85)(0.15)}{1,109}} = \sqrt{0.000115} = 0.0107$$

$$C[0.85 - 1.96(0.0107) < P < 0.85 + 1.96(0.0107)] = 0.95$$

$$C[0.85 - 0.021 < P < 0.85 + 0.021] = 0.95$$

$$C[0.829 < P < 0.871] = 0.95$$

Atopy in Children and Parental Social Class

ABSTRACT

Objectives. This analysis was conducted to determine whether atopic diseases were related to social class in a pediatric population of a German middle-class country.

Methods. A cross-sectional study of 2,674 schoolchildren was carried out in 1992 and 1993 in 3 towns in the Federal East Germany. Parents completed a standardized questionnaire regarding health events and lifestyle factors. In addition, skin-prick tests were performed and total serum immunoglobulin E (IgE) was determined.

Results. Lifetime prevalence rates for atopic diseases and rates of atopic sensitization were highest in children from social class III (in which parents had more than 10 years of formal education) and lowest in social class I (less than 10 years of parental education), while rates in social class II (5 to 9 years of parental education) were similar to an intermediate level.

Conclusions. The data confirmed the assumption that in Germany, social conditions, social inequalities, and/or under the socialist system, which were influenced by a social gradient in health outcomes. The findings support the hypothesis that ecological factors in children's lives could be one reason for the increasing rates of atopic diseases during the last 3 decades. (*Am J Public Health*. 1998;88:1318-1324)

Joachim Heinrich, Dorothea Altmann, Jürgen A. Paprotny, Christa NPW, Martina Mjos, Christa, Inge P. Fiedler, Hans-Joachim, and M. Peter Wechsung, Friedrich Schiller

In industrialized Western countries, atopic diseases and allergic sensitization in both children and adults have been reported to occur more frequently in higher than in lower socioeconomic groups.¹⁻⁴

Little is known about the distribution of health parameters in general and atopic diseases in particular in the different social categories or populations of the formerly communist countries of Eastern Europe. Studies performed shortly after the collapse of the communist system revealed that prevalence rates for atopic diseases and allergic sensitization in children and young adults in Eastern European countries were substantially lower than those observed in Western Europe.⁵⁻⁷ It has been postulated that factors associated with Western lifestyle may be responsible for the differences in these relatively "rare" populations.^{8,9}

The fact that differences in the prevalence of allergic diseases parallel differences in socioeconomic status within Western societies and between West and East leads to the speculation that increased access to modern lifestyle might be associated with a rise in atopic diseases. Detecting a similar social gradient for atopy in an Eastern European population would provide additional evidence in favor of this theory.

In the past, East German society was regarded as characterized by a relatively uniform distribution of resources and living conditions. In the German Democratic Republic, as in all former communist countries, socioeconomic differences between social groups were relatively small. Education and basic health care were equally accessible to all groups in society. Health promotion programs represented an important aspect of the health care system and were considered by a network of research facilities in GDR hospitals, schools, and places of employment. Immunization programs were highly successful and day care facilities employing well-trained personnel were widely available.¹⁰ Nevertheless, in spite of a general

lifestyle uniformity, subtle social stratification in German socialist countries existed. This study was designed to determine whether the occurrence of atopic diseases or atopic sensitization in the Federal East Germany was related to parental social class.

Subjects and Methods

Study Population

The cross-sectional health survey was conducted in 1992 and 1993 in 3 communities of the state of Mecklenburg-Vorpommern, a 16-state administrative district of the Federal state of Germany and a rural area invited to participate. One third of the schools from each administrative district of the district were randomly selected to represent the total population of Mecklenburg. All eligible children in these selected schools were invited to the study. There were 2,672 legal subjects; participation was distributed by 1,773 children and returned by 2,471. Information on social status was obtained for 2,662 subjects (99.6%). Participation rates in the different phases of the study and age and sex

Joachim Heinrich, Dorothea Altmann, Jürgen A. Paprotny, Martina Mjos, Christa, Inge P. Fiedler, Hans-Joachim, and M. Peter Wechsung are with the East Research Center for Environmental and Health, Institute of Epidemiology, Mecklenburg, Vorpommern, Germany, or Wechsung is also with the Institute of Epidemiology, Ludwig-Maximilians-University Munich, Germany. Address correspondence to Dr. Heinrich, East German Research Center for Environmental and Health, Post Office Box 101553, D-2000 Hamburg, Germany.

Requests for reprints should be sent to Joachim Heinrich, MD, PhD, East German Research Center for Environmental and Health, Institute of Epidemiology, Post Office Box 101553, D-2000 Hamburg, Germany. This paper was accepted February 11, 1998.
Note: The contents of this paper are solely the responsibility of the authors and do not necessarily represent the official views of the Federal Governmental Center, National Institute of Health.

TABLE 2—Lifetime Prevalence of Atopic Diseases and Characteristic Symptoms as Reported by Parents and Proxy Proxies of Physicians Diagnosed Atopic Dermatitis, Allergic Rhinitis, and Elevated Total Serum IgE in 100 Children Aged 5 to 14 Years (N = 2405), by Social Class (Merkel, JAMA, Germany, 1989, 1990)

	Social class ^a					
	I		II		III	
	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)
Atopic diseases or symptoms (parent/proxy informant)						
Allergic or atrophic dermatitis ^b	1111	4.7 (4.0, 5.5)	1171	7.6 (6.8, 8.4)	1021	10.4 (9.5, 11.3)
Wheezing (more than once) ^c	1171	16.7 (14.9, 18.5)	1117	20.6 (19.0, 22.2)	1021	23.4 (21.6, 25.2)
Rhinitis	1021	16.7 (14.9, 18.5)	1122	16.6 (15.0, 18.2)	1021	17.4 (15.6, 19.2)
Quercetous rashes ^d	1021	11.5 (10.0, 13.0)	1171	14.1 (12.5, 15.7)	1021	16.5 (14.7, 18.3)
Atopic rhinitis ^e	1021	11.5 (10.0, 13.0)	1122	12.1 (10.5, 13.7)	1021	13.7 (12.0, 15.4)
Allergic conjunctivitis ^f	1021	10.8 (9.4, 12.2)	1171	12.6 (11.0, 14.2)	1021	14.3 (12.5, 16.1)
Allergic dermatitis (dermatologic examination)						
Allergic sensitization (skin prick test)						
At least 1 of 12 tested allergens	1021	11.0 (9.7, 12.4)	1027	15.0 (13.5, 16.5)	1024	22.1 (20.5, 23.7)
At least 2 of 12 tested allergens	1021	11.0 (9.7, 12.4)	1027	15.0 (13.5, 16.5)	1024	22.1 (20.5, 23.7)
At least 3 of 12 tested allergens	1021	11.0 (9.7, 12.4)	1027	15.0 (13.5, 16.5)	1024	22.1 (20.5, 23.7)
At least 4 of 12 tested allergens	1021	11.0 (9.7, 12.4)	1027	15.0 (13.5, 16.5)	1024	22.1 (20.5, 23.7)
At least 5 of 12 tested allergens	1021	11.0 (9.7, 12.4)	1027	15.0 (13.5, 16.5)	1024	22.1 (20.5, 23.7)
Total serum IgE ^g or total IgE ^h	1021	27.8 (25.5, 30.1)	1024	15.6 (14.2, 17.0)	1021	14.0 (12.6, 15.4)

Note. CI = confidence interval.
^aThe social class of a family was defined by the highest parental grade completed by either the mother or the father of the study subject.
^bChildren with parental education of less than 10 grades were included as belonging to social class I; 10 grades, class II; more than 10 grades, class III.
^cPhysician-diagnosed wheezing in respiratory patients.
^dWheezing by parents.
^ePhysician-diagnosed allergic rhinitis in respiratory patients.
^fPhysician-diagnosed allergic conjunctivitis in respiratory patients.
^gTotal serum IgE in total IgE.
^hTotal serum IgE in total IgE.

symptoms. The effects of these potentially confounding variables were assessed in bivariate models that included each covariate separately. Additionally, covariates reaching significance levels of $P < 0.05$ in the bivariate analyses were selected for the final multivariate model.

Results

Lifetime prevalence rates for most of the atopic diseases and characteristic symptoms reported by the parents were highest in children from families with the highest level of parental education (social class III) and lowest in children from families with the lowest level of parental education (social class I). In children from social class III, prevalence rates were consistently at an intermediate level (Table 2).

In the physical examination, atopic dermatitis (eczema) was diagnosed in 2.0% of the children classified as belonging to social class III and in 3.3% of the children in social class II, while none of the 163 examined children in social class I presented signs of atopic dermatitis. Other health parameters assessed at the physical examination did not reveal significant differences between the social categories. Height, weight, and stage of the teeth were comparable in all 3 groups (data not shown).

Allergic sensitization, defined as a positive response of 3 or more allergens to at least 1 of

the 12 tested allergens, was found in 29.5% of the children. The allergic sensitization rates were 23.1%, 26.6%, and 11.5% in the children from social classes III, II, and I, respectively. Allergic sensitization against allergen groups or individual allergens as well as skin reactions to 2 or more allergens showed a similar social gradient (Table 2).

To assess the influence of total serum IgE on the relationship between social class and allergic sensitization, the subjects were stratified into a group with high levels above or equal to 100 IU/ml, 1000 IU/ml, or below the entire population and a group whose total serum IgE was below the cutoff point. Although children with high total serum IgE levels presented higher rates of allergic sensitization than children in the low IgE groups, the effect of social class on allergic sensitization was evident in both cases (Figure 1).

The distribution of health-relevant factors and lifestyle characteristics among children in the 3 social classes is presented in Table 3. These factors were assessed to elucidate living conditions that may explain the observed differences in health outcomes between the social classes.

The influence of potentially confounding covariates on the association between allergic sensitization (dependent variable) and social class (explanatory independent variable) and the existence of interaction were

analyzed for 1000 subjects with complete data for the relevant variables. Children in social classes II and III were compared with participants in social class I, which served as the reference group.

The multivariate odds ratio for allergic sensitization comparing social class III with class I was 2.1, while the odds ratio comparing class II with class I was 2.0 (Table 4). Adjustment for individual covariates did not substantially influence the association between allergic sensitization and social class. However, one model assuming covariates reaching a significance level of $P < 0.05$ was presented in Table 4. Interactions, assessed by including two each of the following models (multivariate odds of the relationship between allergic sensitization and the covariate under scrutiny, was not present in any of the tested models). The final multivariate model included all variables selected a priori as theoretical grounds (sex, parental unemployment when skin-prick test was performed, smoking exposure, and total serum IgE). Only 2 other variables, study region and receipt of family benefits, resulted in significance levels of $P < 0.05$ or less and met the criteria required for inclusion in the final multivariate model.

Total serum IgE (converted to the natural logarithm) and treated as a continuous variable had a considerable influence on the association between social class and allergic sensitization. Inclusion of the IgE variable in

TABLE 2—Lifetime Prevalence of Atopic Diseases and Characteristic Symptoms as Reported by Parents and Point Prevalence of Physician-Diagnosed Atopic Dermatitis, Allergic Sensitization, and Elevated Total Serum IgE in Children Aged 5 to 14 Years (n = 2402), by Social Class: Sachsen-Anhalt, Germany, 1992–1993

	Social class ^a					
	I		II		III	
	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)
<i>Atopic disease or symptom (questionnaire information)</i>						
Asthma or wheezy bronchitis ^b	191	4.7 (2.2, 8.8)	1173	7.6 (6.3, 9.4)	1021	10.8 (8.9, 12.8)
Wheezing (more than once) ^c	173	8.7 (4.9, 13.9)	1117	20.9 (18.5, 23.4)	961	22.8 (20.4, 25.6)
Eczema ^d	190	4.2 (1.8, 8.1)	1180	9.6 (8.0, 11.4)	1024	11.8 (9.9, 14.0)
Eczematous rashes ^d	169	8.5 (4.9, 13.4)	1170	14.1 (12.2, 16.2)	1021	16.5 (14.2, 18.9)
Allergic rhinitis ^d	190	1.1 (0.1, 3.8)	1180	4.1 (3.0, 5.4)	1024	5.0 (3.7, 6.5)
Allergic reaction ^d	190	10.5 (6.5, 15.8)	1170	12.6 (10.8, 14.7)	1023	15.3 (13.2, 17.7)
Atopic dermatitis (dermatologic examination)	163	0.0 (0.0, 2.2)	1053	3.3 (2.3, 4.6)	909	2.0 (1.2, 3.1)
<i>Allergic sensitization (skin-prick test)</i>						
At least 1 of 12 tested allergens	165	11.5 (7.1, 17.4)	1057	20.6 (18.2, 23.2)	904	22.1 (19.5, 25.0)
Mite allergens only (der p1 or der 11)	165	3.0 (1.0, 6.9)	1057	7.7 (6.1, 9.4)	904	8.3 (6.6, 10.3)
Fungal allergens only (aspergillus, alternaria)	165	5.5 (2.5, 10.1)	1057	5.2 (3.9, 6.7)	904	7.3 (5.9, 9.4)
Pollen (local grasses, hazel, birch, plantain, mugwort)	165	7.3 (3.8, 12.4)	1057	14.3 (12.2, 16.5)	904	15.5 (13.2, 18.0)
Cat epithelium	165	0.0 (0.0, 2.2)	1057	3.1 (2.2, 4.4)	904	3.7 (2.5, 5.1)
At least 2 of 12 tested allergens	165	8.5 (4.7, 13.8)	1057	12.9 (10.9, 15.0)	904	15.2 (12.9, 17.7)
Total serum IgE ≥ 140 IU/mL ^e	151	27.8 (20.8, 35.7)	904	19.6 (17.2, 22.2)	859	19.2 (16.6, 22.0)

Note. CI = confidence interval.

^aThe social level of a family was defined by the highest school grade completed by either the mother or the father of the study subject.

Families with parental education of less than 10 grades were defined as belonging to social class I; 10 grades, class II; more than 10 grades, class III.

^bPhysician-diagnosed diseases as reported by parents.

^cPerceived by parents.

^dThis value represented the 80th percentile of the entire population.

For Social Class I, Asthma or Wheezy bronchitis

$n = 191$ $p = 0.047$ or 4.7%

1. *The hypothesis:* $H_0: P = 0.10$ vs $H_1: P \neq 0.10$

2. *The assumptions:* Independence

3. *The α -level:* $\alpha = 0.05$

4. *The test statistic:*
$$z = \frac{p - 0.10}{\sqrt{\frac{p(1-p)}{n}}}$$

5. *The rejection region:* Reject $H_0: P = 0.10$, if z is not between ± 1.96

6. *The result:*

$$z = \frac{0.047 - 0.100}{\sqrt{\frac{0.047(1 - 0.047)}{191}}}$$

$$z = \frac{0.053}{\sqrt{\frac{0.047(0.953)}{191}}}$$

$$z = \frac{0.053}{\sqrt{\frac{0.0448}{191}}} = \frac{0.053}{\sqrt{0.0002}} = \frac{0.053}{0.0153}$$

$$z = 3.46$$

7. *The conclusion:* Reject H_0 : $P = 0.10$ since z is not between ± 1.96

Confidence Interval, with $\alpha = 0.05$

$$n = 191, p = 0.047, p(1-p) = 0.047(0.953) = 0.0448$$

$$C\left[p - 1.96\sqrt{\frac{p(1-p)}{n}} < P < p + 1.96\sqrt{\frac{p(1-p)}{n}}\right] = 0.95$$

$$C\left[0.047 - 1.96\sqrt{\frac{0.0448}{191}} < P < 0.047 + 1.96\sqrt{\frac{0.0448}{191}}\right] = 0.95$$

$$C[0.047 - 1.96(0.0153) < P < 0.047 + 1.96(0.0153)] = 0.95$$

$$C[0.047 - 0.03 < P < 0.047 + 0.03] = 0.95$$

$$C[0.017 < P < 0.077] = 0.95 \quad \text{or}$$

$$C[1.7\% < P < 7.7\%] = 0.95 \quad \text{vs} \quad C[2.2\% < P < 8.8\%] = 0.95$$