

The epidemiology of ocular and nasal allergy in the United States, 1988-1994

Kavita Singh, MD,^a Sara Axelrod, MD, MPH,^b and Leonard Bielory, MD^{c,d} *Brentwood, Tenn, and Newark, New Brunswick, and Springfield, NJ*

Background: Allergies give rise to the fifth-leading group of chronic diseases. However, the specific prevalence of ocular allergy is poorly described.

Objective: We sought to provide a more accurate representation of the epidemiology of ocular allergy in the United States.

Methods: The National Health And Nutrition Examination Survey III performed in the United States from 1988-1994 was the source for the data collected. Items from the questionnaire regarding ocular and nasal allergy symptoms in relation to skin prick testing were stratified by age, race, region, and sex.

Results: The sample size is 20,010: 1,285 (6.4%) reported ocular symptoms, 3,294 (16.5%) reported nasal symptoms, 5,944 (29.7%) reported both ocular and nasal symptoms, and 9,487 (47.4%) were asymptomatic. Forty percent of the population reported at least 1 occurrence of ocular symptoms in the past 12 months. Those 50 years and older have a higher frequency of isolated ocular symptoms ($P < .001$). There is an increase in the frequency of symptoms in those younger than 50 years in the populations of subjects with ocular and nasal symptoms combined and isolated nasal symptoms ($P < .001$). Ocular symptoms are more frequent than nasal symptoms in relation to animals ($P < .001$), household dust ($P < .001$), and pollen ($P < .001$).

Conclusion: This analysis provides the first representation of the epidemiology of ocular allergy in the United States. Up to 40% of the population, the highest reported to date, have experienced ocular symptoms at least once in their lifetime, with a peak of symptoms in the months of June and July. (*J Allergy Clin Immunol* 2010;126:778-83.)

Key words: Ocular allergy, epidemiology, nasal allergy symptoms, seasonal allergic conjunctivitis, perennial allergic conjunctivitis, vernal keratoconjunctivitis, atopic keratoconjunctivitis, giant papillary conjunctivitis

Abbreviations used

MEC: Mobile examination center

NHANES: National Health and Nutrition Examination Survey

SAC: Seasonal allergic conjunctivitis

Allergies affect more than 50 million Americans and account for the fifth-leading chronic disease group. Allergic rhinoconjunctivitis (nose and eye involvement) is more commonly referred to as allergic rhinitis because the nasal symptoms of congestion and rhinorrhea are a more common complaint compared with ocular symptoms. Allergic conjunctivitis is a mast cell-mediated hypersensitivity reaction that can be an acute or chronic illness that involves inflammation of the conjunctiva, sparing the cornea in the mild forms but in the more chronic forms possibly involving the cornea and threatening vision in the forms of vernal keratoconjunctivitis and atopic keratoconjunctivitis. Symptoms for all forms of ocular allergy include tearing, itching and burning, vasodilatation, and chemosis.

The prevalence of allergic conjunctivitis has not been well studied. The third National Health and Nutrition Examination Survey (NHANES III), 1988-1994, provides the ability to estimate the epidemiology of ocular allergy, as well as its relation to allergen exposure and immediate skin testing, in a cross-sectional sample of the US population. This analysis evaluates the prevalence of ocular allergy and nasal allergy symptoms in relation to skin prick testing, which can then be extrapolated to reflect prevalence in the US population. The primary objective is to examine the prevalence and describe the epidemiology of ocular and nasal symptoms as they relate to age, region, and allergen triggers in the US population.

METHODS

NHANES III

The NHANESs are standardized surveys providing a snapshot of the health and nutrition of the US population. NHANES III is the third population-based survey that was conducted over a 20-year period by the National Center for Health Statistics to determine the health and nutritional status of the US population from 1988 through 1994. The survey was conducted throughout 81 counties in the United States. Over the 6-year period, 39,695 persons were selected, and of those, 33,994 (89%) were interviewed in their homes. All those interviewed were invited to be included in the medical examination section of the survey; 30,818 (78%) were examined in the mobile unit, and 493 were examined in their home. The population surveyed represents the civilian noninstitutionalized population 2 months to 90 years of age.

Questionnaire

The questionnaire component of this study was separated into the adult (>17 years old) and youth (2 months to 16 years old) questionnaires. This

From ^aDepartment of Medicine-Pediatrics, Cool Springs Internal Medicine & Pediatrics, Brentwood; ^bDepartment of Allergy and Immunology, the University of Medicine and Dentistry-New Jersey Medical School, Newark; ^cthe Center for Climate Prediction, Rutgers University, New Brunswick; and ^dSTARx Allergy and Asthma Research Center, Springfield.

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Reprint requests: Leonard Bielory, MD, 400 Mountain Ave, Springfield, NJ 07081.

E-mail: drlbielory@gmail.com.

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analysis focuses only on adult data. The questionnaire included demographics, socioeconomic status, dietary and nutrition habits, and health-related questions concerning many areas of disease. Our substudy analysis included demographic variables and specific questions from the respiratory and allergy section. The questions were designed to obtain information on trigger factors and severity of lower and upper airway disorders, as well as ocular symptoms related to allergies (see [Appendix E1](#) in this article's Online Repository at www.jacionline.org).

Allergy skin testing in NHANES III

Prick-puncture allergy skin testing was performed on all subjects 6 to 19 years old and on a random selection of half of the population 20 to 59 years old. Ten allergens were tested, and all seasonal and perennial aeroallergens were examined (peanut allergen was omitted), including *Dermatophagoides farinae* (house dust mite), *Felis domesticus* (cat), *Blattella germanica* (German cockroach), *Ambrosia artemisiifolia* (short ragweed), *Lolium perenne* (perennial rye), *Alternaria alternata*, *Cynodon dactylon* (Bermuda grass), *Salsola kali* (Russian thistle), and *Quercus alba* (white oak). The 2 controls included histamine phosphate and 50% glycerol saline. Immediate skin reactions were read 15 ± 5 minutes after administration, and orthogonal dimensions of both the wheal and flare were recorded. A 0 was recorded if all dimensions were less than 3 mm, and all 4 dimensions were recorded if any dimension was greater than 3 mm. A positive wheal reaction was considered as any wheal area greater than 3 mm.

Those who had no baseline shortness of breath but had difficulty breathing at the time of the examination, those who had baseline shortness of breath at the time of the examination had worsening shortness of breath, and those who had a history of severe reaction to allergen testing previously or had severe bilateral eczema on the upper extremities at the time of the examination were medically excluded from allergy skin testing.

Statistical analyses

The comprehensive database published by the Centers for Disease Control and Prevention was analyzed. Because the survey design is complex, sample weighted populations (see [Fig E1](#) in this article's Online Repository at www.jacionline.org; the description is shown in the Methods section of this article's Online Repository at www.jacionline.org) were used to estimate the means, incidence, and prevalence of the variables of interest. The main objective of the analysis was to describe the epidemiology of ocular symptoms associated with allergen exposure (defined as ocular allergy) in the United States during the abovementioned time period. The first stage of data analysis was characterizing the populations and their association with the variables described below. The following question from the respiratory segment of the questionnaire (see [Appendix E1](#)) was used to define 4 distinct populations: "L11. During the past 12 months, have you had any episodes of: A. Stuffy, itchy, or runny nose? B. Watery, itchy eyes?" Once these populations were extracted, each was examined independently for their relation to the following variables: age, census region, the number of episodes of symptoms, presence of a smoker in the home, and exacerbation by pollen and other triggers (including exposure to animals, having a cat in the home, and household dust). This was performed through sequential step-wise extractions (see [Fig E2](#) in this article's Online Repository at www.jacionline.org). A fourth population was defined by using the same question described above to create a negative control group (populations are defined in [Table E1](#) in this article's Online Repository at www.jacionline.org).

The second stage of data evaluation involved linking the association of wheal reactivity with symptoms in the above 4 populations. The longest wheal length and width were evaluated for each allergen and negative and positive controls and used to calculate the area of the wheal by using the following formula: $(\pi/4) \times \text{Diameter wheal width} \times \text{Diameter wheal length}$. For standardization, the areas of both controls were subtracted from the calculated area of wheal for each participant (positive = area > 3 mm²). The percentage of positive wheal reactions was then compared across populations. Simple χ^2 analysis was performed.

RESULTS

The NHANES study surveyed a total of 33,944 subjects. Of these, 20,010 (59%) answered the relevant questions used to

determine the subset populations: 1,285 (6.4%) reported ocular symptoms alone, 3,294 (16.5%) reported nasal symptoms alone, 5,944 (29.7%) reported both ocular and nasal symptoms, and 9,487 (47.4%) were asymptomatic (no ocular and no nasal symptoms, see [Fig E1](#)).

At the time of the conducted study, 40% of the population reported at least 1 occurrence of ocular symptoms, and 54% reported at least 1 occurrence of nasal symptoms. Six percent reported repeated isolated ocular or nasal symptoms (16% with isolated nasal symptoms and 30% with combined ocular and nasal symptoms). [Table 1](#) shows projections in the years 2008 and 2010.

[Figs 1, 2, and 3](#) stratify age, census region, number of episodes per year, and symptom triggers by the 3 symptomatic populations. With regard to age, the population was divided into age groups by decade to evaluate the prevalence of symptoms. Approximately 30% of those with nasal symptoms or ocular and nasal symptoms were in the 17- to 29-year-old range compared with 10% in the 70- to 89-year-old range, with a consistent trend downward with increasing age. In contrast, 15% to 20% of those with ocular symptoms reported symptoms throughout each decade of life. Age groups by symptom are examined by using χ^2 analysis. For isolated ocular symptoms in age groups of 17 to 39 years (33.6%) and greater than 40 years (66.4%), there is a statistically significant difference between the 2 age groups ($P < .001$), with the older age group having a higher frequency of isolated ocular symptoms. For both ocular and nasal symptoms combined, the age groups created were 0 to 49 years (72.4%) versus 50 or more years (27.6%), revealing a statistically significant difference ($P < .001$), with the younger age group having a higher frequency of both ocular and nasal symptoms. For isolated nasal symptoms, the age groups created were 0 to 49 years (68.8%) versus 50 or more years (31.2%), with the younger group having a statistically significantly higher frequency of nasal symptoms ($P < .001$).

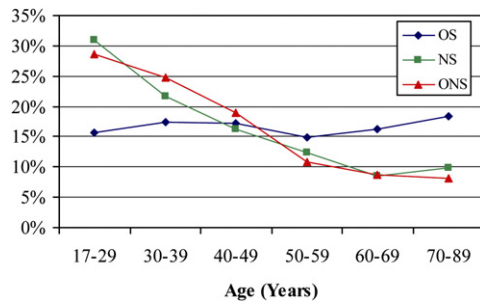
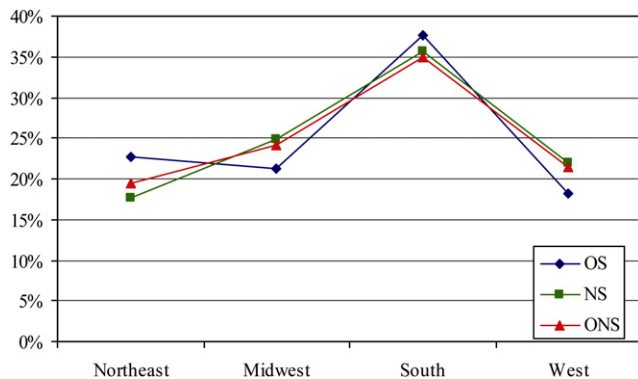
All 3 populations displayed similar trends in prevalence across the census region except for a slight increase in the South (17% to 22% in the Northeast, 21% to 25% in the Midwest, 18% and 21% in the West, and 35% to 38% in the South, [Fig 2](#)).

Subjects were also asked to report how many episodes they experienced in 1 year. Those with nasal symptoms alone recalled fewer than 7 isolated episodes, with 33.7% of subjects experiencing only nasal symptoms reporting 1 episode compared with the population with ocular symptoms (20%) and the population with ocular and nasal symptoms (15.7%) reporting only 1 episode per year ([Fig 3](#)). In analyzing a relationship of symptoms to potential triggers, all 3 populations had symptoms equally triggered by tobacco smoke (33.9% to 36.4%) and cat exposure (17.6% to 21.6%). A larger percentage of the population with ocular and nasal symptoms had symptoms triggered by animal exposure, household dust, and pollen compared with the population with ocular and nasal symptoms, almost 50% in each case. Interestingly, pollen as a trigger was greater in the population with ocular symptoms than the population with nasal symptoms (44% vs 24%, [Fig 4](#)). By using χ^2 analysis comparing ocular versus nasal symptoms by trigger, ocular symptoms are reportedly more common than nasal symptoms in relation to the common allergens of animals, household dust, and pollen ($P < .001$).

When broken down by month, all 3 populations had similar overall trends with regard to symptoms triggered by pollen; however, the population with nasal symptoms and that with ocular and nasal symptoms had peaks in the Spring (April-May) and Fall

TABLE I. Prevalence of symptoms with projections in 2008 and 2010

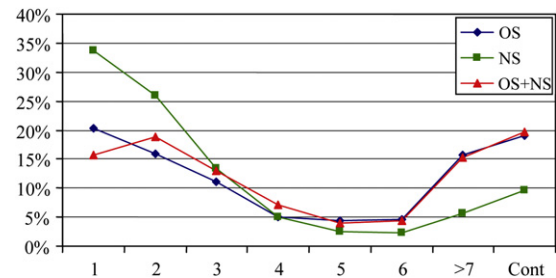
General population	Percentage	1988-1994: 187,647,206	2008: 305,043,450	2010: 308,935,581
Any episode of ocular symptoms	40%	74,207,809	122,017,380	123,574,232
Any episode of nasal symptoms	54%	101,777,776	164,723,463	166,825,214
Isolated ocular symptoms	6%	9,556,028	18,302,607	18,536,134
Isolated nasal symptoms	16%	37,102,699	48,806,952	49,429,693
Both ocular and nasal symptoms	30%	64,651,782	91,513,035	92,680,674

**FIG 1.** Symptoms experienced by age. NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.**FIG 2.** Symptoms experienced by census region. NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

(Sept-Oct), whereas the population with ocular symptoms was more frequently affected in June and July (Fig 5).

In an attempt to further correlate the symptom complex with specific allergens, a subset of participants in NHANES were skin tested to an allergen panel (see the Methods section); 10,789 (31.8%) surveyed had skin test results reported, but only 6,032 (30%) had skin testing and answered the questions of the allergy segment: 23% in the ocular symptoms group, 32% in the nasal symptoms group, 32% in the ocular and nasal symptoms group (experienced both ocular and nasal symptoms), and 29% in the asymptomatic group (see Fig E3 in this article's Online Repository at www.jacionline.org).

When evaluating skin testing by symptom, the population with ocular symptoms revealed a greater percentage of positive wheal reactivity to weeds (24.2%), 3 times the amount compared with grass (8.1%), mold, and indoor allergens (8.4%). When taking into account the asymptomatic population, mold had no effect on reactivity. In the population with nasal symptoms, the weed allergens correlated with greater wheal reactivity, with almost no positive wheal reactions in any of the other allergen groups. Although these 2 populations had greater reactivity in the weed category, the population with ocular symptoms was greater than the

**FIG 3.** Symptoms by number of episodes per year. NS, Nasal symptoms; OS, ocular symptoms; OS + NS, ocular and nasal symptoms.

population with nasal symptoms (6% to 18% vs 2% to 11%). The population with ocular and nasal symptoms showed greater wheal reactivity in all categories of allergens, with weed being the greatest (11% to 25%), but similar reactivity to tree (10%), grass (12%), and indoor allergens, such as cat (13%) and mite (10%, Fig 6).

On evaluation of the number of allergens to which the populations had a positive wheal reaction, the population with nasal symptoms had the greatest percentage of no allergen reactivity. This implies that very often those with nasal symptoms had no positive skin test responses. The population with ocular symptoms had the greatest amount of reactivity in the group with 1 to 3 allergen category. The population with ocular and nasal symptoms showed high wheal reactivity toward all allergens (Fig 7).

DISCUSSION

The analysis of NHANES III demonstrates that there are 3 distinct populations with regard to ocular and nasal allergy symptoms and that each of these populations demonstrates differences in epidemiology and skin reactivity profiles. At the time of NHANES III, 6% of the US population, approximately 18.5 million (according to current US population clock) persons, reported isolated ocular symptoms throughout the year, and up to 40% reported symptoms at least once during the 6-year period of the conducted study, the highest prevalence reported to date. Ocular symptoms tend to be prevalent throughout all decades of adult life in contrast to those with nasal symptoms alone or both ocular and nasal symptoms, which appear to be more common at younger ages. When comparing age group by symptom, older patients (>50 years old) have more frequent isolated ocular symptoms, whereas younger patients (<50 years old) have more frequent isolated nasal and combined nasal and ocular symptoms. This might be partly due to other ocular conditions that could develop later in life contributing to this, such as tear film dysfunction (dry eye syndrome), which appears to increase with age, whereas atopy decreases with age.

Trends in the prevalence of ocular symptoms alone are similar by census region for all 3 populations, with the greatest prevalence in the South. Southern climates are associated with increased

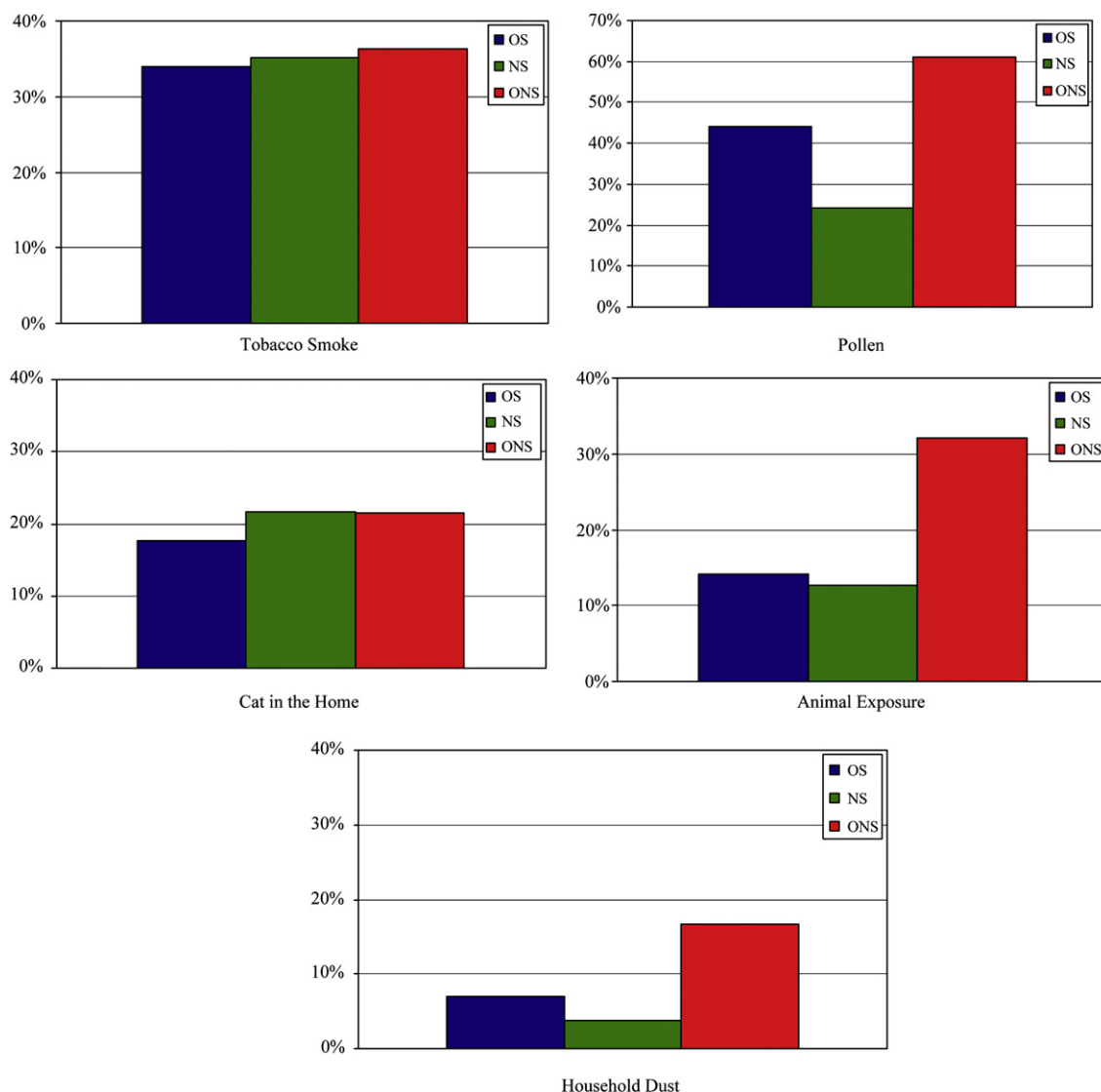


FIG 4. Symptoms triggered by environmental allergens. NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

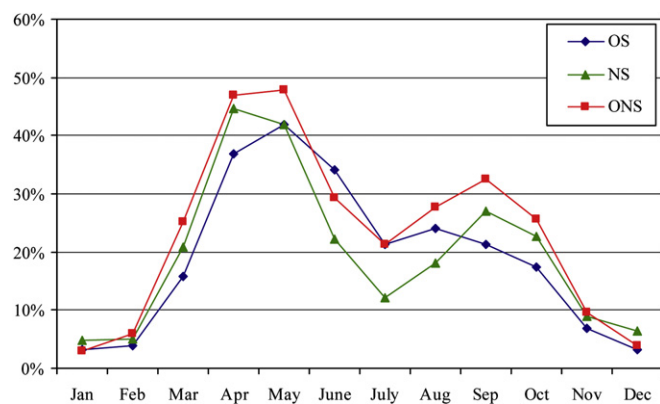


FIG 5. Symptoms experienced by month of year. NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

temperature and extremes in humidity (moisture and dryness). Climate change can also project that allergies, specifically ocular allergies, might be increasing over the course of the next century.¹

NHANES III provides evaluation of skin testing reactivity and its relation to our 3 populations. When the populations were extracted, the percentage in each population was almost equal, with the outlier being the population with ocular symptoms at 23%. In addition, skin testing of those who reported no symptoms was also analyzed to provide a control population. Weed and pollen had the greatest reactivity in all 3 populations, which is expected because pollen is one of the most potent triggers of allergy symptoms. We found that the population with nasal symptoms experienced the least percentage of wheal reactivity. The population with ocular symptoms had positivity based on skin reactions to all classes of allergen, except for mold.

It is estimated that by 2015, half of the population of Europe will be affected by ocular allergies, such as hay fever, and the introduction of ragweed to the European continent will undoubtedly increase

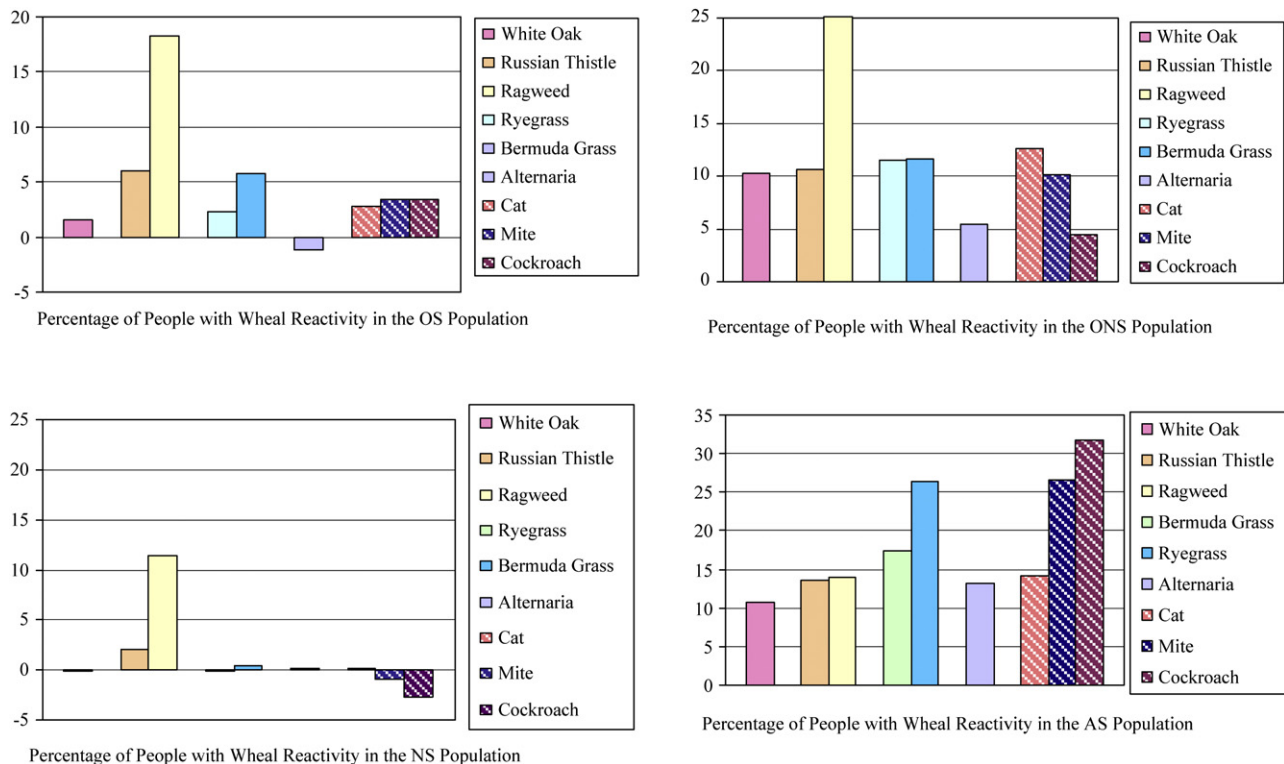


FIG 6. Comparison of wheal activity across all populations. The values shown in the last graph of the asymptomatic (AS) population were subtracted from the original data, resulting in the above results. This was done to account for those in the population without symptoms who still show skin wheal reactivity (false-positive results). NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

this even more.² Ocular allergy imposes a notable economic cost through lost productivity, days off school and work, and costs of treatment and remedies (<http://www.birminghamsciencecity.co.uk>). Some recent studies have tracked quality-of-life issues, such as lost productivity in patients with ocular allergy.

A seasonal allergic conjunctivitis (SAC) study in Spain (201 patients with SAC and 200 control subjects) reported that nearly 20% of allergic patients experienced a direct effect in terms of work absenteeism ($x = 2.84$ days) and 45% in terms of decreased productivity because of their allergic symptoms within a 1-year period. The scores of patients with allergy were significantly less than those of control subjects for overall vision, distance vision, ocular pain, mental health, role limitations, and dependency domains.³

Similarly, a British study reported a greater degree of discomfort and a lower perception of health compared with a control population in patients with allergy versus those without allergies. The patients also reported extra time spent visiting doctors for treatment. Total per-patient cost was £64.61 (US \$128.79) for a retired patient and £142.29 (US \$283.67) for an employed patient.⁴ Participants in a Spanish study estimated that within 1 year, they spent an average of 150.82 Euros (US \$203.72) on medication, air filters, and other items needed to help alleviate their symptoms. Adding this to the cost of reduced productivity, the total per-sufferer cost of SAC is estimated at 348.50 Euros/y (US \$470.80/y).³

These studies reveal the potential financial effect that allergic conjunctivitis has on employee work productivity and quality of life. These results are probably still an underestimation because only small portions of patients with ocular allergy seek treatment.

Many of the epidemiologic studies conducted in the United States have focused on allergic rhinitis and nasal symptoms with

and without ocular data. For example, the Allergies in America Survey found 38% of the US population has nasal allergies, but up to 25% to 40% of these persons reported associated red, watery, itchy eyes.⁵ In 2007, a European survey found that among patients with allergic rhinitis, itchy/red eyes and watery eyes were reported by 71% and 67%, respectively, of patients reporting these symptoms.⁶ Similarly, in 2007, a review of 447 patients with allergic rhinitis in the United States revealed that 64% of patients reported experiencing itchy/red eyes, whereas 43% reported watery eyes.⁷ These surveys demonstrate the effect of ocular allergy as part of the burden associated with allergic rhinitis and potentially reveal the epidemiology of isolated ocular allergy.

An epidemiologic ocular allergy survey was performed during the winter of 1994-1995 to define the main characteristics of patients with chronic, perennial allergic conjunctivitis or keratoconjunctivitis. Of 791 patients, 40% had perennial manifestations without any seasonal exacerbation, whereas 50% experienced a seasonal worsening.⁸ In 1998, a review estimated that SAC affects up to one fifth of the adult population in the United Kingdom.⁹ Likewise, a study in 2000 approximated that 20% of the American population is afflicted with SAC.¹⁰ In a Mexican review of children between the ages of 6 and 14 years, the prevalence of ocular allergy was found to be 9.7%.¹¹ A review was performed of children aged 5 to 15 years referred during the period of 2002-2004 in whom allergic conjunctivitis, asthma, allergic rhinitis, or eczema was diagnosed; 458 children with a mean age of 9.4 years were studied. One hundred thirty-seven (30%) had allergic conjunctivitis.¹²

In Phase III of the International Study of Asthma and Allergies in Childhood,¹³ time trends in the prevalence of rhinoconjunctivitis symptoms were analyzed. Cross-sectional questionnaire surveys

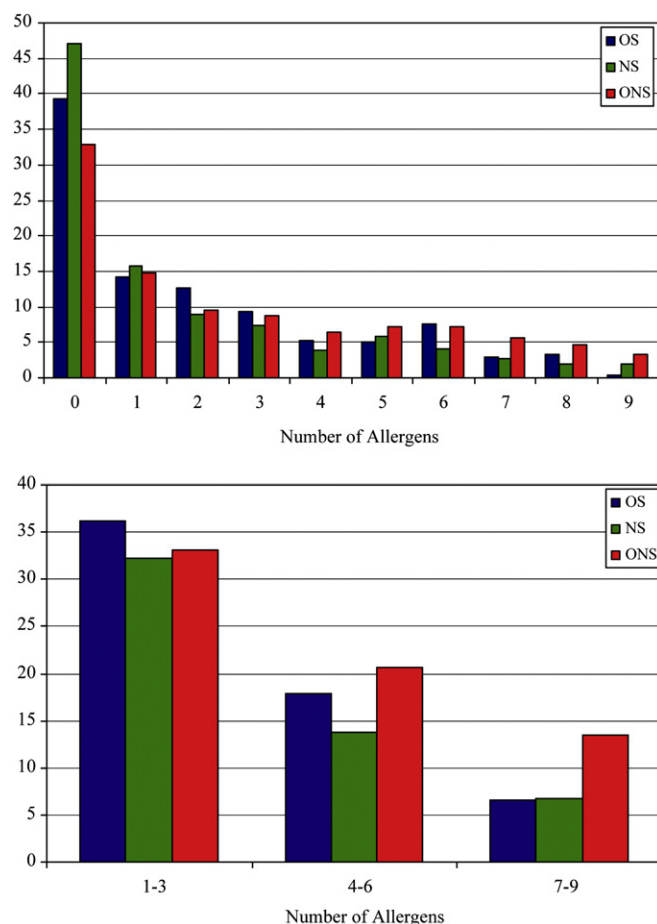


FIG 7. Numbers of allergens by trigger symptoms. NS, Nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

with identical protocols and questionnaires were completed a mean of 7 years apart in 2 age groups comprising 498,083 children. A worldwide increase in rhinoconjunctivitis prevalence was observed, but the variations were considerable within the test centers, and they found no consistent regional pattern. Prevalence increases in the older children exceeding 1% per year were recorded in 13 centers. They found a prevalence increase in several centers, mostly in low- and middle-income countries. The increases were more pronounced in the older age group, suggesting that environmental influences on the development of allergy might not be limited to early childhood.¹³ In the Allergologica 2005 study, the prevalence of allergic rhinoconjunctivitis in children younger than 14 years was 44.7%, making it the most frequently diagnosed allergic disorder.¹⁴

In a review on the epidemiology of allergic diseases in Turkey using the International Study of Asthma and Allergies in Childhood questionnaire, the prevalence of allergic rhinitis and allergic conjunctivitis was 14.5% and 13%, respectively. The burden of allergy was 27.1%. The prevalence of concomitant eczema and rhinitis was 1.9%. Also, using the International Study of Asthma and Allergies in Childhood questionnaire, a study in the Asia-Pacific rim noted that rhinoconjunctivitis was only modestly common in adolescents but was quite prevalent in the younger children in the Asia-Pacific region, ranging up to 24% in Taiwan.¹⁵

In 2008, in an epidemiologic review of 1,106 Finnish and Russian schoolchildren, the prevalence of allergic conjunctivitis

was 4.7% versus 3.5% ($P = .234$) in the respective populations of children.¹⁶

Our analysis demonstrates that clinical ocular and nasal symptoms in NHANES III provide a snapshot of allergic and nonallergic entities that reflect linkage (overlap) and independent disorders of the eye in some patients. This is important from a public health perspective but also important to the individual patient because it shapes the treatment plan. The focus has often been on rhinitis and less so on conjunctivitis.

Limitations include the questionnaire and the way that the questions were phrased. We had to decide which questions we believed were appropriate for the survey and the fact that pediatric data and results are not included in this analysis.

The NHANES III database provides the comparison of the epidemiology of allergy symptoms and allows the ability to more clearly define particular populations as the public health burden of allergies continues to grow.

We thank Michael Brimacombe for assistance with statistical analysis.

Clinical implications: This representation of the epidemiology of ocular allergy in the United States has implications that necessitate that anterior inflammatory disorders of the eye, including ocular allergy, be addressed on a public health level.

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METHODS

Description of sample weights

Sample weights are available for analyzing NHANES III data. One of the following 3 sample weights will be appropriate for nearly all analyses: interviewed sample final weight (WTPFQX6), examined sample final weight (WTPFEX6), and mobile examination center (MEC)– and home-examined sample final weight (WTPFHX6). Choosing which of these sample weights to use in any analysis depends on the variables being used.

These subsample weights are for analysis of allergy measurements. Allergy skin reactivity tests were administered to all MEC-examined persons aged 6 to 19 years and a random half-sample of the adults aged 20 to 59 years. Eligible MEC-examined persons who did not complete the allergy tests have a sampling weight of 0 and are excluded from the analyses. Final MEC examination weights were first adjusted for selection of the half-sample among adults (20-59 years) and poststratified to the unpublished Current Population Survey 1990 (phase 1) and 1993 (phase 2) population control estimates of the US population adjusted for undercount in the final step. For details, see Weighting and Estimation Methodology (US Department of Health and Human Services, 1996) and NHANES III Analytic and Reporting Guidelines (US Department of Health and Human Services, 1996; ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHANES/NHANESIII/1A/lab-acc.pdf).

APPENDIX E1. Questions from the NHANES III questionnaire used for the study

Age at interview (screener) -qty..... HSAGEIR
Census region, weighting (Texas in south).... DMPCREGN
Do any pets live in this home..... HFE7
Pet lives here—a cat..... HFE8B
Anyone living here smoke cigs in home..... HFF1
During the past 12 months, have you had any episodes of....
Stuffy, itchy, or runny nose?.... HAL11A
Watery, itchy eyes?..... HAL11B
During the past 12 months, how many episodes of stuffy, itchy,
or runny nose, or watery, itchy eyes, have you had?....HAL12
Are any of the symptoms we have just talked about brought on
by...

Symptoms brought on by: exercise/cold air.... HAL14A
Symptoms brought on by: animals..... HAL14B
Symptoms brought on by: house dust..... HAL14C
Symptoms brought on by: pollen..... HAL14E
Month pollen symptoms worse: all months..... HAL15A
Month pollen symptoms worse: January..... HAL15B
Month pollen symptoms worse: February..... HAL15C
Month pollen symptoms worse: March..... HAL15D
Month pollen symptoms worse: April..... HAL15E
Month pollen symptoms worse: May..... HAL15F
Month pollen symptoms worse: June..... HAL15G
Month pollen symptoms worse: July..... HAL15H
Month pollen symptoms worse: August..... HAL15I
Month pollen symptoms worse: September..... HAL15J
Month pollen symptoms worse: October..... HAL15K
Month pollen symptoms worse: November..... HAL15L
Month pollen symptoms worse: December..... HAL15M
Stuffy, itchy, or runny nose?

- 1 Yes
- 2 No
- 8 Blank but applicable
- 9 Don't know
- Blank

Watery, itchy eyes?

- 1 Yes
- 2 No
- 8 Blank but applicable
- 9 Don't know
- Blank

During the past 12 months, how many episodes of stuffy, itchy,
or runny nose, or watery, itchy eyes, have you had?

- None, never
- 001-365
- 555 Constantly/continuously
- 888 Blank but applicable
- 999 Don't know

Are any of the symptoms we have just talked about brought on
by...

IF NECESSARY STATE SYMPTOMS: "Wheezing, whis-
tling, stuffy, itchy, or runny nose, watery, itchy eyes."

Animals?

- 1 Yes
- 2 No
- 8 Blank but applicable
- 9 Don't know

Blank
House dust?
1 Yes
2 No
8 Blank but applicable
9 Don't know
Blank
Pollen?
1 Yes
2 No
8 Blank but applicable
9 Don't know
Blank

During which months of the year does pollen make your
symptoms worse? CIRCLE ALL THAT APPLY

All months
1 Yes
2 No
8 Blank but applicable
9 Don't know
Blank

The same above responses apply to all of the following
months...

January
February
March
April
May
June
July
August
September
October
November
December

TABLE E1. Survey questions L11A and L11B and the control group

L11a	L11b	Population
Yes	Yes	Nasal and ocular symptoms
Yes	No	Nasal symptoms
No	Yes	Ocular symptoms
No	No	No symptoms

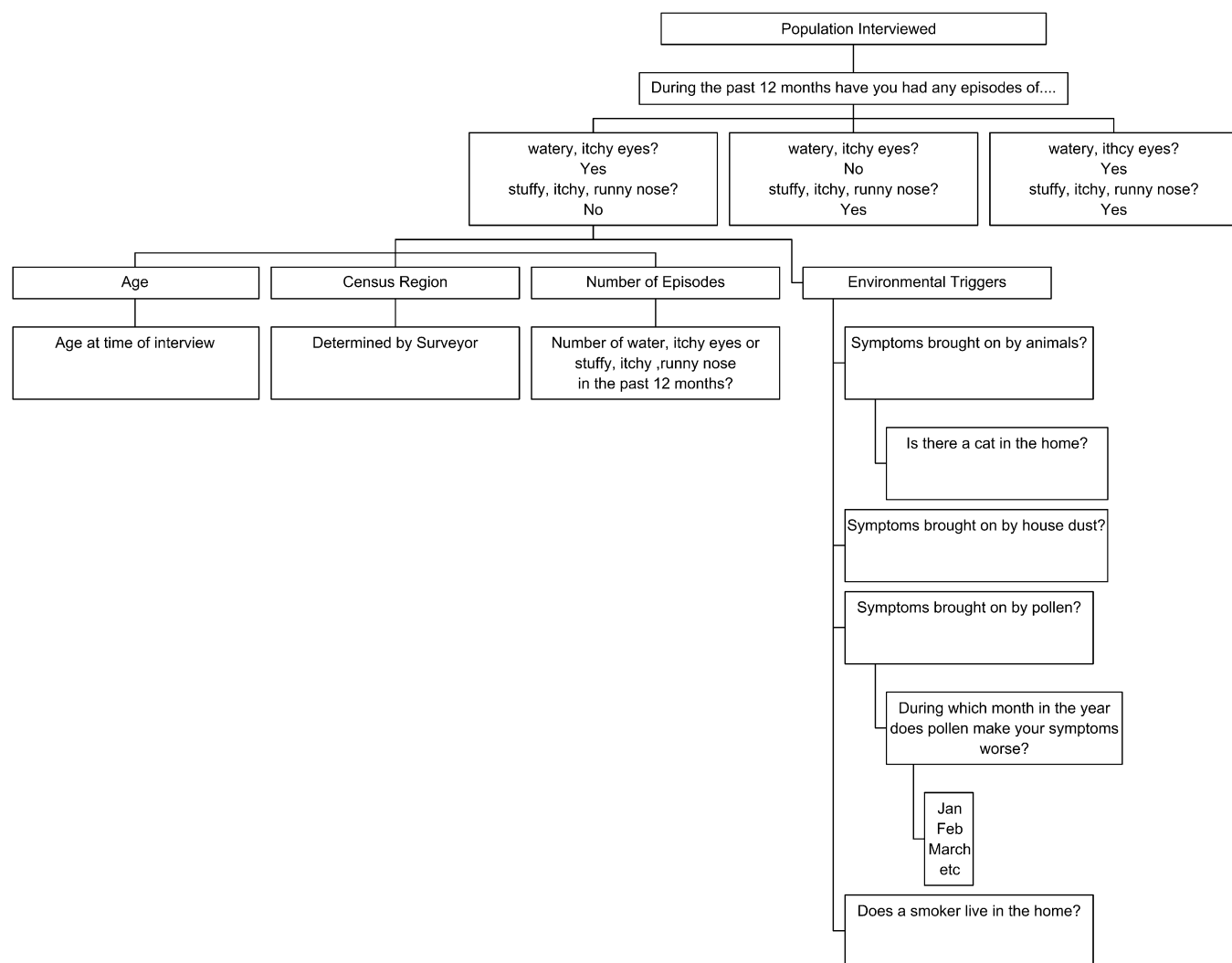


FIG E1. Stratification of data. Once these populations were extracted, each was examined independently for their relation to the following variables: age, census region, the number of episodes of symptoms, the presence of a smoker in the house, exacerbation by pollen, and other triggers. These other triggers include animals, a cat in the home, and household dust.

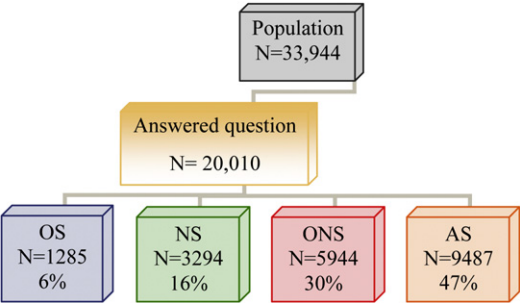


FIG E2. Prevalence of symptoms by question response. AS, Asymptomatic; NS, nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.

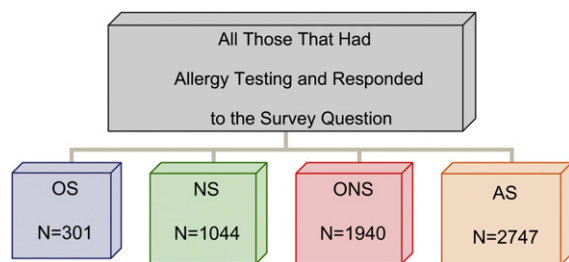


FIG E3. The percentage that received skin testing and answered the allergy questions. AS, Asymptomatic; NS, nasal symptoms; OS, ocular symptoms; ONS, ocular and nasal symptoms.