

# Prevalence of positive skin test responses to 53 allergens in patients with rhinitis symptoms

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## ABSTRACT

*Prior studies looking at allergic sensitization have focused on narrow age ranges or small numbers of allergens. This study is the first to examine the prevalence of positive skin test responses in a symptomatic military population with a wide age range of patients and large number of allergens. This study was a retrospective analysis of our skin test database. We included 1137 patients aged 4–79 years old who underwent our standard skin-prick testing panel of 53 aeroallergens and 2 controls using the Quintest device (Hollister-Stier, Spokane, WA). Results indicated that 81.6% of patients had at least one positive skin test. Rates of atopy were similar between male and female patients; 9.2% of patients were monosensitized. The average number of positive skin tests peaked in the 10- to 19-year age group at 13.1 and declined in older age groups. The prevalence of atopy peaked in the 30- to 39-year age group at 85.5% and decreased in older age groups. The most common allergens were grasses, mountain cedar, and dust mites. Sensitization rates for many underreported allergens, including mouse and rat, are presented. This study shows that 81.6% of patients in a symptomatic military population were atopic. These rates are high, even when compared with other allergic populations. Atopy peaked in young adulthood and declined in older age groups. Grasses, mountain cedar, and dust mites were the most common allergens. Although performed in a military population, these results should be applicable to many allergy practices.*

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**Key words:** Age, allergens, allergic rhinitis, military, natural history, prevalence, reactivity, retrospective, rhinitis, skin test

Rhinitis is one of the most common clinical conditions that allergists encounter. Skin testing is the main tool used to determine if a particular patient's rhinitis symptoms are allergic in etiology. In addition, skin testing is useful in guiding treatment recommendations. Several previous studies on skin test reactivity have been performed on both general and symptomatic population samples, typically using limited age ranges and small numbers of allergens. This study was designed to evaluate rhinitis patients of all ages undergoing testing with a large panel of allergens, a scenario more typically seen in the average allergy clinic.

This is also the first study looking at skin test reactivity in a symptomatic military population. The military population is quite unique because of its mobility, with most military personnel and their families relocating every few years. Between 2000 and 2001, 37% of military personnel moved, whereas only 15% of civilians moved.<sup>1</sup> Military personnel were nine times more

likely to move to another state and four times more likely to move from abroad. We speculated that this increased mobility might increase the diversity of allergic sensitization in this population. The purpose of this study was to determine the rates of skin test reactivity to common aeroallergens broken down by age group and to identify the most common allergen sensitivities in a military population.

## METHODS

This study was a retrospective analysis of our skin test database over the past 2 years. We included 1137 patients between the ages of 4 and 79 years who were referred to the Wilford Hall Medical Center Allergy/Immunology clinic in San Antonio, TX, with rhinitis symptoms. Each patient underwent skin-prick testing using the Quintest device (Hollister-Stier, Spokane, WA) and a panel of 53 aeroallergens plus a positive and negative control. A positive result was defined as a wheal 3 mm greater than the negative control read at 15 minutes. Atopy was defined as at least one positive skin test. Histamine (1 mg/mL) and 50% glycerin diluent were used as the positive and negative controls, respectively. Patients were excluded if they had either a negative histamine or positive diluent control ( $n = 77$ ). The aeroallergens, their concentration, and manufacturers are shown in Table 1.

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Table 1 Extracts

| Extract                                 | Strength       | Manufacturer    |
|-----------------------------------------|----------------|-----------------|
| Ash, white                              | 1:20 w/v       | Hollister-Stier |
| Birch mix                               | 1:10 w/v       | Hollister-Stier |
| Box elder/maple mix                     | 1:10 w/v       | Hollister-Stier |
| Cottonwood, common                      | 1:20 w/v       | Hollister-Stier |
| Cypress, Arizona                        | 1:20 w/v       | Hollister-Stier |
| Elm, American                           | 1:20 w/v       | Hollister-Stier |
| Hackberry                               | 1:20 w/v       | Hollister-Stier |
| Mesquite                                | 1:20 w/v       | Greer           |
| Mountain cedar                          | 1:10 w/v       | Hollister-Stier |
| Mulberry mix                            | 1:20 w/v       | Hollister-Stier |
| Oak mix                                 | 1:10 w/v       | Hollister-Stier |
| Olive                                   | 1:10 w/v       | Hollister-Stier |
| Palm, queen                             | 1:20 w/v       | Greer           |
| Pecan                                   | 1:10 w/v       | Hollister-Stier |
| Pine                                    | 1:20 w/v       | Hollister-Stier |
| Sycamore, American                      | 1:20 w/v       | Hollister-Stier |
| Walnut, black                           | 1:10 w/v       | Hollister-Stier |
| <i>Alternaria tenuis</i>                | 1:10 w/v       | Hollister-Stier |
| <i>Aspergillus fumigatus</i>            | 1:10 w/v       | Hollister-Stier |
| <i>Aspergillus niger</i>                | 1:10 w/v       | Hollister-Stier |
| <i>Bipolaris (Curvularia specifera)</i> | 1:10 w/v       | Hollister-Stier |
| <i>Epicoccum nigrum</i>                 | 1:10 w/v       | Hollister-Stier |
| <i>Fusarium vasinfectum</i>             | 1:10 w/v       | Hollister-Stier |
| <i>Helminthosporium interseminatum</i>  | 1:10 w/v       | Hollister-Stier |
| <i>Hormodendrum cladosporides</i>       | 1:10 w/v       | Hollister-Stier |
| <i>Penicillium notatum</i>              | 1:10 w/v       | Hollister-Stier |
| Bahia                                   | 1:10 w/v       | Hollister-Stier |
| Bermuda                                 | 10,000 BAU/mL  | Hollister-Stier |
| Johnson                                 | 1:10 w/v       | Hollister-Stier |
| Rye                                     | 100,000 BAU/mL | Hollister-Stier |
| Timothy                                 | 100,000 BAU/mL | Hollister-Stier |
| Burning bush (Kochia)                   | 1:10 w/v       | Hollister-Stier |
| Cocklebur, common                       | 1:10 w/v       | Hollister-Stier |
| Dock/sorrel mix                         | 1:10 w/v       | Hollister-Stier |
| Lambs quarter                           | 1:10 w/v       | Hollister-Stier |
| Marshelder/poverty mix                  | 1:20 w/v       | Hollister-Stier |
| Nettle (urtica)                         | 1:20 w/v       | Hollister-Stier |
| Pigweed/careless mix                    | 1:10 w/v       | Hollister-Stier |
| Plantain, English                       | 1:10 w/v       | Hollister-Stier |
| Ragweed GSW                             | 1:20 w/v       | Hollister-Stier |
| Russian thistle                         | 1:20 w/v       | Hollister-Stier |
| Sagebrush/mugwort                       | 1:20 w/v       | Hollister-Stier |
| Scale, wing                             | 1:20 w/v       | Hollister-Stier |
| <i>D. farinae</i>                       | 10,000 AU/mL   | Hollister-Stier |
| <i>D. pteronyssinus</i>                 | 10,000 AU/mL   | Hollister-Stier |
| Cat hair (AP)                           | 10,000 BAU/mL  | Hollister-Stier |
| Dog hair—dander                         | 1:10 w/v       | Hollister-Stier |
| Cockroach mix: American/German          | 1:10 w/v       | Hollister-Stier |
| Feather mix: chicken/duck/goose         | 1:10 w/v       | Hollister-Stier |
| Mouse epithelia                         | 1:20 w/v       | Greer           |
| Rat                                     | 1:10 w/v       | Greer           |

AP = acetone precipitated; BAU = bioequivalent allergy unit; GSW = (giant, short, Western).

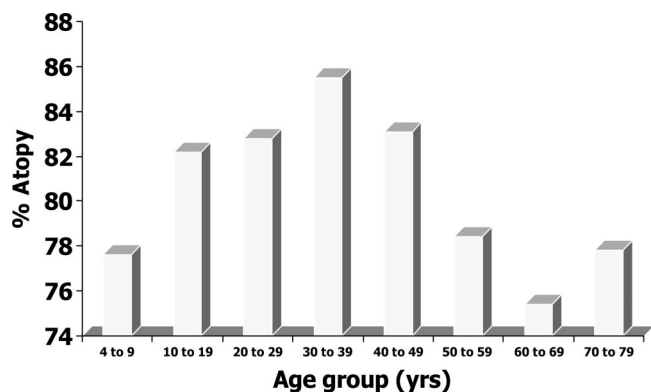


Figure 1. Percent atopy by age group.

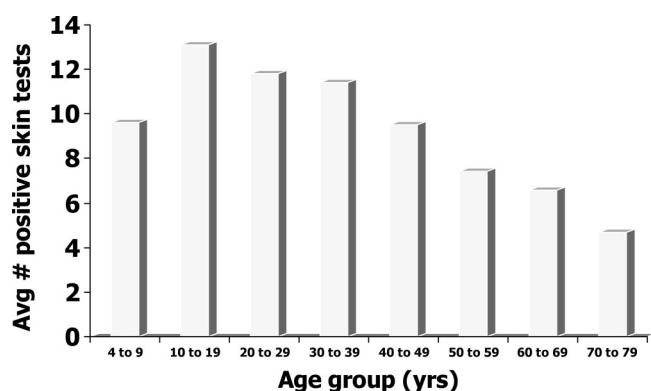


Figure 2. Average number of positive skin tests by age group.

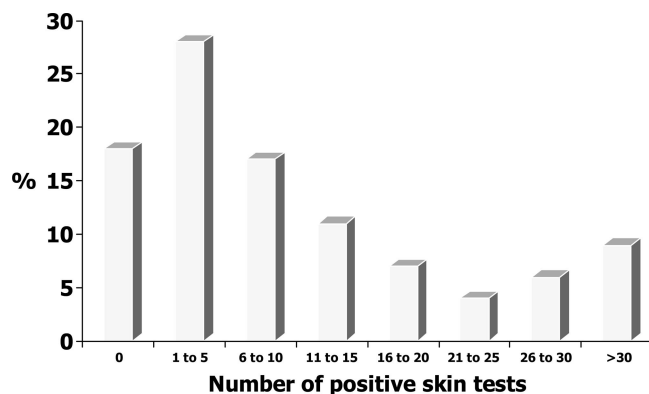


Figure 3. Percentage of the patients by number of positive skin tests.

Table 2 Most common allergens

| Allergen                | Prevalence (%) |
|-------------------------|----------------|
| Bahia                   | 44.8           |
| Rye                     | 44.5           |
| Timothy                 | 44.4           |
| Mountain cedar          | 43.0           |
| <i>D. pteronyssinus</i> | 40.7           |
| Bermuda                 | 40.5           |
| Ragweed                 | 39.7           |
| <i>D. farinae</i>       | 37.1           |
| Johnson                 | 34.9           |
| Oak                     | 34.2           |

## RESULTS

Results showed that 81.6% (928/1137) of patients had at least one positive skin test. Rates of atopy were similar between male (84%) and female (80%) patients. Sixty-two percent of atopic patients were positive to a combination of indoor and outdoor allergens, 30% were positive to indoor allergens alone, and only 7% were positive to outdoor allergens alone. Rates of sensitization were similar from year to year, based on analysis of 6-month periods within the 2-year study.

The prevalence of atopy was at least 75% in all age groups (Fig. 1). The prevalence began at 77.6% in the 4- to 9-year age group, increased through childhood and young adulthood, peaked at 85.5% in the 30- to 39-year age group, and then decreased with subsequent age groups. The mean number of positive skin tests peaked in the 10- to 19-year age group at 13.1, remained higher than 11 until age 40 years, decreased to 9.5 in the 40- to 59-year age group, and decreased consistently after age 50 years to 4.7 in the 70- to 79-year age group (Fig. 2).

Figure 3 reflects the population in terms of number of positive skin tests. The most common result was for the patient to have between 1 and 5 positive results (28%), followed by 6–10 positive results (17%). Percentages decreased thereafter; however, 8% of patients had >30 positive skin tests.

The 10 most common allergens are shown in Table 2. All five grasses on our skin test panel were in the top 10. Bahia, rye, and timothy were our 3 most widespread allergens, followed by bermuda (6th) and johnson (9th). Mountain cedar (4th) was our most sensitizing tree, with oak (10th overall) second. Mountain cedar is a ubiquitous tree in south Texas and is a significant source of allergic rhinitis (known locally as “cedar fever”) in winter months. The most prevalent environmental allergen was dust mite (*Dermatophagoides pteronyssinus*, 5th; *Dermatophagoides farinae*, 8th). Ragweed (7th) was the predominant weed.

Table 3 lists the most sensitizing allergens by class. The most common trees (Table 3) were mountain cedar and oak. Mountain cedar (43%) was by far the most frequently positive, 9% more than oak. Other prevalent trees included cottonwood, ash, mesquite, pecan, olive, mulberry, and elm, all present in >25% of patients. The major weeds (Table 3) were ragweed, Russian thistle, sagebrush/mugwort, and pigweed/careless, present in >30% of patients. Pigweed/careless, kochia, marshelder/poverty, and lambs quarters were all present in >20% of the population. *Alternaria* was the most common mold (28%), followed by *Helminthospor-*

Table 3 Allergen prevalence

| Allergens                    | Prevalence (%) |
|------------------------------|----------------|
| <b>Weeds</b>                 |                |
| Ragweed                      | 39.7           |
| Russian thistle              | 33.1           |
| Sagebrush/mugwort            | 31.5           |
| Pigweed/careless             | 30.5           |
| Kochia                       | 28.6           |
| Marshelder/poverty           | 27.8           |
| Plantain                     | 25.0           |
| Lambs quarters               | 24.0           |
| Wing scale                   | 18.3           |
| Dock/sorrel                  | 18.3           |
| Cocklebur                    | 16.3           |
| Nettle (Urtica)              | 10.6           |
| <b>Trees</b>                 |                |
| Mountain cedar               | 43.0           |
| Oak mix                      | 34.2           |
| Cottonwood, common           | 33.7           |
| Ash, white                   | 32.3           |
| Mesquite                     | 32.0           |
| Pecan                        | 29.8           |
| Olive                        | 28.8           |
| Mulberry mix                 | 28.6           |
| Boxelder/maple mix           | 27.7           |
| Elm, American                | 25.6           |
| Hackberry                    | 25.6           |
| Sycamore, American           | 25.2           |
| Birch mix                    | 24.0           |
| Cypress, Arizona             | 23.5           |
| Alder, red                   | 22.8           |
| Palm                         | 14.8           |
| Walnut, black                | 14.4           |
| Pine                         | 6.1            |
| <b>Molds</b>                 |                |
| <i>Alternaria tenuis</i>     | 28.4           |
| <i>Helminthosporium</i>      | 27.7           |
| <i>Cladosporium</i>          | 21.6           |
| <i>Fusarium</i>              | 19.2           |
| <i>Epicoccum</i>             | 15.9           |
| <i>Aspergillus fumigatus</i> | 15.1           |
| <i>Bipolaris</i>             | 13.1           |
| <i>Penicillium</i>           | 8.4            |
| <i>Aspergillus niger</i>     | 7.5            |
| <i>Rhizopus</i>              | 6.1            |
| <b>Environmentals</b>        |                |
| <i>D. pteronyssinus</i>      | 40.7           |
| <i>D. farinae</i>            | 37.1           |
| Cat                          | 33.9           |
| Cockroach                    | 19.1           |
| Dog                          | 11.6           |
| Mouse                        | 10.6           |
| Feather                      | 8.3            |
| Rat                          | 7.3            |
| <b>Grasses</b>               |                |
| Bahia                        | 44.8           |
| Rye                          | 44.5           |
| Timothy                      | 44.4           |
| Bermuda                      | 40.5           |
| Johnson                      | 34.9           |

*rium* and *Cladosporium* (Table 3). Other prevalent molds included *Fusarium*, *Epicoccum*, and *Aspergillus*, all positive in over 15% of patients. Dust mites were the predominant environmental allergens, followed closely by cats (33.9%), cockroaches (19%), dogs (11.6%), mice (10.6%), feathers (8.3%), and rats (7.6%).

In this study, 9.2% of patients were monosensitized. Mountain cedar (15.3%) was the most frequent allergen responsible for monosensitization, followed by dust mites (9.4%), cats (9.4%), and cockroaches (7.0%). These 4 allergens were responsible for 41% of all monosensitization. Of note, while mountain cedar and dust mites were among the 10 most common allergens overall in this study, cats and cockroaches were not.

Considering individual allergens by age group, we found that regardless of the allergen, skin test positivity changed with age. Figure 4 A shows that four of the most common allergens (bahia, mountain cedar, dust mites, and ragweed), all showed an increase in the rate of positive skin tests through childhood and young adulthood and then a steady decline after age 30–39 years as the population ages. Figure 4 B examines the 10 predominant trees and show a peak prevalence in the 10- to 19-year age group and a steady decrease in older age groups. Mountain cedar maintains a higher rate of reactivity through the 60- to 69-year age group, once again showing its importance in this region. The grasses (Fig. 4 C) and weeds (Fig. 4 D) show very similar patterns as the trees. Interestingly, the molds (Fig. 4 E) show a different pattern, with an earlier peak in the first 10 years of life and a subsequent decline thereafter. The environmental allergens (Fig. 4 F) peak in prevalence in the 20- to 29-year age group (dust mites, cats, and cockroaches) with a steady decline thereafter except for dogs, which increased again after the age of 70 years. Certain environmentals (cats, dust mites, and cockroaches) showed a much greater peak prevalence compared with the other members of the group.

## DISCUSSION

This study shows a high rate of atopy in a symptomatic referral military population. Compared with previous reports, this study is unique because it includes a larger age range of patients, a larger number of allergens, and a mobile population. In our opinion, this study is a more accurate reflection of a typical allergy clinic, where physicians skin test a wide age range of rhinitis patients to an extensive panel of aeroallergens. As such, allergists' skin testing to an analogous panel of aeroallergens might expect to see a similar distribution of results. In a recent survey of allergists,<sup>2</sup> the average number (sum of perennial, trees, grasses, weeds and molds) of skin-prick tests was 42.5, comparable with our panel of 53 aeroallergens.

Prior studies looking at positive skin test prevalence can be divided into those that examined general pop-

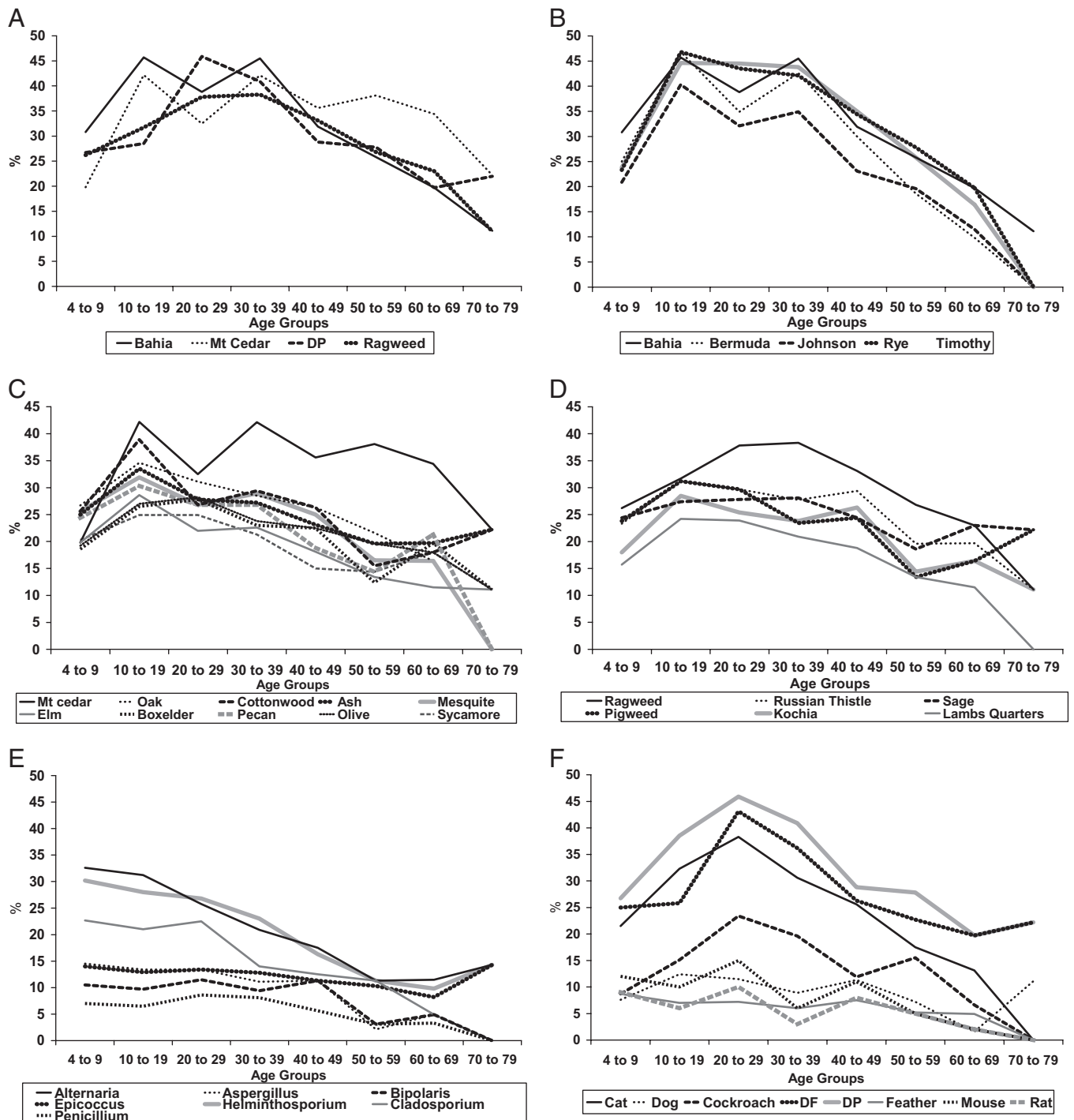


Figure 4. Skin test reactivity by age group. (A) Common allergens; (B) grasses; (C) trees; (D) weeds; (E) molds; (F) environmentals.

ulations and those that examined allergic or symptomatic populations<sup>3</sup> (Table 4). This investigation is unique because it is the first study looking at a symptomatic military population. Several of the general population studies (Table 4) included very narrow age ranges and all used fewer than 15 allergens.<sup>4-6</sup> The highest reported prevalence of skin test reactivity was 54%.<sup>7</sup> The research performed on symptomatic populations (Table 4) included fewer subjects and a smaller number of

allergens, and most incorporated very narrow age ranges. Two of the studies found a similar prevalence of atopy as the current study.

The peak incidence of atopy in our study was in the 30- to 39-year age group. This is consistent with other investigators, who previously reported the highest rate of atopy in the 15- to 30-year age group,<sup>8</sup> the 20- to 34-year age group,<sup>9</sup> and in the <40-year age group.<sup>10</sup> In addition, this study showed decreased rates of skin test

Table 4 Prior studies performed on positive skin test prevalence

| Author                                       | Location       | Subjects | Age (yr) | No. of Allergens | % Positive |
|----------------------------------------------|----------------|----------|----------|------------------|------------|
| General population studies                   |                |          |          |                  |            |
| Gergen (1976–1980) <sup>3</sup>              | U.S. NHANESII  | 16,204   | 6–74     | 8                | 20.2       |
| Curran and Goldman (1961) <sup>6</sup>       | Boston         | 100      | 16–20    | 9                | 5          |
| Hagy and Settupane (1969) <sup>4</sup>       | Providence     | 765      | 16–20    | 14               | 17.4       |
| Barbee <i>et al.</i> (1976) <sup>5</sup>     | Tucson         | 3012     | 3–75     | 5                | 34         |
| Tschopp <i>et al.</i> (1998) <sup>16</sup>   | Switzerland    | 8329     | 18–60    | 8                | 23         |
| Arbes <i>et al.</i> (1988–1994) <sup>7</sup> | U.S. NHANESIII | 10,508   | 6–59     | 10               | 54.3       |
| Allergic or symptomatic populations          |                |          |          |                  |            |
| Freidhoff (1977–1979) <sup>17</sup>          | Baltimore      | 262      | 18–55    | 7                | 55         |
| Hagy and Settupane (1969) <sup>4</sup>       | Providence     | 478      | 16–20    | 15               | 63.9       |
| Hendrick (1969–1971) <sup>10</sup>           | London         | 656      | 10–30    | 22               | 84         |
| Haahtela (1980) <sup>18</sup>                | Finland        | 292      | 15–17    | 16               | 83         |
| This study                                   | San Antonio    | 1137     | 4–79     | 53               | 81.6       |

Source: Adapted from Ref. 3.

reactivity in the older population. The reason for this is not well understood. There is little or no decreased reactivity to histamine, implicating that a diminished overall skin response is not solely responsible. This suggests that there is a different immunologic response to allergens in older individuals.<sup>3</sup>

Compared with prior investigations, the majority of allergens in this study were prevalent at higher rates. For instance, dust mites were positive in 37% (*D. farinae*) and 40% (*D. pteroyrnissinus*) of the current patients versus 27.5% of patients in the third National Health and Nutrition Examination Survey (NHANESIII) study<sup>7</sup> and 6.2% of patients in the NHANESII study.<sup>3</sup> In this study, 39.7% of the patients were sensitized to ragweed compared with 9–26% in other studies.<sup>3,4,11</sup> One exception was cockroaches, which were positive in 19.1% of our patients and 26.1% of the NHANESIII patients.<sup>7</sup>

This study reports sensitization rates for 53 allergens. There is little to no data regarding sensitization rates for many of these allergens. With the exception of oak and birch, the trees on our panel have not been widely reported. For example, rates of mountain cedar sensitization have not been published previously. This study shows that 40% of patients in our population are sensitized to mountain cedar. Also notable is how infrequently patients are sensitized to pine (6.1%). The weeds previously reported elsewhere are ragweed and Russian thistle, while *Alternaria* and *Aspergillus* are the molds cited most often. In addition to these allergens, we report rates of positive skin tests for 10 additional weeds and 8 additional molds (Table 3).

Mouse and rat are under recognized allergens that have been studied more frequently in recent years in inner city patients and occupational settings. However,

sensitization rates in rhinitis patients have not been reported until now. Mouse and rat were positive in 10.6 and 7.6% of our patients, respectively. Mouse and rat allergens have been detected in 95 and 33% of inner city homes in the National Cooperative Inner City Asthma Study.<sup>12,14</sup> Mouse allergen was more prevalent than cockroach, dust mite, or cat allergens in this study.<sup>12</sup> In the National Cooperative Inner City Asthma Study, 18% of patients were sensitized to mouse allergen and 19% of patients were sensitized to rat allergen. Mouse sensitivity was associated with concomitant atopy and elevated levels in the home; there were trends toward increased asthma morbidity but they did not reach statistical significance.<sup>13</sup> Although rat sensitization was not more common when allergen was found in the home, asthma morbidity was increased in those both sensitized and exposed to rat allergen.<sup>14</sup> Thus, mouse and rat allergens may join cockroach allergen as uniquely important indoor allergens in this population. In the occupational setting, sensitization to mouse and rat allergens are common among those working with these animals in the laboratory, with estimates of 10–32% and 12–31%, respectively.<sup>15</sup> Our rates, although less than that found in inner city and occupational settings, suggest that mouse and rat sensitization are present in a significant proportion of a military population.

## CONCLUSIONS

We found that 81.6% of patients in a symptomatic referral military population were atopic, and sensitization peaked in the 30- to 39-year age group. Rates of positive skin-prick test responses declined in older age groups, particularly after the age of 50 years. Grasses,

mountain cedar, and dust mites were the most common allergens. Sensitization rates for many aeroallergens not well documented previously in the literature are presented here. These results, although performed in a military population, should be applicable to most allergy practices.

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