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# Pattern of immediate type hypersensitivity reactions in the Eastern Province, Saudi Arabia

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**Background:** In the period between July, 1992, and July, 1994, 1,159 patients in our Allergy Clinic tested positive to one or more inhalants. The nationalities of the population tested included 806 Saudi Arabs and 241 Western expatriates (mainly North Americans). The others were of various different nationalities.

**Objectives:** Our objective was to determine the pattern of immediate type hypersensitivity reactions among the atopic population in the Eastern Province of the Kingdom of Saudi Arabia.

**Methods:** A standard prick skin test was applied and the reaction was considered positive if there was a 3-mm wheal associated with 10 mm of erythema, greater than the negative control.

**Results:** The ten most common reactions in the Saudi Arab patients were as follows: *Chenopodium album* 53%, Kochia 51%, mesquite 46%, cottonwood 38%, alfalfa 36%, dust mite-farinae 36%, cockroach 35%, house dust 31%, Bermuda grass 29%, and acacia 29%. For North American expatriates living in the area, the ten most common reactions were: dust mite-farinae 43%, house dust 41%, *Alternaria* 36%, grass mix 34%, Bermuda grass 33%, mesquite 32%, cat 31%, Kochia 28%, alfalfa 24%, and *Chenopodium album* 24%.

**Conclusions:** Hypersensitivity to pollens, house dust, dust mite and cockroach was common. Mold and cat allergies were only common among Western expatriates.

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## INTRODUCTION

Respiratory allergy, allergic rhinitis, and bronchial asthma are very common problems in Saudi Arabia.<sup>1,2</sup> Skin tests can provide useful confirmatory evidence for diagnosis of a specific allergy that has been made on clinical grounds. Its characteristic simplicity explains the key position that cutaneous testing occupies in allergy.<sup>3</sup>

The purpose of this article is to describe the pattern of immediate type hypersensitivity reactions among the atopic population in the Eastern Province of the Kingdom of Saudi Arabia, and also to delineate specific atopy among the large outpatient population of a hospital serving the employees of

the largest oil company in the world and their families, which comprises the native population and Western expatriates.

## MATERIALS AND METHODS

### Subjects

One thousand one hundred fifty-nine patients (adults and children more than 5 years of age) suffering from respiratory allergy, allergic rhinitis, and/or bronchial asthma were found to have positive skin prick tests to one or more inhalant antigens. These patients were tested between July, 1992, and July, 1994, at the Allergy Clinic in Saudi Aramco, Dhahran Health Center, Saudi Aramco. The nationalities of these patients were as follows: 806 Saudi Arabs, 241 Western expatriates (mostly North Americans), 48 Indians and Pakistanis, 33 Filipinos, and 31 Arabs (other than Saudi Arabs). Al-

most all the Western expatriates lived in residential camps provided by Saudi Aramco (the largest oil company in the world). All their houses were wall-to-wall carpeted and all had central air conditioning (which ran, on average, 10 months each year). All expatriates repatriated to their home countries for 6 weeks each year (most of them during July and August and some during March and April). The majority of the Saudi Arab patients lived in nearby cities and villages with wall-to-wall carpets and window-type air conditioning units in their homes.

### Skin Testing

All patients were prick skin tested with a set of inhalant allergens obtained from Hollister-Stier (now Miles Inc), Connecticut, USA (Table 1). First generation antihistamines were avoided for 96 hours prior to testing, nonsedating antihistamines were discontinued for 2 weeks prior to testing, and astemizole was discontinued for 1 month prior to testing. A standard skin prick test method was used. A drop of allergen solution was applied on the back. The skin was pricked through the drop with a microlance B-d. The results were recorded after 20 minutes. As a positive control, we used 0.2 mg/mL of histamine, and as a negative control, normal saline. The size of the reaction was measured with a millimeter ruler and the sum of both diameters was recorded and divided by two. The test was performed by a registered nurse trained in the technique, and the reading was performed by an American board certified allergist. The test was considered positive when there was a 3 mm or larger wheal and/or erythema of 10 mm or more, greater than the negative control.

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Table 1. Inhalant Allergens Used for Skin Testing (Hollister-Stier, Miles Inc; Connecticut, USA)

| Concentration |   | Allergens                                                                                      |
|---------------|---|------------------------------------------------------------------------------------------------|
| 1:20W / V     | P | Marshelder-burweed, <i>Iva xanthifolia</i>                                                     |
| 1:20W / V     | P | Bermuda grass, <i>Cynodon dactylon</i>                                                         |
| 1:20W / V     | P | Alfalfa, <i>Medicago sativa</i>                                                                |
| 1:20W / V     | P | Acacia golden <i>Acacia longifolia</i>                                                         |
| 1:20W / V     | P | Lamb's quarters <i>Chenopodium album</i>                                                       |
| 1:20W / V     | P | Clover, sweet/yellow <i>Melilotus officinalis</i>                                              |
| 1:20W / V     | P | Eucalyptus/ <i>Eucalyptus globulus</i>                                                         |
| 1:20W / V     | P | Tree mix #11                                                                                   |
| 1:20W / V     | P | Palm date <i>Phoenix dactylifera</i>                                                           |
| 1:20W / V     | P | Cottonwood <i>Populus deltoides</i>                                                            |
| 1:20W / V     | P | Grass mix #5 Kentucky blue, orchard, red top, Timothy, sweet vernal                            |
| 1:20W / V     | P | Walnut, English, <i>Juglans regia</i>                                                          |
| 1:20W / V     | P | Ragweed mix GS giant, short                                                                    |
| 1:20W / V     | P | Mesquite tree, <i>Prosopis glandulosa</i>                                                      |
| 1:20W / V     | P | Marshelder, true <i>Iva ciliata</i>                                                            |
| 1:20W / V     | P | Kochia/ <i>Kochia scoparia</i>                                                                 |
| 1:20W / V     | P | Cedar, salt, tamarisk, <i>Tamarix gallica</i>                                                  |
| 1:20W / V     | P | Pine, western, <i>Pinus monticola</i>                                                          |
| 1:10W / V     | M | Aspergillus mix ( <i>A.fumigatus</i> , <i>A.nidilans</i> , <i>A.niger</i> , <i>A.terreus</i> ) |
| 1:10W / V     | M | <i>Alternaria tenuis</i>                                                                       |
| 1:10W / V     | M | <i>Cephalosporium acramonium</i>                                                               |
| 1:10W / V     | M | <i>Hormodendrum cladosporioides</i>                                                            |
| 1:10W / V     | M | <i>Helminthosporium interseminatum</i>                                                         |
| 1:10W / V     | I | Cotton linters                                                                                 |
| 1:10W / V     | I | Cockroach mix American/German                                                                  |
| 1:10W / V     | I | Feathers, chicken, duck, goose                                                                 |
| 1:10W / V     | I | Dog hair dander                                                                                |
| 1:10W / V     | I | Dust, house, mix                                                                               |
| 30,000 Au/mL  | I | <i>Dermatophagoides farinae</i> , house dust mite                                              |
| 1:10W / V     | I | Wool, sheep                                                                                    |
| Miscellaneous |   |                                                                                                |
| 1:10          |   | Horse dander                                                                                   |
| 1:10          |   | Camel hair                                                                                     |
| 1:10          |   | Goat hair                                                                                      |

W/V = weight/volume

AU/mL = allergy unit per milliliter

P = pollen

M = mold

I = indoor allergen

### Statistical Methods

To evaluate the significance of the differences between Saudi Arabs and Western expatriates, the odds ratio (OR) is presented. An OR < 1 shows that allergy was less prevalent among Saudi Arabs. An OR > 1 shows that allergy was more prevalent among Saudi Arabs. To show the significance of the data, the confidence interval of the OR is presented. If the confidence interval excludes one, the difference is significant, at  $P < .05$ .

### RESULTS

Detailed results are presented in Tables 2, 3, and 4. Pollen hypersensitivity was very common among the Saudi Arabs (pollens caused most reactions): *Chenopodium album* (lamb's quarters) 53%, *Kochia scoparia* (Kochia) 52%, *Prosopis glandulosa* (mesquite) 46%, *Populus deltoides* (cottonwood) 39%, *Medicago sativa* (alfalfa) 36%, and *Cynodon dactylon* (Bermuda grass) 29%.

Among Western expatriates, the pollen hypersensitivity was less and

the order was as follows: the most important pollens were grass mix #5 (Kentucky blue, orchard, red top, timothy, and sweet vernal) at 34%, Bermuda grass 33%, mesquite 32%, Kochia 28%, alfalfa 24%, and *Chenopodium album* (lamb's quarters) 24%.

Bermuda grass hypersensitivity was the same among Saudi Arab and Western expatriate patients.

Dust mite, cockroach, and house dust hypersensitivities were commonly noted among Saudi Arab patients and among Western expatriates. Cockroach sensitivity was more common among Saudi Arab patients and cat allergy was more common among Western expatriates. Mold allergy was rare among Saudi Arab patients, while *Alternaria* and *Cladosporium* allergies were common among Western expatriates. Other reactions were not common.

### DISCUSSION

The coastal part of the Eastern Province of Saudi Arabia is home to millions of Saudi Arab nationals and a few hundred thousand expatriates from all over the world. It is the focal center of the economy of the Kingdom of Saudi Arabia, as well as an area rich in environmental antigens. These antigens have a significant effect on the health and well-being of the working population, who essentially produce up to 40% of the world's petroleum products. Epidemiologic cognizance of ethnic sensitivities is, therefore, crucial to diagnose and control hypersensitivity reactions and to treat the employees here. The Eastern Province is a low-lying area of prehistoric seabed, with essentially dry scrub desert punctuated by a large area of fertile oases fed by underground aquifers. The renowned humidity and heat of the summer months is relieved by an idyllic temperate climate from October through April. The prevailing winds are predominantly north and west and carry the antigens of the desert dust and flora.

Traditionally, the natives have lived in large oases in this vast desert, depending upon agriculture. The oil

Table 2. Pollens Causing the Most Frequent Reactions

| Pollens       | Total<br>(N = 1159) |            | Saudi Arabs<br>(N = 806) |            |               | Expatriates<br>(N = 241) |            |               | Odds<br>Ratio | Confidence Interval<br>Low-High |
|---------------|---------------------|------------|--------------------------|------------|---------------|--------------------------|------------|---------------|---------------|---------------------------------|
|               | Allergic            | % Allergic | Allergic                 | % Allergic | Rank<br>Order | Allergic                 | % Allergic | Rank<br>Order |               |                                 |
| Chenopodium*¶ | 540                 | 46.5       | 430                      | 53.3       | 1             | 59                       | 24.1       | 11            | 3.53          | 2.52-4.95                       |
| Kochia*¶      | 533                 | 45.9       | 416                      | 51.6       | 2             | 67                       | 27.8       | 8             | 3.1           | 2.24-4.26                       |
| Mesquite*§    | 504                 | 43.4       | 371                      | 46.0       | 3             | 77                       | 31.9       | 6             | 1.82          | 1.33-2.49                       |
| Cottonwood*‡  | 417                 | 36.0       | 312                      | 38.7       | 4             | 66                       | 27.3       | 9             | 1.67          | 1.21-2.33                       |
| Alfalfa§*‡    | 396                 | 34.2       | 292                      | 36.2       | 5             | 58                       | 24.1       | 12            | 1.79          | 1.27-2.52                       |
| Bermuda grass | 340                 | 29.3       | 231                      | 28.7       | 9             | 80                       | 33.2       | 5             | 0.81          | 0.70-1.06                       |
| Acacia        | 323                 | 27.9       | 231                      | 28.7       | 9             | 56                       | 23.2       | 13            | 1.33          | 0.94-1.89                       |
| Grass mix†‡   | 317                 | 27.3       | 210                      | 26.0       | 11            | 82                       | 34.0       | 4             | 0.68          | 0.50-0.94                       |
| Marshelder    | 271                 | 23.4       | 189                      | 23.4       | 12            | 50                       | 20.7       | 15            | 1.17          | 0.81-1.69                       |
| Eastern trees | 260                 | 22.4       | 185                      | 22.9       | 13            | 50                       | 20.7       | 17            | 1.14          | 0.79-1.64                       |
| Ragweed       | 240                 | 20.7       | 162                      | 20.1       | 14            | 56                       | 23.2       | 13            | 0.77          | 0.54-1.10                       |
| Date palm     | 218                 | 18.8       | 148                      | 18.3       | 15            | 43                       | 17.8       | 20            | 1.04          | 0.70-1.53                       |
| Burweed       | 223                 | 19.2       | 146                      | 18.1       | 16            | 54                       | 22.4       | 15            | 0.77          | 0.53-1.11                       |
| Tamarisk      | 180                 | 15.5       | 130                      | 16.1       | 19            | 40                       | 16.5       | 21            | 1.16          | 0.82-1.57                       |

\* More common among Saudi Arabs. † More common among Western expatriates. ‡  $P$  value < .05. §  $P$  value < .005. ¶  $P$  value < .0005; ¶  $P$  value < .000005.

Table 3. Indoor Allergens Causing the Most Frequent Reactions

| Indoor Allergens            | Total<br>(N = 1159) |            | Saudi Arabs<br>(N = 806) |            |               | Expatriates<br>(N = 241) |            |               | Odds<br>Ratio | Confidence Interval<br>Low-High |
|-----------------------------|---------------------|------------|--------------------------|------------|---------------|--------------------------|------------|---------------|---------------|---------------------------------|
|                             | Allergic            | % Allergic | Allergic                 | % Allergic | Rank<br>Order | Allergic                 | % Allergic | Rank<br>Order |               |                                 |
| Dust mite <i>D. farinae</i> | 445                 | 38.3       | 290                      | 35.9       | 6             | 103                      | 42.7       | 1             | 0.75          | 0.56-1.02                       |
| Cockroach*‡                 | 404                 | 34.9       | 279                      | 34.6       | 7             | 61                       | 25.3       | 10            | 1.56          | 1.08-2.19                       |
| Cat†¶                       | 232                 | 20.0       | 140                      | 17.4       | 16            | 76                       | 31.5       | 7             | 0.46          | 0.32-0.64                       |
| Feathers†‡                  | 184                 | 15.9       | 132                      | 16.4       | 17            | 32                       | 13.3       | 22            | 1.28          | 0.83-1.98                       |
| House dust*¶                | 390                 | 34         | 247                      | 31.0       | 8             | 98                       | 41         | 2             | 0.51          | 0.37-0.70                       |

\* More common among Saudi Arabs, † More common among Western expatriates, §  $P$  value < .05, ‡  $P$  value < .005, ¶  $P$  value < .0005, and ¶  $P$  value < .000005.

Table 4. Molds Causing the Most Frequent Reactions

| Molds              | Total<br>(N = 1159) |            | Saudi Arabs<br>(N = 806) |            |               | Expatriates<br>(N = 241) |            |               | Odds<br>Ratio | Confidence Interval<br>Low-High |
|--------------------|---------------------|------------|--------------------------|------------|---------------|--------------------------|------------|---------------|---------------|---------------------------------|
|                    | Allergic            | % Allergic | Allergic                 | % Allergic | Rank<br>Order | Allergic                 | % Allergic | Rank<br>Order |               |                                 |
| Alternaria†¶       | 205                 | 17.6       | 105                      | 13.0       | 20            | 87                       | 36.0       | 3             | 0.41          | 0.30-0.58                       |
| Helminthosporium†¶ | 154                 | 13.2       | 76                       | 9.4        | 21            | 57                       | 23.6       | 11            | 0.27          | 0.28-0.46                       |
| Cladosporium†¶     | 127                 | 10.9       | 64                       | 7.9        | 22            | 53                       | 21.9       | 16            | 0.31          | 0.20-0.46                       |
| Cephalosporium†    | 114                 | 9.8        | 57                       | 7.1        | 23            | 43                       | 17.8       | 19            | 0.35          | 0.22-0.55                       |
| Aspergillus†¶      | 107                 | 9.2        | 55                       | 6.8        | 24            | 39                       | 16.2       | 20            | 0.38          | 0.24-0.60                       |

\* More common among Saudi Arabs, † More common among Western expatriates, §  $P$  value < .05, ‡  $P$  value < .005, ¶  $P$  value < .0005, and ¶  $P$  value < .000005.

brought wealth, urbanization, and adaptation to a Western style of life (eg, wall-to-wall carpeting, air-conditioning, grassy lawns, and new vegeta-

tion). An expatriate population was also introduced representing at least 50 countries, each with its own predilection for allergy, based on the factors

that contribute to individual and national sensitivity. Knowledge of these differences and similarities is key to effective diagnosis and treatment,

meeting personal and collective goals of good health, and high corporate productivity.

There is a feeling that allergic diseases are on the rise among the inhabitants of this area. There are a few published reports of the aerobiology of Saudi Arabia, the Eastern Province, and the neighboring Gulf States.<sup>4,5</sup> There are even a few reports about the pattern of hypersensitivity among the population.<sup>5,6</sup> This is the largest study to discuss the pattern of hypersensitivity in this area of Saudi Arabia and, possibly, in the Middle East.

Al-Nahdi, in an aerobiology survey of the area, found *Chenopodiaceae*, grasses, and *Ambrosia* as the most common botanical groups; *Cladosporium*, *Ustilago*, and *Alternaria* were the most common molds.<sup>4</sup> He skin tested 68 patients in the Eastern Province and found that the most common hypersensitivities were to house dust, cat, and dust mite.<sup>8</sup> Sorensen tested only ten patients and found that four of them reacted to mold, four to Bermuda grass, two to dust mite, two to cats, three to cows and one to rats.<sup>5</sup> In other areas of Saudi Arabia, Al-Frayh studied skin reactivities in 120 asthmatic children from the Central and Western regions of Saudi Arabia. In the Western region (Makkah), the dust mite reactivity was 56.3%, fungal reactivity was 31%, and pollen allergy was 15.4%. In the Central region (Riyadh, the capital city), which is far from water and where there is a dry desert climate, dust mite reactivity was 10%, mold reactivity was 5.8%, and pollen reactivity was 9.3%.<sup>9</sup>

In our study, a comparison was made between hypersensitivity in Saudi Arabs and hypersensitivity in the Western expatriate population. Pollen hypersensitivity (*Chenopodium album*, *Kochia*, mesquite, cottonwood, alfalfa, Bermuda grass, and *Acacia*) was common. Hypersensitivity to indoor allergens, such as dust mite, cockroach and house dust, was also common. Mold allergy was common among the Western expatriates but not among the

Saudi Arabs. There was no clear explanation for this difference in mold allergy. Mold spores were identified in a very limited aerobiologic survey done in the area.<sup>4</sup> Mold spores infest the ducts of central air-conditionings systems, as has been shown in other studies. As Western expatriates live in houses with central air-conditioning, this could be an explanation. In addition, most expatriates go home on repatriation vacation in the summer when mold spores are more prevalent in the USA. Cat allergy was more common among the Western expatriates, many of whom had cats in their houses. Saudi Arabs rarely have domestic cats in their houses, although there are stray cats in the streets.

We believe our study is more representative of hypersensitivity reactions than the few published studies from the Eastern Province of Saudi Arabia because of the large population that was tested in our study compared with the limited number of people tested in previously published studies. We have demonstrated in our study that pollen sensitivity is common among Saudi Arabs, as are sensitivity reactions to house dust mite and to cockroach.

We have recently started skin testing for Russian thistle and mugwort and notice that many of our patients are hypersensitive to these two pollens. More aerobiologic surveys are needed in this important part of the world. Cross-reactivity of domestic flora of the area and the important allergy plants, such as ragweed and cottonwood, needs to be studied. The clinical relevance of these inhalants to allergy symptoms needs further study.

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