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Skin sensitivity reactions to some allergens in different population groups of Ethiopian subjects

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Abstract

The prevalence of allergic diseases to a variety of allergens has only been studied in a few countries and it has never been studied in Ethiopia. This study was aimed at assessing the prevalence of skin sensitivity reactions to allergens in Ethiopian subjects. A total of 216 subjects were tested with a skin scratch test using five types of allergens and also for total and differential white blood cell counts. Positive reaction to one or more allergens was detected in 49.5% of the subjects, the most prevalent allergen being mite extract. Some 27% showed a positive reaction to multiple allergens. The mean eosinophil count was higher in the subjects reacting to at least one of the allergens compared to those with no reaction ($p=0.038$). The results demonstrate a high prevalence of allergic reactions to the few allergens tested. Further studies using several allergens are recommended to substantiate this finding.

Keywords: Allergen, allergic reaction, skin sensitivity, skin scratch test, Gondar, Ethiopia

Background

There are a wide variety of substances that cause allergic reactions in humans. These substances result in allergic contact dermatitis, rhinitis, reactive air way disease, anaphylactic reactions and others (Platts-Mills 1987). Contact dermatitis generally accounts for 4–7% of dermatologic consultations (Mendenhall et al. 1978; Wilkinson & Shaw 1998) and may result in permanent disability in some subjects (Menné et al. 1982). The level of skin sensitivity to certain allergens has increased in recent years because of the availability of various environmental allergens (Ayala et al. 1996). Some allergens may also disappear, resulting in a significant reduction in the prevalence of allergic contact dermatitis in some population groups (Towers & Mitchell 1983). This is probably the reason for the large discrepancy in allergic status between different populations in different countries (Goh 1986).

The challenge in identifying the causative agent for contact allergic dermatitis has led physicians to a necessity for a test with varieties of chemicals that surround the patients. The type of chemicals tested is based on standardization following population-based studies. As the types of allergens vary according to environment, each region (country) needs its own study for prevalence of contact sensitization to different allergens. Contact sensitization to the allergens in this study has never been studied in Ethiopia. A few countries have put their own prevalence for different allergens, and of course some have their own standard of allergens to be tested in patients with contact dermatitis (Lessof 1987).

Even though it is difficult to predict the allergenicity of different chemicals, most allergens that cause contact dermatitis (involving delayed type of hypersensitivity reaction (DTH)) are simple chemicals of low molecular weight, whereas those causing contact urticaria (involving type I hypersensitivity reaction) are large molecules of full antigens (Platts-Mills 1987). Antimicrobial agents, antioxidants, cosmetics, metals, plants, foods, inhalants, insects and organic dyes are generally principal sensitizers and allergens (Platts-Mills 1987). These different chemicals or allergens vary in clinical manifestation when introduced to the body. The manifestation could either involve; type I (immediate) hypersensitivity reaction resulting in urticaria, asthma, or diarrhea based on the route of allergen entrance or it could result in chronic eczema of the skin due to type IV hypersensitivity reaction (Platts-Mills 1987).

The type of allergen causing these presentations is identified using either patch testing for the mechanism that involves type IV hypersensitivity reaction or by a skin prick test for those presentations involving immediate hypersensitivity reactions (type I) (Lessof 1987). Patch testing identifies antigen specific T-cells, whereas skin prick testing detects immunoglobulin E bound to mast cells (Wide et al. 1967). The skin prick test has been used in identifying the inducing agents of food allergy, contact urticaria, allergic rhinitis and asthma. Both tests have shown a reliable and simple way to identify causative agents in those patients (Bousquet 1988; Berger 2002; O'Brien 2002).

The common offending allergens of 108 Indian asthmatic patients were found to be; insects (grass hopper, locust, and cockroach – 17.5%); dusts, danders, pollens and fungi using skin prick test (Prasad et al. 2001). The distribution of contact sensitization has also been assessed in an unselected population in Denmark, and 15.2% of the sampled population were found to be allergic to one or more of the 23 allergens tested (Nielsen & Menné 1992). In another study, 6% of children and 1–2% of adults were also found to have food allergy (Sicherer 1999).

People living in moist environments were found to react to moulds more frequently in the skin prick test, indicating the importance of the environment in developing allergy (Immonen et al. 2001). Occupation has also increased the prevalence of allergy to certain allergens that are abundant in the working environment (Groenewoud et al. 2002; Khader et al. 2005). Apart from this, some studies showed the negative impact of the environment containing the allergen for the occurrence of allergic diseases (Horak et al. 2002; Burr et al. 2003). Race has also affected the prevalence of allergic diseases in some studies (Hjern et al. 2000). Even though there is clear evidence that infection in early childhood can prevent the occurrence of allergic diseases (Jones et al. 2003; Friedrich et al. 2006), some infections like HIV/AIDS, have increased the frequency of occurrence of allergy (Dikeacou et al. 1993). Down regulation of the immune system because of increased expression of certain cytokines in diseases such as tuberculosis (Rosenberg & Fauci 1990) and parasitic infections (Carvalho et al. 2006), is an important cause of decreased reactivity to allergens. Apart from environment and diseases that modulate the immune system, the incidence of allergic diseases tends to increase with age because of accumulation of allergies acquired over time (Coenraads et al. 1983).

The above figures and facts are good indices to give attention and to extend the survey to areas where not much has been done on the subject matter. Furthermore, the level of

sensitivity and allergic status in a population changes with time, and varies not only with the region, but also with the individuals (Wilkinson et al. 1980). Because of this, a timely monitored, updated and standard prevalence of allergic status and skin sensitivity of the population is crucial for each country and region. Therefore, this study was aimed at determining the allergic status of Ethiopian subjects for some allergens and to assess whether there is any difference because of disease, age and environment.

Subjects and methods

Subjects

A total of 216 subjects (122 females) in six groups were selected at random from Gondar University Hospital, Gondar, northwest Ethiopia from December 2005 to February 2006. Group 1 ($n=51$, 22 females): diabetic patients (Type I and II) from a twice weekly diabetic clinic; group 2 ($n=49$, 37 females): patients with acquired immunodeficiency syndrome (AIDS) from a daily HIV clinic which have World Health Organization (WHO) stage III or IV disease; group 3 ($n=8$, all females): asthmatic patients from a once weekly asthma clinic; group 4 ($n=20$, 10 females): smear positive pulmonary tuberculosis (TB) patients from a regular out-patient clinic; group 5 ($n=29$, 10 females): healthy and sick infants under 12 months of age from a pediatrics and immunization unit; group 6 ($n=59$, 35 females): apparently healthy adult blood donors, attendants, and colleagues. The study proposal was approved by the research ethics committees of the University of Gondar. Informed consent was obtained from all participants.

Socio-demographic and clinical data

Data on socio-demographic information, details of symptoms for any disease and allergic status of self or family, as well as any drug intake were collected using a structured questionnaire. General physical examination and anthropometry were performed by a medical doctor for all patients. Patients who had two diseases during the study period were excluded.

Skin scratch test

Skin scratch tests were carried out for five types of allergens on the inner side of the forearm (on the thigh in infants). The allergens used were mite extract, dog fur, egg white, *Candida albicans*, and a mould *Penicillium* (Torii Pharm. Co. Ltd., Japan). Fifty percent glycerin and 5% saline solution was used as a negative control (Torii Pharm. Co. Ltd., Japan). The tested area was cleansed with alcohol and a gentle scratch carried out with a lancet, onto which drops of the allergens were added. The results were read after 20 min and considered positive (reactive) if there was a raised wheal or erythema at least 3 mm wider than the control reaction (Lesso 1987). Subjects who had taken antihistamines, sodium cromoglycate or beta adrenergic blocking drugs within the preceding three weeks of the test were excluded.

Laboratory tests

Venous blood was collected from all subjects. Total and differential white blood cell counts were performed by the standard procedures. The percentage of eosinophils was multiplied by the total white blood cell count to get absolute eosinophil count.

Data analysis

The data were entered and analyzed using SPSS Version 12.0 statistical package (SPSS, Inc., Chicago, IL, USA). Comparison of variables was done using Pearson Chi-square test and Fisher's exact test.

Results

Representative photographs of skin reactions to the various allergens are shown in Figures 1–4. From the 216 patients tested, 49.5% were found to be allergic to one or more of the allergens tested (Table I). Males and females reacted equally, 47.3% versus 51.6%, respectively ($p = 0.108$). The mean age with exclusion of the infants was 34.3 years with a standard deviation of 13.4 years. Allergens did not discriminate age when infants are excluded. The most prevalent allergen was mite (28.7%), whereas the least prevalent was *Penicillium* (13.0%) (Figure 5). Nearly 27% of the subjects showed a positive reaction to multiple allergens.

The mean eosinophilic count was 110 cells/ml for those subjects who showed a reaction to none of the allergens and 178 cells/ml for those who reacted to one type of allergen. Subjects who reacted to two, three, four and five types of allergen had a mean eosinophilic count of



Figure 1. A positive reaction to mite extract is visible as raised wheal (arrow) in a healthy individual. Reaction to the control is also visible to the left of the wheal as small elevation due to dermographism.



Figure 2. This asthmatic lady is allergic to two allergens (dog fur and candida). The control is the first from the left.

280 cells/ml, 179 cells/ml, 254 cells/ml and 301 cells/ml, respectively. There was no significant difference in absolute eosinophilic count among those who showed reaction to any of the allergens, despite the number of allergens they reacted to. However, the absolute eosinophil count was significantly higher in those who reacted to a single allergen than in those with no reaction ($p = 0.038$).

The pattern of reactivity for the five types of allergens in the different population groups is summarized in Table II with their respective mean eosinophilic count. Except for an increased frequency of positive reaction to *Penicillium* in AIDS patients, there was no significant difference in the pattern of reactivity to each of the allergens in each group of subjects when compared to the other groups. The frequency in which different subjects reacted to an allergen varied among different groups of subjects ($p = 0.018$). The prevalence of allergic reaction to any of the specific allergens was much lower in infants ($p = 0.01$). In addition, infants reacted to multiple allergens very infrequently as only four (13.8%) infants reacted to multiple allergens and no infant was found to react to more than three types of allergen. Only two infants who had started weaning reacted to egg white. The prevalence of allergic reaction to the tested allergens did not significantly vary among different groups of patients and apparently healthy individuals. However, the total eosinophilic count was found to be high in patients with asthma ($p = 0.000$), despite the finding that asthmatic patients' reaction to the tested allergens was not significantly higher than the other groups in the study population ($p = 0.189$). Total eosinophilic count did not vary significantly in the other groups of subjects.



Figure 3. An erythematous reaction to mite extract is indicated with arrow. The control is the pinpoint erythema near the tattoo mark.

Discussion

This study demonstrated for the first time, that almost half of the study subjects were allergic to at least one of the five allergens tested. This number is significantly higher than those studies conducted in other countries. In India, 17.5% are allergic to insects and 15.4% to dusts (Prasad et al. 2001), whereas in Denmark 15.2% of the population were found to be allergic to one or more of the 23 allergens tested (Nielsen & Menné 1992). This finding is also an indicator of very high prevalence of the allergic diseases in the population studied, not only to the tested allergens but also to variety of allergens abundant in the environment but not tested in the study. The results of this study are comparable with a study conducted in an urban population of Helsinki in which more than half of those aged 26–39 years were sensitized and 24% were sensitized to at least four allergens (Pallasaho et al. 2006). Together

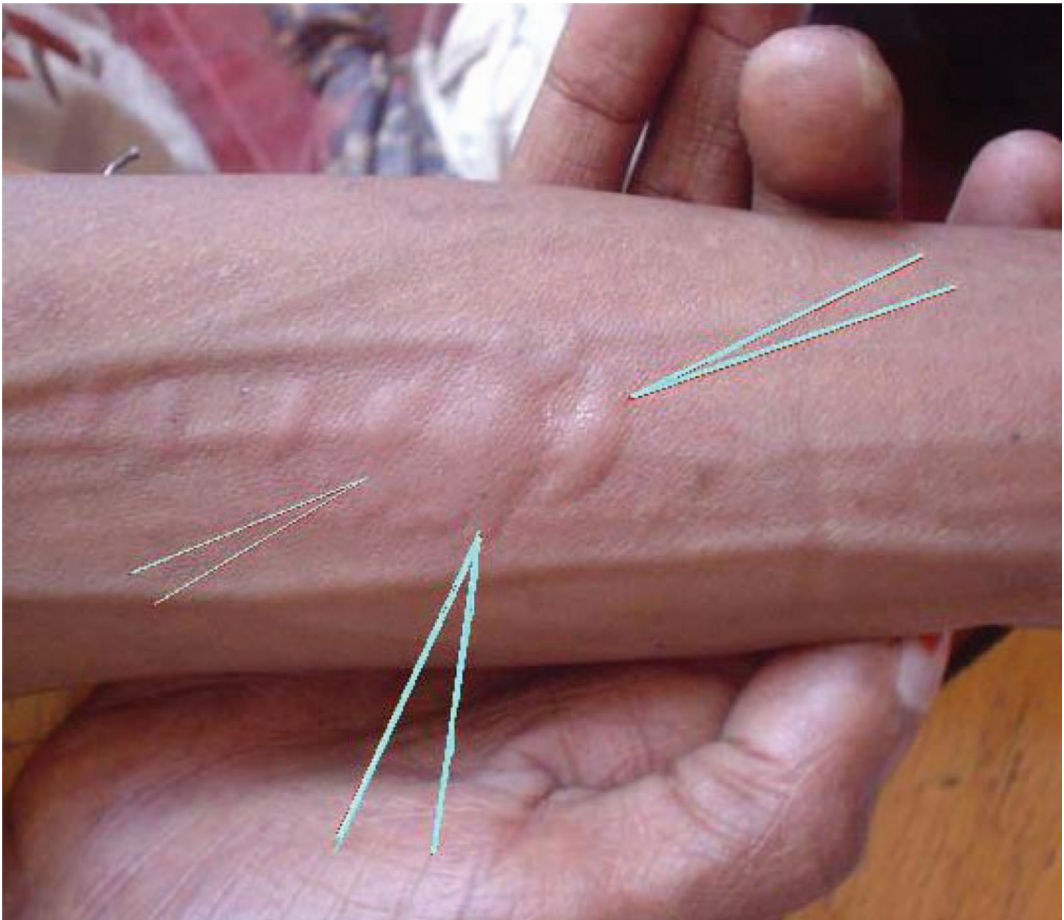


Figure 4. A confluent wheal is made because of positive reaction to three types of allergens that are applied consecutively in this HIV/AIDS patient.

Table I. Skin sensitivity and reaction to multiple allergens of Ethiopian subjects.

Number of allergens	Frequency	Percent	Cumulative percent	Mean eosinophilic count (cells per ml)
Zero	111	51.4	51.4	110
One	45	20.8	72.2	178
Two	33	15.3	87.5	280
Three	15	6.9	94.4	179
Four	5	2.3	96.8	254
Five	7	3.2	100.0	301
Total	216	100.0		168

with a high discrepancy of results observed in different countries, this result holds the fact that environment is an important determinant for the occurrence and frequency of allergic diseases in a given population. The high prevalence of reaction to mite extract in our findings is also an index to the role of the environment. Mite, an important cause of skin infestation, is abundant in poor, crowded and neglected communities (Burn 1998) like our study group. The high prevalence of allergy to dog fur is not an exception to this rule. The relatively high

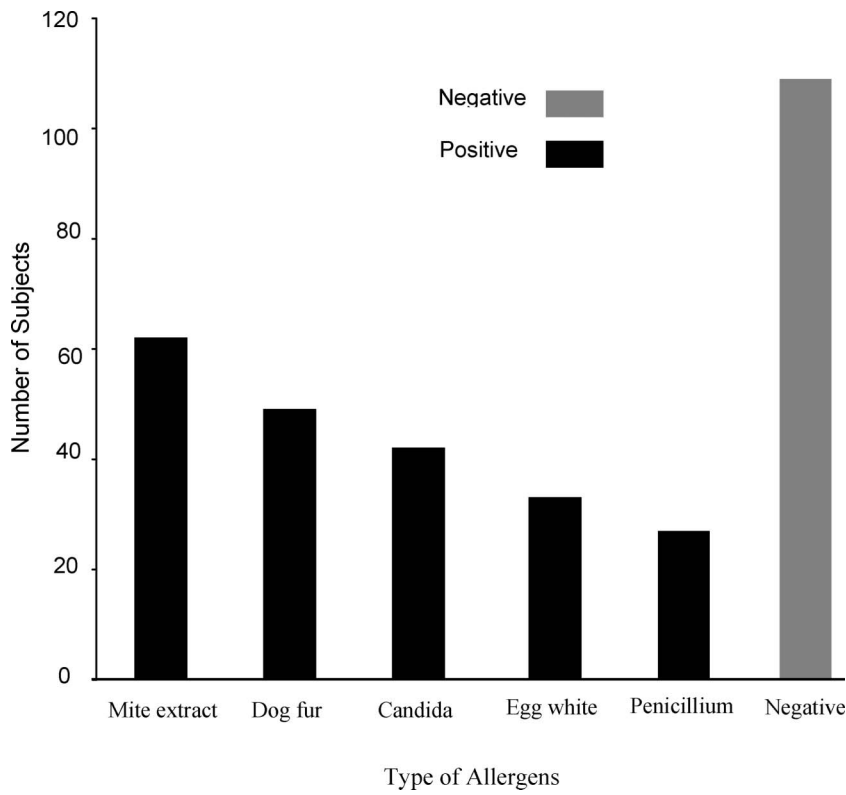


Figure 5. Frequency of positive skin scratch test in 216 Ethiopian subjects to five types of allergens.

Table II. The frequency of reactivity to five types of allergens in different population group of Ethiopian subjects with their respective mean eosinophilic count.

	Diabetics		AIDS* patients		Asthmat-ics		Tuberculosis patients		Healthy adults		Infants	
	n	%	n	%	n	%	n	%	n	%	n	%
Allergic to mite extract	15	29.4	17	34.7	3	37.5	7	35.0	16	27.1	4	13.8
Allergic to dog fur	14	27.5	11	22.4	2	25.0	6	30.0	13	22.0	3	10.3
Allergic to Candida	12	23.5	11	22.4	4	50.0	4	20.0	6	10.2	5	17.2
Allergic to egg white	9	17.6	9	18.4	2	25.0	5	25.0	7	11.9	2	6.9
Allergic to <i>Penicillium</i>	7	13.7	11	22.4	1	12.5	3	15.0	5	8.5	1	3.4
Allergic to any [‡]	28	54.9	26	53.1	6	75.0	12	60.0	27	45.6	10	34.5
Allergic to none [¶]	23	45.1	23	46.9	2	25.0	8	40.0	32	54.2	19	65.5
MEC [†]	82		234		494		220		126			

*Acquired Immunodeficiency Syndrome; [†]Mean eosinophil count (cells/ml); [‡]Total positives; [¶]Total negatives.

number of subjects reacting to egg white should also not be underestimated as egg could be an important cause of diarrhea and morbidity in the population, especially in infants and AIDS patients in whom diarrheal diseases are amongst the important causes of morbidity and mortality (Pickering & Synder 2004; Ahlquist & Camilleri 2005).

Eosinophils, important mediators of allergy (Frigas & Gleich 1987), are expected to increase during allergic diseases. This is indicated in the study by the significantly high number of

eosinophils in subjects who have allergic diseases compared to those who have not shown reaction to any of the allergens. But the fact that the eosinophil count does not vary in subjects who react to any of the allergens despite the number of allergens they react to is an important finding and suggests the eosinophil count does not increase in patients who have allergic diseases (who already have eosinophilia [Frigas & Gleich 1987]), even when they are sensitized to new allergens. This implies that stimulation of eosinophil production and differentiation is non-specific and does not consider the type of allergen introduced to the body, and that eosinophil count varies based on whether a person has an allergic disease or not, and not on the number of allergic diseases the patient has, unless he/she has other causes of eosinophilia.

The prevalence of allergic diseases to the five types of allergens did not vary significantly among diabetics, AIDS patients, TB patients, asthmatics and healthy individuals. This indicates that these diseases have no role either in exposure to allergens or response to the specific allergens. But the significantly high number of eosinophils in asthmatic patients who are equally allergic indicates that other factors (probably genetic) contribute to the increased eosinophil count of asthmatics.

One might expect increased prevalence of allergic reaction to *Candida albicans* in HIV/AIDS patients and diabetics as these groups of patients are prone to candidal infections. Surprisingly this increase in allergic reaction to *Candida* in AIDS and diabetes patients is found to be statistically insignificant when compared with normal subjects and other groups of patients. This is explained by the fact that sub-clinical *Candida* infection is also common in the general population as the organism *Candida albicans* can be found as normal commensal of the gastrointestinal tract (MacKie 1997) and may sensitize these non-AIDS and non-asthmatic subjects in the same way.

Despite normal pattern and frequency of allergic reaction to the five types of allergens among different age groups, infants showed a significantly low rate of reaction to the allergens. This is an indicator that previous exposure is probably a prerequisite for developing allergic diseases together with the fact that reaction to egg white was detected only after the start of weaning. A multitude of factors might play a role in the lack of difference in allergic status of adults. One explanation is that as far as the person is living in the same environment, he/she may have 'completed' exposure to all allergens found in his/her environment. The age at which he/she 'completed' exposure could be during late childhood or early adulthood resulting in diminished rate of development of reaction to an allergen unless the person changes the environment or unless new allergens are instituted to his/her environment. Anergy because of repeated exposure to the allergen may also answer this question.

In conclusion, the prevalence of allergic skin reaction was very high among the different population groups. Further studies involving more allergens are required to substantiate our findings.

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