

Patch testing and contact allergens in Ethiopia – results of 514 contact dermatitis patients using the European baseline series

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Background: Patch testing is essential to diagnose allergic contact dermatitis. Dermatologists in many countries use a baseline (standard) series covering the major allergens responsible for allergic contact dermatitis in their population, with the addition of relevant allergens for the individual patient. However, a baseline series has not yet been developed for Ethiopia. Our objective in this study is to identify common contact allergens to form the basis of a future baseline series in Ethiopia.

Methodology: We patch tested 514 subjects with dermatitis according to the recommended procedure using the European baseline series for 1 year.

Results: 52.7% of the tested subjects showed positive reaction for at least one allergen tested. The top five contact allergens identified were nickel sulfate, fragrance mix I, cobalt chloride, *p*-tert-butylphenolformaldehyde (PTBP) resin and potassium dichromate. Positive reactions to nickel and PTBP were commoner in females. PTBP positivity was strongly associated with foot eczema. Positive test reactions were commoner in cement workers, notably to potassium dichromate, which was also a commoner allergen in patients presenting with hand dermatitis. There were no reactions to several allergens, including neomycin, benzocaine, budesonide, primin and quaternium-15.

Conclusion: Comparable patch test results with other countries have been shown and the European baseline series can be used as a baseline series in Ethiopia with some modification.

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First described by Joseph Jadassohn in 1894, patch testing in a designated unit is essential to the diagnosis of allergic contact dermatitis (1,2). The abundance of chemicals able to elicit allergic reactions in the environment is responsible for the high prevalence of allergic contact dermatitis in the community (2). Patch testing is a diagnostic means of identifying these chemicals having the ability of initiating a type IV hypersensitivity reaction and causing allergic contact dermatitis (3). Most centres use a core series of allergens (baseline series) that represent the commonest allergens in their population (4). The baseline series of allergens varies from country to country and with time (5). Standardizing patch

test series in a country first involves identification of the commonest allergens causing allergic contact dermatitis in the population. There are no standard series of patch test allergens in Ethiopia and our objective in this study is aimed at identifying common allergens responsible for allergic contact dermatitis in a mixed urban and rural population using the European baseline series.

Subjects and Methods

The European baseline series (S-1000) of allergens from Chemotechnique Diagnostics® (Vellinge, Sweden) was used to test patients suspected of having allergic contact dermatitis using the

recommended standard procedure (3). Each subject was instructed to avoid excessive movement, perspiration and bathing. Two readings at D2 and D3 were scheduled. For patients unable to attend three times, a single reading at D4 was scheduled according to a recommendation by some authors (6). A positive reaction was considered when there was an erythematous infiltrated lesion with papules or vesicles. This reaction was graded (1+ to 3+) based on the intensity in accordance with an internationally accepted patch test reading scale (3). Faint erythema without infiltration and confined to the area of the chamber was considered as irritant reaction or doubtful and scheduled for late reading at D7 and reevaluated.

The data were then entered to EPI INFO™ statistical software (Version 3.3.2, February 2005; Center for Disease Control, Washington DC, USA) for analysis. The Chi square test was used to evaluate statistical significance of differences among variables and a *P*-value of 0.05 is taken as a cut-off point for level of significance.

Results

Demography

A total of 514 patients with dermatitis were tested from 1 November 2007 to 31 October 2008. Three hundred and forty-three (66.7%) were females and

the rest were males. The age of the study population ranged from 18 to 76 years with a mean age of 36.3 years and standard deviation of 12.1 years. Most of the subjects (79.4%) were from urban areas.

MOAHLFA Index

Male patients contributed 33.3%, occupational dermatitis 21.0%, atopic dermatitis 1.5%, hand dermatitis 44.0%, leg dermatitis 14.4%, face dermatitis 34.6% and age greater than 39 years 37.7% of the study population.

Contact allergens

A total of 26 allergens were tested on each subject and 271 (52.7%) subjects showed positive reactions to at least one allergen, 201 (39.1%) subjects had positive reactions only for one allergen, 59 (11.5%) for two allergens and 11 (2.1%) for three allergens. The frequency of positive reactions for each allergen is listed in Table 1. Example pictures of some of the clinical presentations are illustrated in Figs. 1–3.

Females showed positive reactions in 55.7% of cases and males in 46.8% of cases. There is no statistically significant difference between the two (*P* = 0.057). Half of the subjects aged 40 years or more reacted for at least one allergen without any statistical difference with subjects aged less than 40 years.

Table 1. Frequency of positive patch test reactions to European baseline series in 514 subjects

Allergen in European baseline series	Frequency		95% Confidence limits
	Number	Percent	
Nickel sulfate	91	17.7	14.6–21.3
Fragrance mix I	76	14.8	11.9–18.2
Cobalt chloride	41	8.0	5.9–10.8
<i>p</i> -tert-Butylphenolformaldehyde resin (PTBP)	40	7.8	5.7–10.5
Potassium dichromate	33	6.4	4.5–9.0
<i>p</i> -Phenylenediamine base	13	2.5	1.4–4.4
<i>Myroxylon pereirae</i> (Balsam of Peru)	10	1.9	1.0–3.7
Formaldehyde	10	1.9	1.0–3.7
Epoxy resin	7	1.4	0.6–2.9
Mercapto mix	6	1.2	0.5–2.7
Thiuram mix	6	1.2	0.5–2.7
Sesquiterpene lactone mix	4	0.8	0.2–2.1
Colophonium	3	0.6	0.2–1.8
Lanolin alcohol (Wool Alcohols)	3	0.6	0.2–1.8
Clioquinol	2	0.4	0.1–1.6
<i>N</i> -Isopropyl- <i>N</i> -phenyl-4-phenylenediamine	2	0.4	0.1–1.6
Tixocortol-21-pivalate	2	0.4	0.1–1.6
Paraben mix	1	0.2	0.0–1.3
Mercaptobenzothiazole	1	0.2	0.0–1.3
Methylchloroisothiazolinone (and) methylisothiazolinone	1	0.2	0.0–1.3
Neomycin sulfate	0	0	–
Benzocaine	0	0	–
Quaternium-15	0	0	–
Primin	0	0	–
Budesonide	0	0	–
Methyldibromo glutaronitrile	0	0	–



Fig. 1. *p*-tert-Butylphenolformaldehyde resin in shoe adhesives is a common cause of allergic contact dermatitis in Ethiopia.



Fig. 2. Shoe dermatitis. Positive reaction to *p*-tert-butylphenolformaldehyde resin was shown.

The top five positive allergens were compared between different sexes and age groups and the corresponding *P*-value mentioned in Table 2. Females showed significantly higher rate of reactions for nickel sulfate and *p*-tert-butylphenol formaldehyde (PTBP) resin than males. There was no statistically significant different rate of reaction among those aged less than 40 and those 40 or more years for any of these top five allergens.

The commonest contact allergens were also compared among different occupations and area of dermatitis involvement (Tables 3 and 4).

Cement workers had the highest incidence of positive patch test reactions and office workers



Fig. 3. Allergic contact dermatitis because of Ethiopian Compositae.

the lowest. Higher rates of positive patch test reactions were detected for potassium dichromate in cement workers [odds ratio (OR) = 41.39, 95% confidence interval (CI) between 34.61 and 48.56], for cobalt chloride in metalworkers (OR = 4.81), and for fragrance mix in farmers (OR = 1.60).

The highest rates of positive patch reactions were seen in subjects with dermatitis affecting the foot or trunk and the lowest in dermatitis affecting the scalp or face. Positive reactions to PTBP were frequent in subjects presenting with foot dermatitis (OR = 47.93, 95% CI between 14.47 and 158.76). Patients with hand dermatitis also had a high rate of positive reactions to potassium dichromate (OR = 5.2, 95% CI between 2.22 and 12.26) and trunk dermatitis subjects for nickel sulfate (OR = 2.48, 95% CI between 1.49 and 4.11). Subjects with generalized involvement tend to have higher rates of reaction for fragrance mix I.

Discussion

About half of the subjects tested with the European baseline series showed positive reactions to one or more allergens. The baseline series in different regions and countries is able to detect 40–70%

Table 2. The top five allergens compared between sexes

Allergen	Percent positive (sex)		Odds ratio	95% Confidence limit for odds ratio
	Male	Female		
Nickel sulfate	9.4	21.9	0.369	0.208–0.655
Fragrance mix I	13.5	15.5	0.850	0.501–1.442
Cobalt chloride	9.4	7.3	1.313	0.681–2.531
<i>p</i> -tert-Butylphenolformaldehyde resin (PTBP)	0.6	11.4	0.046	0.006–0.337
Potassium dichromate	9.4	5.0	1.979	0.974–4.022

Table 3. Occupation and common allergens

Occupation	Number	Percent positive					
		Total	Nickel sulfate	Fragrance mix I	Cobalt chloride	<i>p</i> -tert-Butylphenol formaldehyde resin (PTBP)	Potassium dichromate
Office	101	44.6	17.8	8.9	5.9	5.9	3.0
House maid	92	55.4	22.8	14.1	4.3	13.0	7.6
Metal work	60	60.0	21.7	11.7	23.3	3.3	5.0
School	55	52.7	18.2	12.7	3.6	7.3	3.6
Farmer	53	47.2	18.9	20.8	5.7	13.2	5.7
Merchant	25	48.0	20.0	20.0	8.0	0	4.0
Medical	15	60.0	26.7	0	13.3	6.7	0
Cement work	15	86.7	0	6.7	33.3	0	66.7
Others	98	52.0	10.2	23.5	3.1	8.2	4.1

Table 4. Area of eczema involvement and common allergens

Area	Number	Percent positive					
		Total	Nickel sulfate	Fragrance mix I	Cobalt chloride	<i>p</i> -tert-Butylphenol formaldehyde resin (PTBP)	Potassium dichromate
Scalp	50	48.0	22.0	10.0	10.0	4.0	4.0
Face	178	47.2	19.7	16.9	6.7	2.2	5.1
Neck	94	52.1	19.7	16.9	6.7	2.2	5.1
Trunk	100	58.0	30.0	18.0	8.0	1.0	2.0
Arm	63	52.4	25.4	12.7	11.0	1.6	3.2
Hand	226	53.5	14.6	13.7	11.9	3.1	11.5
Leg	74	50.0	20.3	16.2	10.8	4.1	4.1
Foot	134	59.7	16.4	13.4	5.2	27.6	6.7

of the allergens causing allergic contact dermatitis, even though higher and lower rates have been reported (7–13). The result in our study is comparable with most of the studies from these countries.

Allergic contact sensitization is known to be influenced by environmental, cultural, occupational, individual, genetic and racial or ethnic factors (8, 14–16). This can explain the different rates of positive reactions for each allergen tested compared to rates in other countries. For example, neomycin sulfate is the second commonest contact allergen in India (12) and *p*-phenylenediamine the third commonest allergen in China (7). The unavailability of topical neomycin and the relatively less frequent use of hair dye in Ethiopia are responsible for the absence and low rate of positive reactions for these allergens, respectively. Although rarely detected in some other countries (7,14,17,18), PTBP was the fourth commonest allergen in our study.

Comparable results have been reported in a Hispanic population (19). This could be because of the widespread use this resin to glue leather and plastic shoes in Ethiopia. There were no positive reactions for methylidibromo glutaronitrile, budesonide, primin, quaternium-15, benzocaine and neomycin sulfate. We recommend exclusion of these allergens from a future Ethiopian baseline series to minimize the cost of patch testing. Conversely, a study of the major industries in the country may show important additional occupational allergens which might justify inclusion in a baseline series.

Many studies showed significantly higher rates of positive patch test reactions in females than males (20–22), whereas there was no significant difference between males and females in our study. This is in agreement with a study in India (12) and might be the result of environmental and study

population differences. However, our study has shown higher rates of positive patch test reactions for nickel sulfate and PTBP in females than males. Higher rates of positive patch test reactions for nickel sulfate in females are also documented in other studies (17,23) and are related to their ear piercing, cosmetic application and ornament use behaviour. Nickel is an abundant metal which is commonly seen in ornaments, buttons and zippers of clothes that have direct contact mainly to the trunk. This was shown in our population by higher rates of positive reactions in subjects affected by trunk dermatitis. The higher rate of positive reaction to PTBP in females and foot dermatitis is related to frequent use of open shoes fastened with this glue that easily leaches out on to the skin (Figs. 1 and 2).

Occupation is an important factor for development of allergic contact dermatitis and occupational contact dermatitis represents 80–90% of all occupational dermatoses. The hands are involved in 80–90% of cases (24). Construction work is one among the most important occupations predisposing to allergic contact dermatitis (25) and is most commonly because of potassium dichromate (26,27). This is shown in our study by higher rates of positive reactions to potassium dichromate in cement workers and in subjects with hand dermatitis. Occupational factors are also responsible for higher rates of positive reactions to cobalt chloride in metalworkers and may explain the surprisingly high incidence of fragrance mix I positivity in farmers, perhaps reflecting exposure to lichens. Our results are similar to previous studies of Swedish metalworkers (28) and New Zealand farmers (29), respectively. Lichens are very common in the Ethiopian highlands, including genera, such as *Cladonia*, *Parmelia* and *Usnea*, which are recognized as allergenic. Further testing in rural areas may show a greater incidence of positive reactions to compositae allergens, which can produce severe clinical reactions (Fig. 3). The native Texan compositae, *Parthenium hysterophorus*, well recognized as a major allergen when naturalized in India, is an increasingly problematic weed in rural areas of Ethiopia (30).

Even though allergic contact dermatitis is believed to increase with age (31), positive reactions in our study population were not affected by age. This may be due to our study subjects which were all adults. The age of the study population may also be the reason for the lower incidence of atopic dermatitis in the MOAHLFA index. Unfortunately, data are not available for the incidence of atopy in the Ethiopian urban population, although our impression is that it is rarer than in Europe.

Conclusion

More than half patch tested dermatitis patients reacted to at least one allergen of the European patch test baseline series. The top five contact allergens identified were nickel sulfate, fragrance mix I, cobalt chloride, PTBP resin and potassium dichromate. There were no positive reactions for methyldibromo glutaronitrile, budesonide, primum, quaternium-5, benzocaine and neomycin sulfate. It is probable that these allergens could be safely omitted when devising a baseline series for Ethiopia. Further studies should include specific testing where clinically relevant, e.g. for specific occupations such as hairdressing or rubber manufacture.

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