

Report

Clinical-epidemiological features of contact dermatitis in rural and urban communities in northern Ethiopia: correlation with environmental or occupational exposure

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Abstract

Background The widespread diffusion of low-quality products as well as the local cultural habits could be a relevant cause of allergic diseases in developing countries. In the present observational study, we explored the prevalence of allergic contact dermatitis in both rural and urban settings in northern Ethiopia, where skin diseases represent a frequent cause of morbidity. Clinical features and specific reactivities in association with environmental or occupational exposure were investigated.

Patients and methods We patch tested 480 consecutive patients, visited at the Mekele IDC, exhibiting symptoms of contact dermatitis. A detailed medical history of each patient was collected.

Results A positive patch-test response was observed in 50% of subjects; nickel was the most frequent sensitizer (26.2%), followed by p-tert-butylphenol formaldehyde resin (10%), fragrance mix (7.1%), potassium dichromate (5.4%), cobalt chloride (4.6%), disperse blue (2.3%), and p-phenylenediamine (1.7%). Gender-related differences were analyzed for single allergen. Eczema represented the most common manifestation, affecting the head and neck as primary skin areas. While reactivity to nickel interested almost all the occupational categories, sensitization to other allergens could be ascribed to working habits or environmental exposure.

Conclusions The results gathered from this study, the first one conducted within the Tigray region in Ethiopia, confirm the need to take appropriate measures to limit the nickel rate in metal objects and may be useful to design allergenic series suitable for patch testing in those geographical settings.

Introduction

The epidemiology of skin diseases in African populations has not been extensively studied.^{1,2} In particular, allergic diseases have only recently gained serious attention,³ although they are at present the most common health problem observed in primary care settings.⁴

According to a recent clinical study performed by our group at the Italian Dermatological Centre (IDC) in Mekele, skin diseases represent the most frequent cause of morbidity in both urban and rural areas in Ethiopia⁵ and represent the sixth most frequent cause of outpatient visits to health facilities nationwide.^{6,7} However, in Ethiopia and other developing countries, few epidemiological studies have investigated allergic skin disorders in different ethnic groups and the rate of allergic sensitiza-

tion to particular substances⁸⁻¹¹ related to their environmental or occupational exposure. In assessing allergic contact dermatitis, patch testing should include, in addition to a baseline (standard) series that covers the main allergens responsible for skin disease in the population, allergens considered to be important for the individual patient, taking into consideration his/her specific cultural practices, which could be responsible for ethnic differences in sensitivity to patch testing,¹² as opposed to the individual ability to mount an immunological response.¹ In light of these considerations, detailed epidemiological studies in rural and urban centers performed by a non-Eurocentric point of view (local allergens, locally validated questionnaires, and diagnostic procedures) could then help to understand the increasing rate of allergic disorders and provide the basic knowledge needed to set

targeted strategies for healthcare and disease prevention in Africa.

The objective of the present observational study was to estimate the prevalence of contact dermatitis, the sensitivity to specific allergens, the skin areas affected, and the potential association with occupational exposure among outpatients attending the IDC in Mekele.

Patients and methods

Patch tests were performed using the recommended standard procedure¹³ for all 480 patients who presented consecutively to the IDC in the period from January 2010 to February 2011 with suspected allergic contact dermatitis. The allergens (listed in Table 1) were applied using 8-mm aluminum Finn Chambers® on Scanpor® tape (Epitest Ltd, Oy, Tuusula, Finland), and fixed to the back of the patients with adhesive tape, in particular Fixomull® stretch (BSN Medical, GmbH, Hamburg, Germany). The allergen in petrolatum filled slightly more than half of the chamber volume and, for aqueous allergens, a filter paper disc (Whatman 3M Epitest Ltd, Oy, Tuusula, Finland) was placed in the chamber. Two readings at D2 and D3 were scheduled. A late reading at D7 was scheduled for those patients who had an unclear reaction and for those able to come to the IDC.

For each patient, sociodemographic information and information on behavior and medical history was collected, including age, gender, geographic provenance, personal and family history of allergies, lifestyle, occupational exposure, history of drug reactions, and duration of symptoms. The

information was collected at the same time as the clinical assessment of the type and localization of skin lesions.

In cases in which there was a positive response to the patch test, the potential environmental exposure to the substance(s) containing the given allergen was investigated by collecting further information on the patient's habits.

Statistical analysis

The statistical significance of correlations between positive patch-test responses and sociodemographic factors or disease localizations was analysed using the Chi-square, one-way analysis of variance, and odds ratio. The level of statistical significance was set at $P < 0.05$. Statistical analyses were performed using SPSS Statistics version 17.0 software (SPSS, Chicago, IL, USA).

Results

Study population

A total of 480 patients with clinically suspected allergic contact dermatitis were subjected to patch testing. Considering the gender, 309 (64.4%) individuals were females and 171 (35.6%) were males. The median age was 25 years (range: 3–78 years). All but one of the participants were adults; the only child was a 3-year-old who presented with atopic dermatitis with an allergic component due to contact with environmental allergens. Of these individuals, 218 (45.2%) were from Mekele; the remaining individuals were from other districts throughout the

Table 1 Frequency of positive patch-test reactions by allergen and gender

Positive reaction (%)					
Allergens	All subjects <i>n</i> = 480	Patch-test positive <i>n</i> = 240	Females positive <i>n</i> = 152	Males positive <i>n</i> = 88	<i>P</i> (χ^2)
Nickel sulfate	26.2	54.6	53.8	56	n.s.
p-tert-Butylphenol formaldehyde resin	10	20.3	30.8	2.4	0.001
Fragrance mix	7.1	14.5	11.2	20.2	0.01
Potassium dichromate	5.4	11	9.1	14.3	n.s.
Cobalt chloride	4.6	9.3	6.3	14.3	0.01
Disperse blue	2.3	4.8	4.9	4.8	n.s.
p-Phenylenediamine	1.7	3.4	2.9	4.2	n.s.
Compositae mix	1.3	2.7	3.4	1.7	0.05
Thiuram mix	1.2	2.4	1	5	0.05
Mercapto mix	1.1	2.1	2.4	1.7	n.s.
Euxil	1.1	2.1	2.4	1.7	n.s.
Neomycin sulfate	0.7	1.5	1.9	0.8	n.s.
Balsam of Peru	0.6	1.2	1	1.7	n.s.
Paraben mix	0.6	1.2	1.9	0	n.s.
Wool alcohols	0.6	1.2	1	1.7	n.s.
Epoxy resin	0.4	0.9	0.5	1.7	n.s.
Colophonium	0.3	0.6	1	0	n.s.
<i>N</i> -Isopropyl- <i>N</i> -phenyl-4-phenylenediamine	0.3	0.6	0	1.7	n.s.
Budesonide	0.1	0.3	0.5	0	n.s.

Table 2 Sites of skin involvement by allergen

Allergen	Head/neck <i>n</i> pos. (%)	Hands <i>n</i> pos. (%)	Feet <i>n</i> pos. (%)	Arms <i>n</i> pos. (%)	Legs <i>n</i> pos. (%)	Chest <i>n</i> pos. (%)	Back <i>n</i> pos. (%)	<i>P</i> (χ^2)
Nickel sulfate	42 (22.6)	24 (12.9)	23 (12.4)	29 (15.6)	5 (2.7)	62 (33.3)	1 (0.5)	<0.001
p-tert-Butylphenol formaldehyde resin	5 (8.8)	6 (10.5)	35 (61.4)	5 (8.8)	4 (7.0)	2 (3.5)	0	<0.001
Fragrance mix	12 (21.4)	11 (19.6)	5 (8.9)	11 (19.6)	6 (10.7)	8 (14.3)	3 (5.4)	0.35
Potassium dichromate	12 (26.1)	7 (15.2)	7 (15.2)	9 (19.6)	3 (6.5)	6 (13.0)	2 (4.3)	0.04
Cobalt chloride	5 (12.8)	9 (23.1)	8 (20.5)	9 (23.1)	3 (7.7)	4 (10.3)	1 (2.6)	0.5
Disperse blue	3 (14.3)	1 (4.8)	2 (9.5)	4 (19.0)	7 (33.3)	3 (15.3)	1 (4.8)	0.2

Tigray region. Most of the subjects (67.4%) were from urban areas, and 30.0% were students.

The clinical symptoms at presentation were psoriasis-like (40.7%), dyshydrotic-type dermatitis (29.6%), and nummular-type dermatitis (8.0%). The clinical evolution was chronic for more than half of the patients (56.8%), subacute for 30.7%, acute for 11.4%, and relapsing for 1.1%.

Patch Testing

Each patient was tested for 19 allergens (Table 1). Of the 480 individuals tested, 240 (50.0%) had at least one positive response; of these individuals, 173 (36.0% of the entire study sample) had a positive response to only one allergen, 40 (8.3%) to two allergens, 20 (4.2%) to three allergens, four (0.83%) to four allergens, and three (0.6%) to five allergens. Irritant reactions were considered as negative responses. The most frequent cause of allergic contact dermatitis was nickel, followed by p-tert-butylphenol formaldehyde resin, fragrance mix, potassium dichromate, cobalt chloride, disperse blue, and p-phenylenediamine.

With regard to gender, 152/309 (49.2%) females and 88/171 (51.5%) males had a positive patch test. Compared with males, females were more likely to have had a positive response to p-tert-butylphenol formaldehyde resin (OR = 14.20, 95% CI: 3.40–59.4), yet they were less likely to have developed a sensitization to cobalt chloride (OR = 0.40, 95% CI: 0.16–0.97) and fragrance mix (OR = 0.50, 95% CI: 0.24–1.00). We also found a gender difference for compositae mix and thiuram mix, yet the difference was not significant ($P = 0.05$). Finally, females were more likely to have had a positive response to potassium dichromate, yet the difference with respect to males was not significant.

Allergen sensitivity and skin area involved

The head and neck were the most frequently affected areas (19.9%), followed by feet (17.5%), chest (15.8%), limbs (14.2%), hands (12.7%), and back (5.6%). Among women, the most commonly affected areas were the head and feet, whereas among men the most commonly affected areas were the chest, hands, and arms. The site of skin involvement was in some instances significantly

Table 3 Distribution of sensitivity to the six most common contact allergens by occupation

Occupational activity	Subjects with positive patch-test (%)	Nickel sulfate, %	p-tert-Butylphenol formaldehyde resin, %	Fragrance mix, %	Potassium dichromate, %	Cobalt chloride, %	Disperse blue, %
Cleaners	13/20 (65.0)	38.5	38.5	7.7	7.7	0.0	7.7
Construction-workers	22/34 (64.7)	22.7	0.0	9.1	31.8	31.8	4.5
Drivers	7/10 (70.0)	17.3	14.3	57.1	0.0	0.0	11.3
Farmers	12/23 (52.2)	66.7	29.7	8.3	1.3	2.3	0.0
Health workers	4/13 (30.8)	50.0	25.0	25.0	0.0	0.0	0.0
Housewives	28/74 (37.8)	32.1	38.6	10.7	4.3	3.6	10.7
Merchants	9/29 (31.0)	66.7	0.0	33.3	0.0	0.0	0.0
Metal workers	12/28 (42.9)	50.0	50.0	0.0	0.0	0.0	0.0
Military	10/24 (41.7)	70.0	20.0	0.0	10.0	0.0	0.0
Office workers	31/54 (57.4)	35.5	35.5	19.4	3.2	0.0	6.5
Students	86/146 (58.9)	62.8	15.1	7.0	7.0	5.8	2.3
Unemployed	6/25 (24.0)	41.7	23.3	26.7	8.3	0.0	0.0

associated with reactivity to a specific allergen (Table 2). In particular, nickel sulfate and potassium dichromate were associated with chest and head/neck dermatitis, and p-tert-butylphenol formaldehyde resin was associated with feet dermatitis; fragrance mix was recorded in subjects presenting head, hand, and arm dermatitis, yet the association was not significant. Individuals with generalized leg involvement tended to have higher rates of reaction for disperse blue. Considering the personal history, 33.6% of individuals working at the same place reported the same skin site of clinical signs.

Allergen sensitivity and occupation

The prevalence of sensitization to specific allergens, by occupation, is shown in Table 3. Reactivity to nickel sulfate was not associated with occupation, as the prevalence of positive patch tests was comparable when comparing occupations. However, there was a significantly reduced probability of developing an allergy to nickel sulfate for drivers (OR = 0.11, 95% CI: 0.01–0.90) and unemployed persons (OR = 0.08, 95% CI: 0.02–0.33). A significant positive association was found between reactivity to fragrance mix and being a driver (OR = 11.09, 95% CI: 2.35–52.44) or a merchant (OR = 3.94, 95% CI: 0.93–16.72); between reactivity to potassium dichromate and cobalt chloride and being a construction worker (OR = 7.37, 95% CI: 2.40–22.64); and between reactivity to disperse blue and being a driver (OR = 4.15, 95% CI: 0.45–38.17).

Discussion

This observational study, performed on 480 individuals living in the Tigray region of northern Ethiopia, was undertaken as part of collaborative efforts between the Italian San Gallicano Dermatology Institute and local non-governmental organizations, with the objective of gathering epidemiological data on the prevalence of contact allergy and improving the knowledge on the sensitizing substances to which individuals in this region are exposed. Mekele is the largest city in northern Ethiopia, located 650 km north of the capital, Addis Ababa, and it is an important economic and educational center. Local industry includes Mesfin Industrial Engineering, a steel manufacturer, and the Messebo Cement Factory, northern Ethiopia's principal cement production facility. The literacy rate in this region is 51.75%, which is higher than the 15.71% national rate. The school attendance rate is 91.1% for primary school, 17.7% for middle school, and 52.1% for high school. With regard to sanitary conditions, about 88% of urban households have access to safe drinking water, and about 51% have toilet facilities. However, most (83%) of the people from this region live in rural areas

where the sanitary conditions are worse. Based on socioeconomic data provided in the Statistical Report of the 2007 Population and Housing Census Results of Federal Democratic Republic of Ethiopia, and on previous studies,^{6,14,15} we defined the panel of allergens considered in the present study. As also found in a previous report,¹⁶ 50% of our patients showed a positive patch test, and we found basically no difference between women (about 49%) and men (about 51%). Of the individuals with a positive patch test, 36% had a positive reaction to only one allergen. Accordingly with other studies, the median prevalence of contact allergy to at least one allergen is about 22% (range 12.5–40.6%) in different populations.^{6,15}

In our study, the allergen to which patients were most commonly positive was nickel sulfate (26.2%), followed by p-tert-butylphenol formaldehyde resin (10%), fragrance mix (7.1%), potassium dichromate (5.4%), cobalt chloride (4.6%), disperse blue (2.3%), and p-phenylenediamine (1.7%). Interestingly, nickel sulfate allergy, which is generally associated with the use of low-quality jewelry and ear piercing,^{17,18} did not account for the high prevalence of sensitivity in women; in fact, the wearing of necklaces and bracelets appears to be equally fashionable among both sexes in Ethiopia, and there exists the common practice of making jewelry out of everyday objects. For example, students create ornaments for decorating clothes or to adorn their arms and neck using small metal objects and the aluminum from beverage cans. Moreover, nickel is frequently used for tribal decorations and work tools¹⁹ and accordingly was not significantly associated with occupation in our study.

Although rarely reported as an allergen in European or Asian surveys,^{20,21} p-tert-butylphenol formaldehyde resin, which has been identified as an important sensitizer component of a resin used to glue leather and plastic shoes,^{22,23} was the second most common sensitizer in our study, following nickel. It was responsible for footwear dermatitis in cleaners, office workers, housewives, and metal workers, probably because of the practice of wearing shoes without socks and the high foot transpiration due to the hot climate.

Of interest are the results of the analysis of occupational risk. Sensitivity to fragrance mix was mostly found among men drivers, who make heavy use of fragrances and perfumed oils, and merchants of cosmetics powders and perfumes.

Reactivity to cobalt alone is rare, and in most cases it is associated with reactivity to chromate,²⁴ which is consistent with our results. In fact, the majority of individuals with a positive patch test to cobalt were also reactive to chromate. In particular, among construction workers, this prevalence reached 100%. Cobalt chloride, although present in cement in small amounts, was the third most

common contact allergen among construction workers with occupational dermatitis, after chromate and epoxy resin.^{25–27} This finding suggests that this concomitant hypersensitivity is not due to a cross-reaction but to an actual simultaneous sensitization due to combined exposure, given that both of these allergens are present in cement. With regard to the overall prevalence of cobalt sensitization in the entire study sample (4.6%), it was lower than that reported in a study conducted in the southern region of Ethiopia.¹⁶ A possible explanation could lie in the fact that in Mekele and its surrounding districts, the use of cement in local building is very recent, as is the establishment of a cement factory, located a few kilometers outside of the city.

Thiurams and dithiocarbamates, which are represented by the thiuram mix in patch testing, are important components of natural and synthetic rubber products. In this study, a number of occupations in healthcare are associated with a high risk of sensitization to the thiurams in natural or synthetic rubber gloves. An unexpected result of this study was the high rate of sensitivity to composite mix, which was particularly high in females. Composite mix was included in the series of allergens tested because of the adverse impact of the plant *Parthenium hysterophorus* in Ethiopia.²⁸ In Ethiopia and other African countries, this invasive annual weed, which causes severe infestations of crop fields, is controlled almost exclusively by hand-weeding by women and school-age children, which is consistent with our results.

The relatively less frequent use of other allergens, such as topical neomycin, budesonide, and hair dye, in Ethiopia appears to be responsible for the absence or very low rate of sensitization to these allergens.

Conclusion

This is the first study conducted in the Tigray region, and our results could be used to formulate allergenic standard series suitable for clinical testing in this particular setting.

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References

- 1 Alexis AF, Sergay AB, Taylor SC. Common dermatologic disorders in skin of color: a comparative practice survey. *Cutis* 2007; 80: 387–394.
- 2 Taylor SC. Epidemiology of skin diseases in people of color. *Cutis* 2003; 71: 271–275.
- 3 Van Ree R, Yazdanbakhsh M. Allergic disorders in African countries: linking immunology to accurate phenotype. *Allergy* 2007; 62: 237–246.
- 4 Obeng BB, Hartgers F, Boakye D, Yazdanbakhsh M. Out of Africa: what can be learned from the studies of allergic disorders in Africa and Africans? *Curr Opin Allergy Clin Immunol* 2008; 8: 391–397.
- 5 Accorsi S, Barnabas GA, Farese P, et al. Skin disorders and disease profile of poverty: analysis of medical records in Tigray, northern Ethiopia, 2005–2007. *Trans R Soc Trop Med Hyg* 2009; 103: 469–475.
- 6 Hay RJ, Bendeck SE, Chen S, et al. Skin diseases. In Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P, eds. *Disease Control Priorities in Developing Countries*, 2nd edn. Oxford: Oxford University Press, 2006: 707–722.
- 7 Federal Ministry of Health. *Health and Health-Related Indicators*. Addis Ababa: Federal Ministry of Health, 2006.
- 8 Ertam I, Turkmen M, Alper S. Patch-test results of an academic department in Izmir, Turkey. *Dermatitis* 2008; 19: 213–215.
- 9 Ayanlowo O, Olumide Y. Routine patch testing in a dermatology clinic of a teaching hospital in Nigeria. *Nig Q J Hosp Med* 2007; 17: 160–164.
- 10 Belhadjali H, Mohamed M, Youssef M, et al. Contact sensitization in atopic dermatitis: results of a prospective study of 89 cases in Tunisia. *Contact Dermatitis* 2008; 58: 188–189.
- 11 Kashani MN, Gorouhi F, Behnia F, Natemi M. Allergic contact dermatitis in Iran. *Contact Dermatitis* 2005; 52: 154–158.
- 12 Deleo VA, Taylor SC, Belsito DV, et al. The effect of race and ethnicity on patch test results. *J Am Acad Dermatol* 2002; 46: 107–112.
- 13 Wahlberg JE. Patch testing. In: Rycroft RJG, Menne T, Frosch PJ, et al., eds. *Textbook of Contact Dermatitis*, 3rd edn. Berlin: Springer, 2001: 435–464.
- 14 Bilcha KD, Shibeshi D, Grangsjö A, Hilete M. Patch test reaction on Ethiopian subjects with eczema. *Int J Dermatol* 2009; 48: 979–983.
- 15 Thyssen JP, Linneberg A, Mennø T, Johansen JD. The epidemiology of contact allergy in the general population – prevalence and main findings. *Contact Dermatitis* 2007; 57: 287–299.
- 16 Bilcha KD, Ayele A, Shibeshi D, Lovell C. Patch testing and contact allergens in Ethiopia – results of 514 contact dermatitis patients using the European baseline series. *Contact Dermatitis* 2010; 63: 140–145.
- 17 Modjtahedi BS, Modjtahedi SP, Maibach HI. The sex of the individual as a factor in allergic contact dermatitis. *Contact Dermatitis* 2004; 50: 53–59.
- 18 Delescluse J, Dinot Y. Nickel allergy in Europe: the new European legislation. *Dermatology* 1994; 189: 56–57.

- 19 Skoet R, Olsen J, Mathiesen B, *et al.* A survey of occupational hand eczema in Denmark. *Contact Dermatitis* 2004; 51: 159–166.
- 20 Bajaj AK, Saraswat A, Mukhija G, *et al.* Patch testing experience with 1000 patients. *Indian J Dermatol Venereol Leprol* 2007; 73: 313–318.
- 21 Uter W, Räämsch C, Aberer W, *et al.* The European baseline series in 10 European Countries, 2005/2006 – results of the European Surveillance System on Contact Allergies (ESSCA). *Contact Dermatitis* 2009; 61: 31–38.
- 22 Collazo MH, Figueroa LD, Sánchez JL. Prevalence of contact allergens in a Hispanic population. *P R Health Sci J* 2008; 27: 333–336.
- 23 Warshaw EM, Schram SE, Belsito DV, *et al.* Shoe allergens: retrospective analysis of cross-sectional data from the north american contact dermatitis group, 2001–2004. *Dermatitis* 2007; 18: 191–202.
- 24 Athavale P, Shum KW, Chen Y, *et al.* Occupational dermatitis related to chromium and cobalt: experience of dermatologists (EPIDERM) and occupational physicians (OPRA) in the U.K. over an 11-year period (1993–2004). *Br J Dermatol* 2007; 157: 518–522.
- 25 Wang BJ, Wu JD, Sheu SC, *et al.* Occupational hand dermatitis among cement workers in Taiwan. *J Formos Med Assoc* 2011; 110: 775–779.
- 26 Uter W, Rhl R, Pfahlberg A, *et al.* Contact allergy in construction workers: results of a multifactorial analysis. *Ann Occup Hyg* 2004; 48: 21–27.
- 27 Condé-Salazar L, Guimaraens D, Villegas C, *et al.* Occupational allergic contact dermatitis in construction workers. *Contact Dermatitis* 1995; 33: 226–230.
- 28 Tamado T, Schutz W, Milberg P. Germination ecology of the weed *Parthenium hysterophorus* in eastern Ethiopia. *Ann Appl Biol* 2002; 140: 263–270.