

ORIGINAL PAPERS

THE EFFECT OF THE WORKING ENVIRONMENT ON OCCUPATIONAL SKIN DISEASE DEVELOPMENT IN WORKERS PROCESSING ROCKWOOL

MARTA KIEĆ-ŚWIERCZYŃSKA¹ and WIESŁAW SZYMCZK²

¹ Outpatient Clinic of Occupational Diseases

² Risk Assessment Unit

The Nofer Institute of Occupational Medicine Lodz, Poland

Key words: Allergic contact dermatitis, Irritant contact dermatitis, Oil acne, Rockwool, Chromium, Cobalt, Nickel, Phenol-formaldehyde resin

Abstract: Our examinations involved 259 workers (46 females and 213 males) manufacturing insulation matting of rockwool and phenol-formaldehyde resin. The control group included 529 people. All of the subjects were patch-tested. The age-adjusted relative risk was used as a measure for evaluating the increase in the incidence of dermatitis and allergy to metals. An atomic absorption method was used to determine metal content in rockwool.

Dermatitis was found in every fourth subject examined, oil acne in every tenth subject; 7.3% of the subjects examined were found to be allergy-positive to nickel, 6.9% to chromium, 5.0% to cobalt, 3.1% to formaldehyde, 1.5% to phenol-formaldehyde resin, 0% to phenol. Out of the 39 subjects examined twice (in 1988 and 1990), 5 were found to be allergy-positive to nickel during the second examination. A statistically significant increase in the risk of incidence of occupational dermatitis and allergy to nickel and cobalt was found in people producing insulation products made of rockwool. The latter material was found to contain 200 ppm chromium, 88 ppm nickel and 29 ppm cobalt.

INTRODUCTION

Rockwool matting for use as an insulating material is produced in Poland by combining molten fibrated basalt with phenol-formaldehyde resin and oil emulsion.

Rockwool is known to be a strong irritant, and phenol-formaldehyde resin is also known to have an allergic effect. However, no information is available in the literature on the sensitizing effect of the metals contained in rockwool and on the

acnegenic effect of the mineral oils used in the manufacture of insulating materials. The aim of this work was to assess the type and frequency of skin lesions and allergy in people exposed to rockwool.

MATERIALS AND METHODS

During 1988-1990, dermatologic examinations were performed in 259 workers (46 females and 213 males) of a plant where insulation materials for use in the construction industry had been produced since 1985. Out of this number 49 workers (10 females and 39 males) were examined twice, in 1988 and 1990 (they came to be examined with another working shift). There was no history of atopic diseases among the test subjects or their families.

The control group included 529 people (203 seamstresses and 326 lumbermen).

All people in the test group were subjected to patch tests using an allergen set supplied by the Department of Applied Pharmacy and Drug Technology, Medical Academy, Sosnowiec, Poland, according to ICDRG recommendations. The set included 0.5% potassium dichromate, 5% nickel sulfate, 1% cobalt chloride, 5% phenol-formaldehyde resin in petrolatum, 1% formaldehyde and 1% phenol in water. The overall chromium, cobalt and nickel contents in the rockwool were determined by the atomic absorption method on a Model 420 Perkin-Elmer absorption meter in an acetylene-air flame.

The increased incidence of dermatitis and hypersensitivity to chromium, cobalt and nickel in the exposed group vs. the controls was determined from the relative risk. The proportions of the subjects with dermatitis and with hypersensitivity to the metals within the test group were different in the individual age classes. Therefore, age adjustment by stratification was used to reduce the effect of age on the relative risk. The estimation of the age-adjusted relative risk values (in order to provide a solution to the problem of testing $H_0: R = 1$ $H_1: R > 1$) was effected by calculating a 95% confidence interval for the relative risk (1).

RESULTS

Table 1 gives the results of the analysis of the incidence of contact dermatitis and oil acne. Dermatitis was more frequent in females (32.6%) than in males (23.5%). The frequency of oil acne in males (11.3%), however, was 5 times higher than that in females (2.2%). Dermatitis was found in 18 (3.4%) controls, including 4 females (2.0%) and 14 males (4.3%). No cases of oil acne were found among the controls. In the majority of workers exposed to rockwool, dermatitis involved not only the hands and arms, but also the face, neck, and the upper portion of the trunk. The skin lesions were associated with strong itching. Some workers used self-made masks of surgical gauze to protect the skin of their faces from the strong irritant effect of rockwool fibres. The sites of oil acne eruptions on the arm, legs, and back corresponded with oil exposure in the places where the workers' protective clothing was saturated with the oil.

The percentage of chromium-sensitive subjects was higher in males (8.0%) than in females (2.2%). The women were 3 times more sensitive to nickel than men (17.4% and 5.2%, respectively — see Table 2). When comparing the results of the patch tests performed twice in the same subjects, an increase in the frequency of sensitivity to

Table 1. Type and incidence of skin disorders in workers employed at manufacturing insulating materials

Skin changes	Women (n=46)		Men (n=213)		Total (n=259)	
	n	%	n	%	n	%
Contact dermatitis	15	32.6	50	23.5	65	25.1
Oil acne	1	2.2	24	11.3	25	9.6

Table 2. Type and incidence of allergy in workers employed at manufacturing insulating materials

Allergens	Women (n=46)		Men (n=213)		Total (n=259)	
	n	%	n	%	n	%
Nickel	8	17.4	11	5.2	19	7.3
Chromium	1	2.2	17	8.0	18	6.9
Cobalt	5	10.9	8	3.7	13	5.0
Formaldehyde	1	2.2	7	3.3	8	3.1
Phenol-formaldehyde resin	0		4	1.9	4	1.5
Phenol	0		0		0	

nickel in males was found to occur. Five males who had negative nickel patch test results in 1988, were found to be nickel-sensitive in 1990. Phenol-formaldehyde resin produced an allergy in 4 males, and formaldehyde in 1 female and 7 males. There was no case of phenol allergy.

When analyzing the frequency of positive patch test results in the subjects affected by dermatitis it was found that allergy to, at least, one of the allergens present in the working environment explained the skin lesions in 6 females and 24 males (allergic contact dermatitis). In the remaining dermatose subjects (9 females and 26 males) the results of the patch tests were negative (irritant contact dermatitis).

Among the controls, 1 female (0.5%) and 10 males (3.1%) were hypersensitive to chromium, 3 females (1.5%) and 3 males (0.9%) to cobalt, 5 females (2.5%) and 1 male (0.3%) to nickel.

Table 3 specifies the values of the age-adjusted relative risk of incidence of dermatitis and allergy to chromium, cobalt and nickel in females and males exposed to rockwool. A significantly increased risk of incidence of dermatitis and allergy to nickel and cobalt in both sexes, and to chromium in males was found to occur. The

Table 3. Relative risk (and confidence intervals) of contact dermatitis and allergy to metals in workers producing insulating materials

	Relative risk age-adjusted by stratification (confidence interval for relative risk)		
	Women	Men	Total
Contact dermatitis	20.37 (5.74; 72.71)	5.51 (2.89; 10.51)	7.89 (4.43; 14.06)
Nickel allergy	9.23 (2.14; 39.74)	10.44 (1.72; 63.32)	6.01 (2.19; 16.49)
Chromium allergy	8.79 (0.38; 200.99) ns	2.68 (1.07; 6.69)	3.72 (1.52; 9.13)
Cobalt allergy	11.17 (1.79; 69.59)	4.16 (1.00; 17.35)	5.19 (1.72; 15.69)

ns — statistically insignificant (relative risk smaller than, or equal to, 1).



value of relative risk of allergy to chromium in females was not statistically significant. Using the atomic absorption method, rockwool was found to contain 200 ppm chromium, 88 ppm nickel, and 29 ppm cobalt.

DISCUSSION

Numerous irritant and sensitizing agents to which workers processing rockwool had been exposed were frequent causes of dermatitis. In 60% of the dermatose females and 52% of the dermatose males, the lesions were caused by irritating agents, rockwool in particular. The latter conclusion is in line with earlier observations on a very strong irritant effect of rockwool (5). The workers, in particularly those who were exposed to dry rockwool (before resin had been applied to it), complained of strong itching during and after work, and erythema on the skin.

The percentage of dermatose females was higher than that of dermatose males, and the value of relative risk was four times higher in females. This is in line with the observation made by other authors that the skin of females was more sensitive to the effect of irritant and/or sensitizing agents as compared with the skin of males (7, 10, 11).

Contact with allergens present in the working environment resulted in frequent sensitization. Nevertheless, hypersensitivity to allergens present in the working environment of the insulation materials plant, such as phenol-formaldehyde resin, formaldehyde or phenol, rarely occurred. Only 4 males were found to be sensitive to resin, and 8 subjects were found to be sensitive to formaldehyde. Phenol-formaldehyde resin is a known basic allergen (2). There have been reports that resin can also cause allergy in the municipal environment (12, 13). In our experiment, the percentage of resin-sensitive subjects was low, merely 2 times higher than that reported by Seidenari et al. (12) for the general population. Occupational hypersensitivity to formaldehyde is more frequent in males, while non-occupational hypersensitivity is more frequent in females (4). Men become sensitized due to contact with plastics (for example with phenol-formaldehyde resins) and cutting oils, women — due to contact with cosmetics and cleaning or washing agents. Formalin is used as a conservant for cutting oils, some cosmetics and cleaning or washing agents. Cronin (4) reports sensitivity to formaldehyde in 2.2% of males and 3.6% of females. In our subjects, the percentages were similar, but slightly higher in males (3.3) than in females (2.2).

We detected an allergy to metals in workers employed at the manufacture of rockwool insulation materials. Up to the present, no such cases have been reported. The percentage of the nickel-sensitive females was higher than that of males. This is in line with earlier observations on the higher frequency of hypersensitivity to nickel resulting from skin contact with metal jewelry in women (8). In our experiment, however, the sensitivity was of a mixed, occupational and non-occupational, character. The latter observation is supported by the relative risk values which were similar for both sexes, the value for males (10.44) being even slightly higher than for females (9.23). The contribution of the occupational factors is also supported by the increased number of cases of allergy in males. Among the 39 males examined twice within a 2-year period, as many as 5 were found to be sensitive to nickel during the second examination.

The cobalt allergy risk value was 3 times higher in females than in males. The percentage of cobalt-sensitive females (10.9) was also higher than that of males (3.7). The sensitization to cobalt is usually secondary: in females, it is associated with sensitivity to nickel, and in males — to chromium (3.6). Hypersensitivity to nickel was found in 4 out of 5 cobalt-sensitive females, and hypersensitivity to chromium was found in 4 out of 8 cobalt-sensitive males. In females, the value of the risk of sensitivity to chromium was not statistically significant, and in males it was low. It is quite probable that the number of chromium-sensitive people during the coming years will increase. Some authors are of the opinion that a long period of time is required to develop an allergy to chromium (5). The machinery range manufacturing the insulation matting had been operative for 5 years only. It is also quite likely that the chromium present in rockwool was characterized by weaker sensitizing properties. It is generally recognized that metallic chromium (unlike nickel and cobalt) is a weak allergen. The allergic effect is produced chiefly by its compounds, particularly hexavalent ones.

No reports on occupational acne in manufacturers of insulation products are available in literature. In our study, oil acne resulting from contact with the oil emulsion added to rockwool was found in almost 10% of the plant personnel. In some of the subjects examined, oil acne might have been due to machine oil and grease used to lubricate the pressing machines.

Our results indicate that the metals contained in rockwool constitute a new source of allergy, especially to nickel and cobalt, and that the mineral oils present in the working environment cause oil acne in the employees of plants manufacturing insulation products.

CONCLUSIONS

1. The risk of occupational dermatitis among the manufactures of rockwool insulation materials is high (7 times higher than in the general population).

2. The etiologic factor of dermatitis include the irritating effect of rockwool and the sensitizing action of phenol-formaldehyde resin and metals present in the working environment, particularly those in rockwool.

3. The risk of nickel allergy is 6 times higher, and the risk of cobalt allergy 5 times higher in people exposed to rockwool than in the controls. An increased nickel allergy is observed among males.

4. Contact with mineral oils produces oil acne in every tenth worker.

REFERENCES

1. Breslow NE, Day NE. Statistical method in cancer research. International Agency for Research on Cancer: Lyon, 1980.
2. Bruze M, Almgren G. Occupational dermatoses in workers exposed to resins based on phenol and formaldehyd. *Contact Dermatitis* 19: 272–277, 1988.
3. Castiglioni G, Carosso A, Manzoni S, Nebiolo F, Bugiani M. Result of routine patch testing of 834 patients in Turin. *Contact Dermatitis* 27: 182–185, 1992.
4. Cronin E. Formaldehyde is a significant allergen in women with hand eczema. *Contact Dermatitis* 25: 276–282, 1991.
5. Eun HC, Lee HG, Paik NW. Patch test responses to rockwool of different diameters evaluated by cutaneous blood flow measurement. *Contact Dermatitis* 24: 270–273, 1991.

6. Fisher AA. Contact dermatitis. Lea and Febiger: Philadelphia, 1986.
7. Gawkrödger DJ, Vesty JP, Wong WK, Buxton PK. Contact clinic survey of nickel sensitive subjects. *Contact Dermatitis* 14: 165–169, 1986.
8. Gollhausen R, Enders F, Przybilla B, Burg G, Ring J. Trends in allergic contact sensitization. *Contact Dermatitis* 18: 147–154, 1988.
9. Hovding G. Cement eczema and chromium allergy: an epidemiologic investigation, Thesis, University of Bergen: Norway, 1970.
10. Lantinga H, Nater JP, Coenraads PJ. Prevalence, incidence and cause of eczema on the hand and forearm in a sample of the general population. *Contact Dermatitis* 10: 135–139, 1984.
11. Rystedt I. Factor influencing the occurrence of hand eczema in adults with a history of atopic dermatitis in childhood. *Contact Dermatitis* 12: 247–254, 1985.
12. Seidenari S, Manzini BN, Danese P, Motolese A. Patch and prick test study of 593 healthy subjects. *Contact Dermatitis* 23: 162–167, 1990.
13. Vincenzi C, Guerra L, Peluso AM, Zucchelli V. Allergic contact dermatitis due to phenol-formaldehyde resin in a knee-guard. *Contact Dermatitis* 27: 54, 1992.

Received for publication: September 8, 1994

Approved for publication: January 3, 1995

