COMPARISON OF RISK OF OCCUPATIONAL DERMATOSES AND ALLERGY TO METALS IN WORKERS EMPLOYED IN PLANTS MANUFACTURING PREFABRICATED BUILDING PRODUCTS MADE OF ORDINARY CONCRETE, CELLULAR CONCRETE AND ASBESTOS CEMENT

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Abstract. The frequency of dermatitis, oil acne and allergies to chromium, cobalt and nickel in persons exposed to cement, fly-ashes and asbestos cement was studied. The metal content in these materials was assessed. It was demonstrated that the risk of dermatitis and allergy to metals, and especially to chromium, is higher in persons manufacturing prefabricated building products of cement than in those manufacturing them of fly-ashes and asbestos cement, and the risk is similar in persons making products out of fly-ashes and asbestos cement.

Occupational dermatoses in building industry workers present the principal diagnostic-expertise problem (4, 5). Occupational dermatoses are the most frequent of all professional diseases diagnosed in building industry workers. Between 1972 and 1976, in Lodz, approximately 40% of all occupational dermatoses were those of building workers (9).

The principal occupational diseases of building workers producing building prefabricates are: dermatitis — brought on by exposure to allergenic and irritative agents in cement, lime and mineral oil, and oil acne resulting from exposure to mineral oils (5, 16).

In Poland, prefabricated products are mainly made of ordinary concrete, cellular concrete and asbestos cement (15). Large-size building elements made of ordinary concrete contain, among other substances, cement — a building binder which is known to be composed of allergic chromium and cobalt compounds (2, 6, 18). Prefabricated products of cellular concrete (blocks, plates) contain cement, fly-ash discard from

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power plants or a fly-ash cement combination. Plants manufacturing insulants for the building industry produce them using asbestos, cement and mineral wool.

About 30% of all wall elements are produced using cellular concrete and 40—50% of this number are made of fly-ash (8).

Previous reports presented data indicating the sensitizing effect of metals composing fly-ash discards used in the building industry (10, 11). The aim of this paper is to compare the frequency of dermatoses and allergy to metals in persons exposed to different materials used in the building industry.

MATERIAL AND METHOD

A group of 1492 persons (184 females and 1308 males) working in building industry plants were examined. The employees studied were aged 18—65 and their employment period lasted from several months to 28 years. Nine hundred and five workers manufactured prefabricated products of cement, 252 of fly-ash discards, 157 of a fly-ash cement combination and 178 of asbestos, mineral wool and cement. The majority of those under examination (excluding persons who produced elements of asbestos cement and mineral wool) were also exposed to lime and gypsum. All the workers examined were exposed to machine greases and oils, and those making prefabricated products of cement and fly-ash were additionally exposed to antiadhesive oils used to lubricate moulds in order to detach concrete more easily.

Workers wore drill clothes and gloves occasionally strenghtened with artificial leather, and leather boots. In order to keep their skin clean workers used a special protective paste and toiled soap. Some of them used creams to grease the skin on their hands.

In all those examined, patch tests were performed adopting generally accepted methods, using a selection of allergens such as 0.5% potassium dichromate, 1% cobalt chloride and 5% nickel sulphate. Patch tests with chromium, cobalt and nickel were performed using two diluents — petrolatum and water with 5% Tween 80. A slight positive reaction (+) was characterized by erythema and oedema in the area where the allergen was applied, a positive reaction (++), by erythema, eodema, papules or blisters, and a strong positive reaction (+++) — by erythema, oedema, papules and blisters expanding beyond the places where the allergens were applied.

The results obtained were subjected to statistical analysis. Percentages were calculated in relation to the number of examinees in particular groups. The significance of differences were statistically analysed

(using the Fisher test) (20). In statistical analyses, it was accepted that the difference between comparable values is significant if $p < 0.05$.

The determination of trace elements (Cr, Co, Ni) in cement, asbestos, mineral wool and fly-ashes was carried out in the Technology and Waste Management Plant "Energopomiar" in Katowice. The content of these metals was determined using the method of atomic absorption with the use of photocolorimeter model 420 produced by Perkin-Elmer with atomization in air-acetylene flame.

RESULTS

The following observations were made from among all the studied subjects: dermatitis — in 360 persons (24.1%), oil acne — in 189 persons (12.7%) and other non-occupational dermatoses — in 469 persons (31.4%).

Dermatitis attacked the skin on the hands. Sometimes skin changes were found on the forearms or on the face (in workers exposed to mineral wool and asbestos). They were characterized by erythemas and oedemas, single cutaneous eruptions in the form of papules or blisters, erosions and crusts. In some persons, epidermal thickening, desquamation, brown melanodermas and deeper palm features dominated.

Oil acne was encountered almost exclusively in males; only in 3 females were the symptoms of oil acne observed. In the clinical picture, papular eruptions, pustules, intensified symptoms of acneiform keratosis follicularis and, frequently, purulent infiltrations were diagnosed. Symptoms were located in those parts of the body which were exposed to oils and greases impregnating protective clothing, i.e. upper and lower extremities, especially on the side of extensors, the skin of the buttocks and the back.

A comparison was made of the frequencies of dermatitis and oil acne in persons manufacturing prefabricated products of cement, fly-ashes, fly-ash-cement mixture and asbestos cement (Table 1). Dermatitis was more frequent in workers exposed to cement rather than those exposed to fly-ashes, cement fly-ash mixture or asbestos cement. Ashes and asbestos cement had a similar effect on the occurrence of dermatitis. Contact with mineral oils in persons manufacturing prefabricated products of cement resulted in oil acne more often than in the case of workers making products of ashes and a fly-ash-cement mixture.

Allergy to chromium compounds was reported in 339 of the workers examined (22.7%), including intense allergy in 127 workers (8.5%) (positive patch tests —++ and strong positive tests —+++). Allergy to cobalt was observed in 210 persons (14.1%) in general, and in 50 of them (3.4%) it was intense.

Hypersensitivity to nickel was observed in 39 persons (2.6%), and in 16 of them (1.1%) this symptom was intensified. Allergy to chromium and cobalt was similar in females and males. Allergy to nickel was five times higher in females than in males.

The frequencies of positive (++) and strong positive (+++) reactions to patch tests with chromium, cobalt and nickel in persons producing prefabricated products of cement fly-ashes, fly-ash-cement mixture and asbestos cement were compared (Table 2). It was found that allergy to chromium compounds was more frequent in persons manufacturing elements of ashes than in those making cement products. Similarly, this allergy was dominant in workers using asbestos cement as compared to those who used ordinary cement to produce building elements. No differences were found concerning allergy frequency to cobalt in the studied groups of workers.

TABLE 1. Comparison of Frequencies of Dermatitis and Oil Acne in Groups of Persons Exposed to Cement, Fly-Ashes and Asbestos Cement

Exposure (number of examined persons)	Dermatitis (n=360)			Oil acne (n=189)		
	n	%	probability of observing the difference	n	%	probability of observing the difference
Cement (n=905)	255	28.2	$p < 0.05$	130	14.4	$p < 0.05$
Fly-ashes (n=252)	52	20.6		22	8.7	
Cement (n=905)	255	28.2	$p < 0.01$	130	14.4	$p > 0.05$
Asbestos-cement (n=178)	32	18.0		30	16.9	
Fly-ashes (n=252)	52	20.6		22	8.7	
Asbestos-cement (n=178)	32	18.0	$p > 0.05$	30	16.9	$p < 0.01$
Cement (n=905)	255	28.2		130	14.4	
Fly-ash-cement mixture (n=157)	21	13.4	$p < 0.001$	7	4.5	$p < 0.001$
Fly-ashes (n=252)	52	20.6	$p < 0.05$	22	8.7	$p > 0.05$
Fly-ash-cement mixture (n= 157)	21	13.4		7	4.5	

Table 3 presents results which refer to the general content of chromium, cobalt and nickel in cement, asbestos, mineral wool and fly-ashes. The chromium and cobalt content in fly-ashes was 3 times higher than that in cement. Fly-ashes contain 4 times more nickel than cement does. Asbestos contains more chromium than cement does (7 times more), 17 times more nickel than fly-ashes do and 80 times more nickel than cement does.

TABLE 2. Comparison of Frequencies of Positive (++) and Strongly Positive (+++) Results of Patch Tests with Metal Allergens (Cr, Co, Ni) in Groups of Workers Exposed to Cement, Fly-Ashes and Asbestos Cement

Exposure (number of persons examined)	Cr (n=127)			Co (n=50)			Ni (n=16)		
	positive (++) and strongly positive (+++) tests	%	probability of observing the difference	positive (++) and strongly positive (+++) tests	%	probability of observing the difference	positive (++) and strongly positive (+++) tests	%	probability of observing the defference
Cement (n=905)	94	10.4	$p < 0.05$	36	4.0	$p > 0.05$	3	0.3	$p < 0.005$
Fly-ashes (n=252)	15	6.0		6	2.4		7	2.8	
Cement (n=905)	94	10.4		36	4.0		3	0.3	
Asbestos-cement (n=178)	9	5.1	$p < 0.05$	6	3.4	$p > 0.05$	4	2.2	$p < 0.05$
Fly-ashes (n=252)	15	6.0		6	2.4		7	2.8	
Asbestos-cement (n=178)	9	5.1	$p > 0.05$	6	3.4	$p > 0.05$	4	2.2	$p > 0.05$
Cement (n=905)	94	10.4		36	4.0		3	0.3	
Fly-ash-cement (n=157)	9	5.7	$p < 0.05$	2	1.3	$p > 0.05$	2	1.3	$p > 0.05$
Fly-ashes (n=252)	15	6.0	$p > 0.05$	6	2.4	$p > 0.05$	7	2.8	$p > 0.05$
Fly-ash-cement (n=157)	9	5.7		2	1.3		2	1.3	

TABLE 3. Comparison of Total Content of Microelements (Cr, Co, Ni) in Cement, Asbestos, Mineral Wool and Fly-Ashes

Sample	Number of samples examined	Element content (ppm)					
		Cr		Co		Ni	
		from — to	$\bar{x}$	from — to	$\bar{x}$	from — to	$\bar{x}$
Cement	2	55—58	56.5	< 10—10	< 10	< 20—29	24.5
Asbestos	1	410	410	71	71	1590	1590
Mineral wool	1	200	200	29	29	88	88
Fly-ashes	4	130—170	152.5	13—80	36.7	78—120	93.5

The content of soluble (hexavalent) chromium in 5 samples of fly-ashes ranged between 0.65 and 3.23 ppm; of cobalt, between 0.32 and 2 ppm; and of nickel, between 0.6 and 0.96 ppm.

DISCUSSION

As technological progress in the building industry accelerates, the picture of occupational dermatoses gradually changes.

Partial mechanization of building industry production has limited skin contact with etiological agents of dermatitis (cement, lime, asbestos), which has lowered the incidence level of this disease. On the other hand, the use in Poland of antiadhesive oils to lubricate moulds in plants manufacturing prefabricated concrete products has frequently resulted in oil acne (16). The introduction of new raw materials such as the use of fly-ash discards from electric power plants instead of cement has brought about still newer changes in the image of occupational diseases in the building industry.

The results presented are consistent with the reports in which the role of allergenic and irritative agents responsible for inducing dermatitis and the acne-inducing role of mineral oils are emphasized.

The incidence of oil acne in persons producing elements of fly-ashes and cement was found to be higher in workers using cement than in those using fly-ashes and a fly-ash-cement mixture to produce concrete. This difference did not arise from the weaker acne-inducing properties of antiadhesive oils applied in the production of building elements made from fly-ashes and fly-ash-cement mixture, since it was ascertained that all the oils used in experimental studies showed similarly noxious effects on skin (13, 17). In our opinion this difference may be attributed to the large number of females employed in the manufacture of prefabricated products of a fly-ash-cement mixture. Females suffered much more rarely from oil acne. They were more careful about obeying the hygiene rules and changed their protective clothing more often.

In about 17% of persons (i.e. less frequently than Weber and Brehm proved (19)), oil acne was observed in those who produced asbestos cement. The authors detected acne changes in more than 50% of the examined subjects. The percentage of oil acne cases in workers manufacturing asbestos cement and in those who produced prefabricated products of cement was similar.

The comparison of frequency of dermatitis and allergy to metals in workers exposed to cement, fly-ashes and asbestos, demonstrated that the risk of dermatitis and allergy to chromium was highest in those who had contact with cement. Exposure to cement induced dermatitis and hypersensitivity to chromium more frequently than exposure to fly-ashes, the fly-ash-cement mixture and asbestos cement. In workers exposed to the fly-ash-cement mixture, dermatitis and allergy to chromium was less frequent than in those exposed solely to cement. This can be explained by the stronger irritative and sensitizing action of cement. However, no stronger effect of the fly-ash-cement mixture as compared to fly-ashes was observed. In workers exposed to the fly-ash-cement mixture and fly-ashes, no differences in the frequency of metal allergies was found. Dermatitis was even more common in those exposed to fly-ashes. We suspect that this situation was influenced by the application of used antiadhesive oils in plants processing fly-ashes, and the application of pure oils in plants processing the fly-ash-cement mixture.

It is known that pure oils irritate the skin less intensively than used ones. Moreover, our study demonstrated that the risk of dermatitis and allergy to chromium, cobalt and nickel in workers producing prefabricated building elements of fly-ashes resembles the risk of dermatitis and allergy to those metals in persons manufacturing asbestos cement.

The sources of allergy to metals in workers exposed to cement have been studied intensively. It has been determined that soluble fractions of chromium compounds which are present in cement cause allergies (18). The total cobalt content in cement is similar to that of chromium, but the level of soluble chromium compounds is much lower (3, 18). Also, cement contains minimal quantities of soluble nickel salts (6). Recently, we reported an allergy to metals in workers exposed to fly-ashes (10, 11). The quantity of soluble chromium in fly-ashes is lower than that found in some samples of cement elsewhere in Europe (2), and more similar to the chromium content in American cement (14).

Comparing the frequency of allergy to chromium, cobalt and nickel with the total content of those elements in raw materials used in the building industry we had not found any clear relationship between the frequency of allergy and the content of those elements in the working environment. However, the larger presence of soluble chromium com-

pounds in cement than in fly-ashes may result in a more frequent allergy to chromium in workers processing cement as compared with those processing fly-ashes. Cobalt oxides in cement and in fly-ashes are not primarily sensitizing, since they hardly dissolve in sweat and cannot penetrate the epidermis. The frequent allergy to cobalt in workers exposed to cement was explained by the formation of soluble cobalt salts after combining with free amino acids of blister exudate from skin changes formed earlier (3). A stronger sensitizing effect can be observed in cobalt found in metal alloys, used machine oils and greases (1). The frequent allergy to nickel in workers producing building elements of fly-ashes was observable in a large number of workers employed in this plant. An allergy to nickel in females is often of an extraoccupational nature and is connected with wearing metal jewellery (7, 12). On the other hand, the frequent allergy to nickel in asbestos cement producers, found in 5.1% of the persons examined, is interesting. The percentage of strongly positive results of patch tests with nickel was also high (2). This hypersensitivity was encountered in 9 persons (3 females and 6 males). One may suspect that an allergy to nickel in workers of an asbestos-cement plant, especially in males, is influenced by the exceptionally high content of this element in asbestos (1590 ppm).

Contact with numerous allergenic agents makes it possible to exactly differentiate the sources of allergy to metals. Workers were exposed not only to cement, fly-ashes and asbestos, but also to used machine oils and greases and used antiadhesive oils. In some workers, perhaps used oils were an additional source of allergy to chromium, cobalt and nickel. The possibility of contact dermatitis from metals contained in oils has been reported earlier (18).

CONCLUSIONS

1. The risk of dermatitis and allergy to chromium compounds was higher in persons producing prefabricated building products of cement than in those exposed to fly-ashes and asbestos cement.

2. The frequency of dermatitis and allergy to metals (chromium, cobalt and nickel) in persons producing elements of fly-ashes and asbestos cement was similar.

3. The exposure to mineral oils of workers producing prefabricated building products of cement and asbestos cement caused oil acne more frequently than contact with oil in workers manufacturing products of fly-ashes.

4. The general content of chromium, cobalt and nickel in fly-ashes, asbestos and mineral wool was higher than the content of these elements

in cement, while the content of soluble chromium compounds was lower in fly-ashes than in cement. No relation was found between the frequency of allergy to metals and the content of elements used in the building industry.

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