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cu o rmat and allergy to metals in Polish construction workers manufacturing prefabricated building units

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The incidence of dermatoses and allergy to metals (Cr, Co. Ni) was determined in 1782 workers exposed to cement, waste fly ash and asbestos cement. They were all also exposed to reclaimed (used), mineral oils. Dermatitis was found in 23.6% of the subjects, rnd oil acne in 11.2%. Allergy to chromium was found in 23% of the subjects the % of definitely positive patch test results (the total of positive ++ and strongly positive +++) was, however, 8.6%. Allergy to cobalt was found in 13.4% of the subjects examined (definite in 3.1%). Allergy to nickel was found in 2.7% of the subjects (definite in 1.1%). The risks of occurrence of occupational skin disease and allergy to metals in subjects exposed to ash were found to be lower than in subjects exposed to cement, and were similar to those in subjects exposed to asbestos cement. Overall chromium, cobalt and nickel contents in rsh and asbestos were higher than m ament. Soluble chromium compound content in ash was lower than in cement from European countries rnd similar to that in American cement.

Key words: prefabricated construction; cement waste fly ash; asbestos cement; occupational; allergic contact dermatitis; chromium; cobalt; nickel; irritant contact dermatitis; oil acne.

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In Poland, prefabricated building units are manufactured mainly from ordinary concrete, cellular concrete and asbestos ament. Ordinary concrete prefabricated products contain cement. lime and sand. Prefabricated products made of cellular concrete contain, apart from lime, gypsum and an aerator (pulverized aluminium). cement, waste fly ash from power plants (produced in the process of hard and brown coal burning) or an ash-cement mix at 1 weight ratio of 11 :1, ash to cement.

About 30% of all wall units produced in Poland are made of cellular concrete, 40–50% of which is fly ash. Roof units are produced from asbestos/cement (ratio of asbestos to cement. 71). Mineral wool is applied as heat insulation.

There are no reports of skin diseases and allergies to metals in construction workers exposed to waste fly ash used for building unit productions.

This study was aimed at the presentation of results of dermatological examinations of workers exposed to various construction raw

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materials and the assessment of the risk of occupational dermatoses and allergies to chromium, cobalt and nickel in workers exposed to cement, waste fly ash and asbestos cement.

Material and Methods

The dermatological survey included 1782 workers (230 female and 1552 male):

(i) 141 subjects were employed in 5 power plants and had contact with fly ash. All of them were on the first shift, working at furnaces (carburizing. ash moving, skimming) and electrofilters.

(ii) 149 subjects were working in one cement plant, in contact with dry cement. All of them were employed on mills and cement kilns, as well as cement loaders and packers.

(iii) 905 subjects were working at producing ordinary or cellular concrete from wet cement. Of them, 853 were workers on the first shift, employed in 5 major factories; they were producing large prefabricated units (whole walls) of ordinary Concrete. 52 workers (the personnel of one small factory) were directly employed in the production of small building blocks (for making walls) of cellular concrete.

(iv) 252 subjects were producing cellular concrete from wet ash. They were the whole personnel of 4 small factories; all employed directly in small building block production.

(v) 157 subjects were producing cellular concrete from wet ash-cement mixes. The group formed the whole personnel of 2 small factories that produced small building blocks.

(vi) 178 subjects were producing prefabricated units from asbestos cement and mineral wool. They came from the whole personnel of one factory. where roof units and h a t insulation materials were produced.

All subjects were additionally exposed to oils and machine greases; workers manufacturing prefabricated building units from cement and ash were also exposed to oils, mostly reclaimed (used), applied te moulds to make concrete units separate from them more easily.

The control group consisted or 111 subjects: 74 tree fellers (mrk) and 37 seamstresses (female). People working physically under conditions of minimal contact with irritant and allergic contact factors were chosen.

Patch tests were conducted in all subjects; a series of allergens including, among others, chromium, cobalt and nickel was used (0.5% potassium dichromate. 5% nickel sulfate and 1% cobalt chloride). All these 3 allergens were diluted in water and petrolatum (Katedra Farmacji Stosowanej i Technologii Leków, Akademia Medyczna, Sosnowiec, Poland). Allergens were applied to squares of filter paper and affixed with adhesive tape of weak imtant effect to the backs of the subjects. After 24 h, the patches were removed and 30 min later they were read for the first time. Further readings were made 48 and 72 h after application. A 3-grade scale of positive patch test intensity was used: + fer weak positive reactions (mythema and infiltration). ++ for moderate positive reactions (erythema, infiltration, papules and/or micro vesicles), +++ for strong positive reactions (erythema, infiltration, papules, larger vesicles and/or bullae).

General chromium, cobalt and nickel content in cement, ash, asbestos and mineral wool was assessed as follows: samples were preheated at 450°C, the remains then solubilized in $HNO_3 + HF + HClO_4$, evaporated to dryness. and these remains finally solubilized in hydrochloric acid. The element content was estimated by the atomic absorption method using a Perkin-Elmer Model 420 photocolorimeter. with atomization in acetylene-air flame. The content estimation of soluble components in ash involved forced washing of the fly ash layer with redistilled water. weight determination of the dry remains from a solution after water was evaporated, and element content determination by the atomic absorption method.

Results

Skin changes were found in 956 subjects (53.6%) of the exposed group: 84 women

(35.6%) and 872 men (56.2%); and in 43 control subjects: 9 women (24.3%) and 34 men (45.9%).

Two main skin diseases were found in the exposed group, the incidence of which was higher than in the control group ($P < 0.0001$). These were dermatitis and oil acne. Dermatitis symptoms of varying intensity observed in this group were found in similar % s of women (22.2%) and men (23.8%). Oil acne occurred almost exclusively in men (12.6%) and was found in only 1.3% of the women examined.

In the control group, dermatitis was found in 10 subjects (1 woman, 9 men). Oil acne was not found in this group.

Both in the exposed *group* and the control group. other skin diseases were often found. The exposed group included, for exampk, 282 cases of tinea pedis, 66 cases of acne vulgaris, *46 cases* of pityriasis versicolor and 39 *cases* of clearly intensified hyperkeratosis manuum. In 14 men of the control group, large patches of hyperkeratosis manuum were found in relation to their work of felling ms; in both sexes of the group, single cases of acne vulgaris. pityriasis versicolor, tinea pedis and psoriasis vulgaris were also found

The incidence of dermatitis and oil acne in workers exposed to cement, ash and asbestos cement was analyzed (Table 1). The incidence of dermatitis in subjects exposed to ament in general, dry cement and ament in the form of concrete was the highest, equal in all cases and amounted to 28.2%. The lowest incidence of skin changes was found in subjects exposed to waste fly ash in power plants. The highest incidence (16.9%) of oil acne was found in workm employed in tbe production of asbestos cement. Not a single *case* of oil acne was found in subjects working with dry cement.

Allergy was found (that is, there was at least 1 positive patch test to chromium. cobalt and nickel) in 71 women *(30.9%)* and 442 men (28.5%) of the exposed *group,* and in 2 women (5.4%) and 9 men (12.2%) of the control group.

Allergy to chromium in the exposed *group* was more frequent in men (23.0%) than in women (19.6%); t k incidence of allergy to nickel was 5 × higher in women (9.1%) than in men (1.7%). The % of cobalt-allergic women was similar to that of men (13.9% and 13.3%, respectively). There was a statistically higher incidence of allergy to chromuum and cobalt ($p < 0.001$) in the exposed group at compared to the control *group.*

hbk 2 presents the results of tbe incidence and intensity of positive patch tests to chromium, cobalt and nickel in workers exposed to cement, ash rnd asbestos cement. It was

Table 1. The incidence of dermatitis a d oil acne in subjects exposed to cement, ash and asbestos cement

Exposure	No. subjects (n = 1782)	Dermatitis (n = 420)		Oil acne (n = 199)	
		n	(%)	n	(%)
Cement					
overall	1054	297	28.2	130	12.3
dry	149	42	28.2	0	
in concrete	905	255	28.2	130	14.4
Ash					
overall	393	70	17.8	32	8.1
fly	141	18	12.8	10	7.1
in concrete	252	52	20.6	22	8.7
Ash-cement mixture	157	21	13.4	7	4.5
Asbestos cement	178	32	18.0	30	16.9

Table 2. The incidence and intensity of positive results of patch tests to metal allergens (Cr, Co, Ni) in subjects exposed to cement, ash and asbestos cement

Exposure (number of subjects)		Positive results of patch tests											
		Cr				Co				Ni			
		weak positive (+)		positive (++) and strong positive (+++)		weak positive (+)		positive (++) and strong positive (+++)		weak positive (+)		positive (++) and strong positive (+++)	
		n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Cement													
overall	(*n* = 1054)	136	12.9	114	10.8	95	9.0	40	3.8	6	0.6	6	0.6
dry	(*n* = 149)	19	12.8	20	13.4	14	9.4	4	2.7	1	0.7	3	20
in concrete	(*n* = 905)	117	12.9	94	10.4	81	9.0	36	4.0	5	0.6	3	0.3
Ash													
overall	(*n* = 393)	62	15.8	22	5.6	40	10.2	8	2.0	14	3.6	7	18
fly	(*n* = 141)	25	17.7	7	5.0	9	6.4	2	1.4	5	3.6	0	
in concrete	(*n* = 252)	37	14.7	IS	6.0	31	12.3	6	2.4	9	3.6	7	2.8
Ash-cement mixture	(*n* = 157)	25	15.9	9	5.7	20	12.7	2	1.3	4	2.5	2	1.3
Asbestos cement	(*n* = 178)	33	18.5	9	5.1	28	15.7	6	3.4	5	2.8	4	2.2
Total	(*n* = 1782)	256	14.4	154	8.6	183	10.3	56	3.1	29	1.6	19	1.1

found that positive results of patch tests in subjects strongly allergic to chromium occurred mostly in workers exposed to cement in general, especially dry cement; to cobalt, in those exposed to cement in general and cement in the form of concrete; to nickel, in those exposed to ash in the form of concrete and asbestos cement.

Statistical analyses of dermatitis, oil acne and allergy to metal incidences were made in building industry workers with various exposures to the above-mentioned materials. The highest incidence of these changes was found in subjects exposed to cement. The risk factor of occupational skin disease and allergy to metals (especially to chromium and cobalt) in subjects exposed la ash was similar to that in subjects exposed to asbestos cement.

Table 3 presents the results of chromium, cobalt and nickel content analysis in raw materials used in the building industry. Chromium and cobalt content in ash was 3 x higher than in cement. Nickel content in ash was 4 x higher than in cement. Chromium and cobalt content in asbestos was 7 × higher than in cement, and that of nickel was 80 × higher.

Soluble (hexavalent) chromium content in 5 samples of ash ranged from 0.65 to 3.23. ppm, that of cobalt from 0.32 to 2 ppm, and tbat of nickel from 0.6 to 0.96 ppm.

Discussion

Occupational dermatoses are frequently diagnosed in construction workers. These dermatoses constituted about 40% of all occupational diseases diagnosed in Lodz in the years 1972–1987 (2).

The occurrence of dermatitis and allergies to chromium and cobalt in workers exposed to cement is a well-known fact (3). However, no cases of dermatitis and allergy to metals in construction workers exposed to waste fly ash have previously been described. Technological

Table 3. Overall content of metals (Cr, Co, Ni) in cement, ash, asbestos and mineral wool

Sample used	Number of samples examined	Content of elements (ppm)					
		Cr		Co		Ni	
		range	x	range	x	range	x
cement	2	55–58	56.5	<10–<10	<10	<20–29	24.5
ash	5	130–170	152.5	13–80	36.7	78–120	93.5
asbestos	1	410	410	71	71	1590	1590
mineral wool	1	200	200	29	29	88	88

advantages of building units made from fly ash (low energy consumption, good heat insulation characteristics, low consumption of basic building materials like cement and lime), along with the advantage of using waste materials, have led to increasing substitution of prefabricated cement units with prefabricated units produced from ash.

The sources of allergies to metals in workers exposed to cement have long been analyzed. It has been found that allergies are induced by soluble fractions of chromium compounds present in cement. Overall cobalt content of cement is estimated in relation to chromium content, but the soluble compound level is far lower (4). Similarly, soluble nickel compounds in cement are scarce (5). Analysis of 59 samples of cement produced in 9 European countries resulted in the conclusion that chromium content ranges from 32 to 176 ppm, that of cobalt from 17 to 63 ppm, and that of nickel from 32 to 116 ppm. Soluble chromium compound content was from 1 to 83 ppm (6). In 42 samples of American cement, the overall chromium content was from 5 to 124 ppm, and that of soluble chromium was from 0.1 to 5.4 ppm (7). In the results presented, overall chromium content in cement was similar to that found in other countries (55–58 ppm). Cobalt and nickel contents were lower (10 ppm and 20–29 ppm, respectively).

Specialized literature provides only random data from the 1960s as far as chromium content in ash from waste materials used for heating housing facilities is concerned (8). In our research, overall chromium, cobalt and nickel content of ash was significantly higher than in cement, and amounted to 130-170 ppm, 13–80 ppm, aad 78–120 ppm, respectively. Soluble chromium, cobalt and nickel compound content was lower (0.65–3.23 ppm, 0.32–2 ppm, 0.6–0.96 ppm, respectively).

The results of our research suggest that ash has imtant and allergic effects. The intensity of these is lower than m the case of cement, but is equal to those of asbestos cement. Lower soluble chromium compound content in ash results in its weak allergic effect. The content of soluble chromium compounds it l o w than in some samples of cement analyzed in Europe (6) and closer to the content of these compounds in American cement (7).

Additional etiological factors for dermatitis in construction workers exposed to various raw materials are lime, gypsum and mineral oils. All these haw irritant effects, and metals present in reclaimed oils also have allergic effects. The possibility of allergy to metals present in used cutting oils has already been noted (4).

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