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# Health Surveillance of Personnel Occupationally Exposed to Microwaves. III. Lens Translucency

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The incidence of lenticular opacities was examined in 841 microwave workers with history of various periods of occupational exposure at 2 W/m<sup>2</sup> to 60 W/m<sup>2</sup> (507 individuals) or at below 2 W/m<sup>2</sup> (334 individuals). The incidence of lenticular opacities was compared between both these groups, as well as analysed within each group, subdivided according to age or duration of occupational exposure. No dependence of the incidence of lenticular opacities on the exposure level, nor on duration of it was found, on the other hand, to have a statistically significant correlation with age.

**C**ATARACTOGENIC effects of high-power density microwave (MW) exposures of the eye are well documented in animal experiments (2,3). MW were also implicated as the pathogenic factor in cases of cataracts in individuals with a occupational exposure history (7). In view of this, possible early signs in the form of any impairment of lens translucency must be looked for in MW workers. The results of such examinations may be used also for resolving the controversial question of induction of lens opacities by long-term, low-level exposures. Lens opacities occur as an inborn defect and may be induced by many factors but the incidence of such changes increases with age. Therefore the incidence of lens opacities in MW workers should be compared to the incidence of these changes in an adequate control group. This is, however, difficult to select. Another possible solution is to compare the incidence of lens opacities in two strictly comparable groups of MW workers, whose working and living conditions differ only in respect to the level of MW exposure. The aim of this paper is to present the results of such an analysis.

## MATERIALS AND METHODS

There were 841 males, aged 20 to 45 years, examined to ascertain their health status. Details concerning their working conditions, methods of health surveillance, and the medical findings were presented in previous pa-

pers (4,5). The whole population was subdivided into two groups—the first comprising 507 individuals exposed occupationally to MW mean power densities above 2 W/m<sup>2</sup> and not over 60 W/m<sup>2</sup> (0.2 and 6 mW/cm<sup>2</sup> respectively) the second group comprising 334 individuals exposed occupationally to mean power densities below 2 W/m<sup>2</sup>. Polish safe exposure limits and work safety rules were strictly observed (see 2 for details).

Detailed ophthalmologic examinations, including evaluation of lens translucency using a slit lamp after dilatation of the pupils, were made. One of the co-authors carried out or supervised all examinations personally in order to ensure uniformity of evaluation of the state of lens translucency. This was classified as Grade 1, 2, 3, 4, or 5 according to the following criteria (8):

- 1.—complete transparency, no opacities are demonstrable
- 2.—single small opacities, dust-like or point-like, radial striations, which may be counted and do not influence visual acuity
- 3.—similar to above, but numerous, no tendency to increase in number or size, no visual acuity impairment
- 4.—similar to above, but with a tendency to increase in number or size on successive examinations
- 5.—any lenticular imperfection causing impairment of visual acuity

## RESULTS

The results are presented in Tables I-IV. It should be pointed out that Grades 3 to 5 were found only in 19% of examined cases. All these cases are considered jointly (grades 3-5) because no statistically valid data may be obtained, if each of these grades is considered separately. The incidence of each of the considered grades of lens translucency (grade 1, 2, 3-5) was compared between groups and within each group subdivided according to age or duration of occupational exposure. The dependence between these variables was analysed by determining the correlation coefficient and verifying its significance using Fisker's formula. Regression curves were

TABLE I. COMPARISON OF CORRESPONDING VALUES (MEAN PERCENT ± STANDARD DEVIATION) OF INCIDENCE OF VARIOUS LENS TRANSLUCENCY GRADES IN GROUPS I AND II SUBDIVIDED ACCORDING TO AGE.

Lens translucency grade	Group I	Group II	I $\tau$ I	F
1	28.1 ± 11.7	22.0 ± 15.3	1.141	1.714
2	53.4 ± 13.5	58.8 ± 15.5	0.940	1.309
3-5	18.3 ± 14.8	19.1 ± 8.9	0.157	2.766

$n_1, n_2 = 13$   
 $k = 24$   
 $f_1, f_2 = 12$   
 Verified I  $\tau$  I with  $t_{0.05, 24} = 2.064$   
 F with  $F_{0.05, 12, 12} = 2.690$   
 Explanations:

$n$  = number of results; I  $\tau$  I = module  $t$  of Student's test;  $k$  = degrees of freedom, F = number of F of Fisher's test;  $f_1, f_2$  = degrees of freedom.

TABLE II. COMPARISON OF CORRESPONDING VALUES (MEAN PERCENT ± STANDARD DEVIATION) OF INCIDENCES OF VARIOUS LENS TRANSLUCENCY GRADES IN GROUPS I AND II SUBDIVIDED ACCORDING TO DURATION OF OCCUPATIONAL EXPOSURE.

Lens translucency grade	Group I	Group II	I $\tau$ I	F
1	27.5 ± 13.1	23.6 ± 12.5	0.885	1.103
2	53.3 ± 9.8	56.8 ± 13.5	0.860	1.872
3-5	22.4 ± 18.2	19.4 ± 8.3	0.610	4.754

$n_1, n_2 = 17$   
 $k = 32$   
 $f_1, f_2 = 16$   
 Verified I  $\tau$  I with  $t_{0.05, 32} = 2.042$   
 F with  $F_{0.05, 16, 16} = 2.350$

TABLE III. THE DEPENDENCE OF LENS TRANSLUCENCY ON AGE OR DURATION OF OCCUPATIONAL EXPOSURE IN GROUP I.

Lens translucency grade	Duration of occupational			Total	Age, yrs			
	1-5	6-10	10		20-25	26-30	31-35	36-45
1	71	54	16	141	55	45	26	15
2	95	108	67	270	54	89	60	67
3-5	27	45	24	96	16	24	23	33

$p = 0.00094$   
 $\chi^2 = 18.61215$   
 $k = 4$   
 $\phi^2 = 0.03671$   
 $K = 0.01836$   
 $p = 0.00001$   
 $\chi^2 = 34.40868$   
 $k = 6$   
 $\phi^2 = 0.06787$   
 $K = 0.02771$

TABLE IV. THE DEPENDENCE OF LENS TRANSLUCENCY ON AGE OR DURATION OF OCCUPATIONAL EXPOSURE IN GROUP II.

Lens translucency grade	Duration of occupational exposure, yrs			Total	Age, yrs			
	1-5	6-10	10		20-25	26-30	31-35	36-45
1	50	30	19	99	32	24	18	25
2	65	61	49	175	32	40	40	63
3-5	19	23	18	60	9	3	7	41

$p = 0.12097$   
 $\chi^2 = 7.29769$   
 $k = 4$   
 $\phi^2 = 0.02185$   
 $K = 0.01092$   
 $p = 0.00000$   
 $\chi^2 = 37.20359$   
 $k = 6$   
 $\phi^2 = 0.11139$   
 $K = 0.04547$

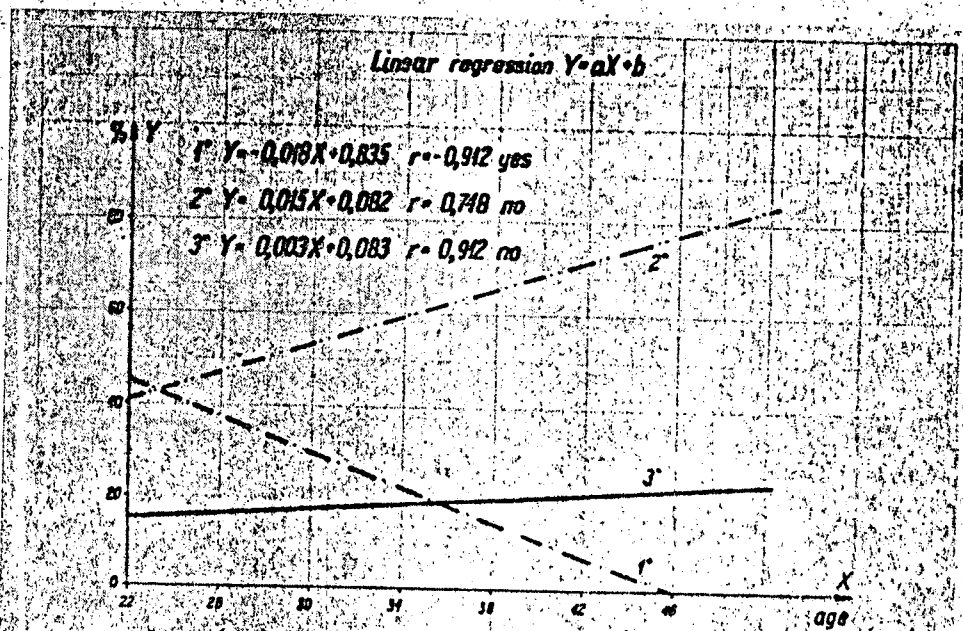
drawn, linear regression only, for the dependence of lens translucency or age (Fig. 1).

**DISCUSSION AND CONCLUSIONS**

A review of the controversial findings (1,7) concerning the incidence of lenticular opacities and imperfections in MW workers lies outside the scope of this work. Large reference lists may be found in the monographs quoted at the end of this paper. The statistical analysis

did not allow demonstration of any dependence of the incidence of various grades of lens translucency on the two compared MW exposure levels (comparison between groups), nor on the duration of occupational exposure (analysis within groups). A clear-cut dependence on age was demonstrated. It is to be regretted that at the time the examinations were made no sufficient attention was paid to the retina. The incidence of retinal lesions in MW workers merits further study (6).

Fig. 1. The linear regression curve demonstrating the dependence of the grades of lenticular translucency on age.



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