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Skin symptoms after the reduction of electric fields from visual display units

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Objectives The objective of this work was to determine whether facial skin symptoms are reduced by decreasing static and low-frequency electric fields produced by visual display units.

Methods The electric fields were reduced by electric-conducting screen filters. Twenty subjects took part in the study while working at their ordinary jobs, first two weeks without any filter, then two weeks with an inactive filter and two weeks with an active filter (or in reversed order). The inactive filters were identical to the active ones except that the ground cable was cut. Measurements showed that the inactive filters reduced the static electric fields nonsignificantly less than the active filters. For extremely low-frequency fields the difference was greater, and the active filters reduced the very low-frequency fields significantly more than the inactive ones.

Results Most symptoms were less pronounced with active filters than with inactive filters. The differences were small, and for one symptom only, tingling, pricking or itching, the result was statistically significant. The recorded physical and psychosocial factors did not explain the reduction with the use of active filters. Days with a long period spent near a visual display unit resulted in significantly more pronounced symptoms than days with short time. The findings registered by a dermatologist did not reveal any consistent difference between the two periods with filters.

Conclusion The results weakly support the hypothesis that skin symptoms can be reduced by a reduction of electric fields.

Key terms dermatological findings, double-blind study, electric conducting screen filters, exposure time, facial skin symptoms, low-frequency electric fields, room temperature, static electric field, workhours.

Some people working with a visual display unit (VDU) experience health problems that might be associated with exposure to electric and magnetic fields. The most common problems are facial skin symptoms such as the sensation of burning, pricking, itching, stinging, and tightness. However, redness, swelling, and rashes are also reported, as well as symptoms of the eyes and the upper part of the respiratory tract and nonspecific symptoms such as headache, tiredness, and dizziness. The possible association between exposure to electric and magnetic fields and the health symptoms are based on case reports (1, 2, 3, 4). Epidemiologic studies have shown a correlation between skin symptoms and work with a VDU (5, 6), background electric fields in the office, and extremely low-frequency (ELF) magnetic fields in front of a VDU (7). However, other factors, both physical and psychosocial, also correlate with the skin symptoms reported by VDU operators (6).

Provocation studies have been carried out in which patients with symptoms associated with exposure to electric and magnetic fields have been exposed to fields from a VDU or to similar fields. Most studies have failed to demonstrate any clear relation between field exposure and symptoms, since symptoms were registered also with sham exposures (8, 9, 10). In a later study (11), the subjects tended to discriminate real exposures from sham exposures (odds ratio 2.16). The result was close to being, but was not quite statistically significant at the 5% level.

In the present study, persons with skin symptoms associated with a VDU worked at their ordinary jobs rather than being exposed in a laboratory. The aim of the work was to determine whether subjectively registered facial skin symptoms are reduced by decreasing the static and low-frequency electric fields produced by the VDU. We also registered symptoms from eyes, the upper respi-

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ratory tract, and some nonspecific symptoms. The results concerning these symptoms have not been included in this report, but are presented in the detailed project report (12).

Subjects and methods

Design of the study

Twenty persons took part in the study while working at their ordinary jobs. The electric fields from their VDU were reduced by mounting electric-conducting screen filters (Vu-Pro-Tek ND 53) in front of the VDU. Two types of filters were used, active and inactive. The inactive ones had the ground cable cut, but the plastic insulation was intact so that it was not possible to see any difference between the filters.

The study lasted six weeks and was divided into three two-week exposure periods. During the first exposure period all of the subjects worked with their VDU without any filter. This period was followed by two weeks with an active filter and two weeks with an inactive filter, the order of use being determined by chance. The individuals and the project co-workers that were in contact with them did not know when the different filters were used. The subjects only knew that they would use two kinds of filters.

Subjects

Twelve women and eight men were selected for the study. They were between 26 and 57 years of age, the average being 40 years. They were selected on the basis of a questionnaire, an interview, and a dermatological examination. The main purpose of the selection was to identify subjects that were most likely to have skin symptoms caused by electric field exposure. They should have skin symptoms that might be associated with work with a VDU, evaluated with respect to the kind of symptoms reported and conditions for when the symptoms appeared and did not appear. Those who had used a screen filter before they took part in the study (12 subjects) should have experienced less pronounced symptoms after having the filter mounted. Subjects with skin diseases that might be influenced by VDU work were included in the study. This might have been the case for five subjects having the following dermatological findings in the facial skin region: acne (3 subjects), seborrhoeic dermatitis (1 subject), and atopic dermatitis (2 subjects). (One subject had two diagnoses.) Except for two persons with salmon patch over glabella, the subjects did not have any dermatological findings indicating any skin disease on the face. As judged from self-reported use of medications and treatments and also from observations in connection with the interview and the dermatological examination, the subjects did not suffer from any mental health problem. We also required that the subjects work with a VDU at least 3 d each week and, on the average, at least 2 h each day.

Registration of skin symptoms and dermatological findings

The symptoms were evaluated daily by each individual. The severeness of the symptoms was marked on a scale with 10 intervals. The first interval (degree 0) represented no symptom, and the last interval (degree 9) indicated that the symptom was very severe.

At the end of each exposure period, a dermatologist examined the facial skin of the subjects. Eighteen facial regions were defined, and for each region the degree of the findings was determined. The following scale was used to define the degree of change: 0 = no change; 1 = slight change; 2 = moderate change; 3 = pronounced change.

Electric and magnetic fields

Electric and magnetic fields were measured at each person's workplace, both at about 0.3 m in front of the VDU, and at the ordinary distance between the VDU and the head. The parameters measured were static electric and magnetic field, ELF (50—2000 Hz) electric and magnetic field, very low-frequency (VLF) (2—400 kHz) electric and magnetic field. In addition, the person's electric potential was recorded with the use of a double metallic plate arrangement together with a static electric field meter.

The static electric field was determined by a "field-mill" type JCI 121/122 from John Chubb Instruments, Cheltenham, England, placed in the center of a 0.6×0.6 m grounded aluminum sheet. For measuring ELF and VLF electric fields, two grounded, perturbing "Guy probes" were used. Both had a geometric size as described by the MPR II standard (13), equipped with different electronic filters for the two frequency bands. They were made at the Institute of Physics, University of Oslo. A spherically shaped, nongrounded, "nonperturbing" probe was used in addition to the Guy probe for the ELF electric field measurements. This probe, utilizing optical fibers for insulation, was made at the same institute. All electric field measurements were done in one direction only, namely, in a horizontal direction facing the VDU. A firm stand was used to keep the probes in a fixed position and direction during all of the measurements.

The static magnetic field was determined with a MAG.01H fluxgate instrument from Bartington Instru-

ments Ltd, Oxon, England. Three separate orthogonal measurements were carried out to determine the three-dimensional static magnetic field. The ELF magnetic field was determined with a Bartington MAG-03MC fluxgate magnetometer. The VLF magnetic field probe was made at the Institute of Physics, University of Oslo. Both the ELF and the VLF probes made simultaneous measurements in three directions to obtain the three dimensional value of the magnetic field.

Signals from the probes were read from their display or by a Fluke 29 multimeter, a Toshiba T1600 lap-top computer equipped with a digitizer card, a Tektronix 2211 digital storage oscilloscope (plus downloading to the computer), or combinations of several of these possibilities. In this way waveforms could be recorded and the frequency analysis performed with Fourier transform. More details regarding measurements and signal analysis have been given elsewhere (12).

There was a great variation in the magnitude of the electric fields and the magnetic fields produced by the different units. The reduction of the electric fields provided by the filters also varied considerably. The ranges of the electric fields, as well as the average and median values measured with and without filters at the ordinary distance between the VDU and the head are given in figure 1. In the following presentation, we have focused on the average values of the electric fields and the reduction caused by the filters.

The static electric field was significantly reduced by both the active and the inactive filters. The difference between the two kinds of filters was statistically insignificant. The ELF electric field was also reduced by both kinds of filters, but most by the active filter. With the active filter mounted, the ELF field was reduced almost to the same level as the background ELF field. Therefore, the active filter effectively reduced the ELF fields produced by the VDU. This finding was confirmed by measurements at a distance of 0.30 m from the VDU and by a Fourier analysis of the data. The VLF electric field was only insignificantly reduced by the inactive filter. About 80% reduction was obtained by the active filter.

The filters had little or no effect on the magnetic fields in front of the VDU. Measured at the ordinary distance between the VDU and the head, the ELF fields ranged from 40 to nearly 400 nT, and the VLF fields from less than 5 to 18 nT. (Values lower than 5 nT could not be measured due to noise in the detector). Nearly equal results were obtained for the ELF fields when either the VDU was on or off, indicating that the VDU contributed little to the total ELF magnetic field measured at this position. The VLF magnetic fields from the VDU were significantly higher than the background fields, which were less than 5 nT in front of most of the units.

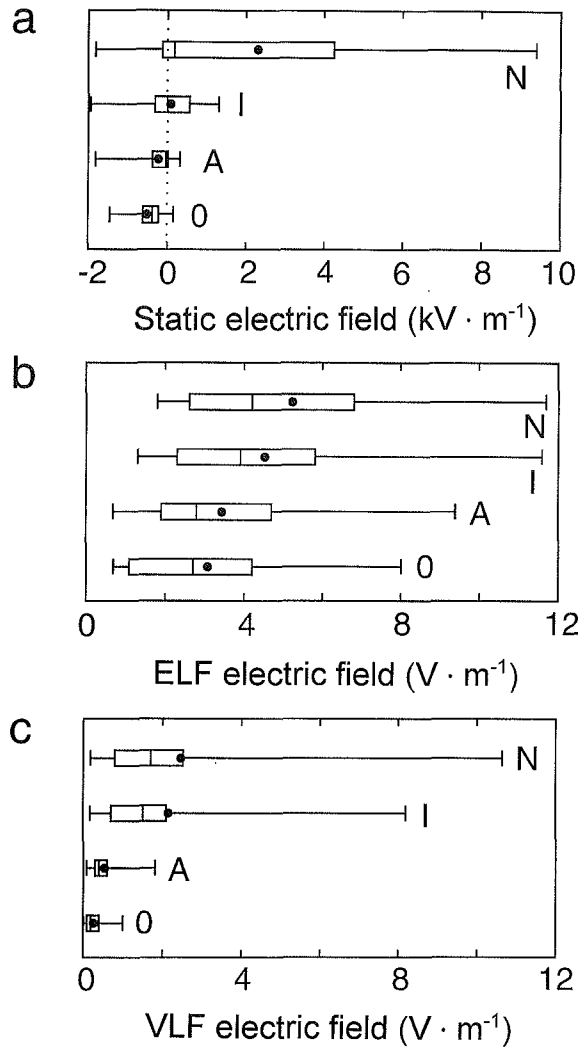

Figure 1. Electric fields measured at the normal distance between the visual display unit (VDU) and the head distance. [a = static field, measured with a field-mill, b = extremely low-frequency (ELF) field, measured with a nonpertubating spherical probe (isolated, not grounded) c = very low-frequency (VLF) electric field, measured with a Guy probe (grounded)] The dots indicate the average values for all of the visual display units. The left and right ends of the boxes show the 25 and 75 percentile values, respectively. The vertical lines dividing the boxes indicate the median values. The ends of the horizontal lines indicate the minimum and maximum values. (N = VDU switched on with no filter, I = VDU switched on with inactive filter, A = VDU switched on with active filter, 0 = VDU switched off)

Physical and psychosocial factors

The dust content and relative humidity were measured at each subject's workplace at the beginning of the study and after each exposure period.

Daily, the subjects registered the time at work, the time in front of the VDU, the time worked 2 m or nearer the VDU, and the room temperature. We also received data on outdoor air temperature and humidity for each day. When the first filter was mounted and at the end of the study, the subjects compared their VDU with and

without a filter with respect to visual properties. Other physical and psychosocial factors that might influence the skin symptoms were registered by the individuals for each exposure period. If a factor changed during an exposure period, the subjects were asked to focus on the last of the two weeks in that period. Questionnaires were used for all registrations done by the subjects.

Statistical methods

The distribution of the data (degree of symptoms) deviated significantly from normality. Therefore, the statistical analyses were performed with Wilcoxon rank tests. Case reports (1, 2, 4) suggest that facial skin symptoms might be reduced by reducing the static or the low-frequency electric fields produced by a VDU. Similarly, skin symptoms are indicated to be reduced by reducing the time spent in front of a VDU (2, 14), and higher room temperatures appear to result in more pronounced skin symptoms than lower temperatures (15). Therefore, when the effects of the different exposure periods, the "exposure times," and the room temperature were analyzed, one-sided signed rank tests were used with each individual as his or her own control. When the group of subjects that had the inactive filter before the active filter and the group that had the active filter first were compared, two-sided sum rank tests were used. A result was considered statistically significant when the significance probability was 5% or less.

Results

Visual effects of the filters

At the beginning of the work with filters, most of the subjects rated the screen with the filters better than one without the filters with respect to reflexes, legibility, and comfort. After having used filters for four weeks, the subjects tended to evaluate the screens with filters even more favorably with respect to reflexes and legibility as compared with the first evaluation. The differences between the two evaluations were, however, small, and for comfort there was no difference.

Skin symptoms — whole study

The first week of the study was meant to be a training period for the subjects. Thus the results from this week were not included in the calculations and statistical analyses. Not all of the subjects experienced all of the skin symptoms, and only those who had registered a symptom at least once during the study were included in the calculations and statistical analysis for that symptom. Due to a mistake, one of the subjects got an active filter when an inactive filter should have been mounted. When different exposure periods of the study were compared, this subject was excluded.

Twelve subjects had an inactive filter before an active filter, and seven had an active filter before an inactive one. On the average, the subjects with the active filter first had more symptoms and more pronounced symptoms than those with an inactive filter first. In table 1, the average degree of symptoms and the number of subjects that registered the various symptoms are shown for each of the two groups and for all of the subjects combined. In general, the symptoms were relatively mild. In only a few cases was the degree of any symptom higher than four (table 1). Only three individuals registered "other symptoms." This class of symptoms, therefore, was not included in the further analysis.

Skin symptoms — differences between exposure periods

The effect of one type of filter might last for some time after having changed to another type. Therefore, when the different exposure periods were compared, for each

Table 1. Average severeness of the symptoms registered during weeks 2–6 of the study. Only the subjects that registered the symptom at least once during the whole study are included.

Facial skin symptoms	Subjects with inactive filter first		Subjects with active filter first		All subjects	
	Degree of severeness of symptom (mean)	Subjects experiencing symptom at least once (N)	Degree of severeness of symptom (mean)	Subjects experiencing symptom at least once (N)	Degree of severeness of symptom (mean)	Subjects experiencing symptom at least once (N)
Heat or burning sensation or stinging	1.4	6	1.5	7	1.4	14
Tingling or prickling or itching	1.8	8	2.1	7	1.9	16
Sensation of tightness or dryness	1.6	9	2.6	7	2.1	17
Tenderness or pain	0.1	4	0.8	4	0.5	9
Redness or flushing	0.6	7	2.0	7	1.4	15
Blisters or acne	0.7	5	1.9	4	1.3	9
Desquamation	1.0	5	1.7	5	1.4	10

[a] On a scale of 0—9.

individual, the average severeness (degree) of the symptom was calculated only for the second week of each exposure period. (This was a choice made when the study was designed.) The individual mean values were used as input for the Wilcoxon signed rank test. The average difference between the exposure periods was calculated with the use of the same individual mean values.

The reduction of skin symptoms between the exposure periods is given in table 2. Almost all of the symptoms were reduced in the two periods with the filters when compared with the period without any filter. When the period with the inactive filter was compared with the period with no filter, only one symptom showed a statistically significant reduction. Three symptoms were statistically significantly less pronounced in the period with the active filter than in the period without a filter. When the periods with filters are compared, most of the symptoms were less pronounced in the period with the active filter. However, the difference was statistically significant only for the symptom called tingling, pricking or itching. For this symptom 10 subjects were better in the period with the active filter than with the inactive filter, two subjects were worse, and three showed no difference. The difference in the severeness of the symptoms varied from –4.2 (more pronounced during active filter use) to +1.4 (less pronounced during active filter use).

The results might possibly have been influenced by the sequence in which the workers used the active and inactive filters. Therefore, we wanted to determine the change in the symptoms over time for the group that had the active filter first and for the one that had the inactive filter first. The results are illustrated by figure 2. For both groups of subjects, the severeness of the symptom was reduced in the first period with a filter, regardless of the type of filter. For the group with the inactive filter first, the reduced symptoms persisted as they changed from the inactive to the active filter. The group with the active filter first experienced a worsening of symptoms as they changed from the active to the inactive filter. However, the difference between these groups of subjects was not

Table 2. Difference in the severeness of the symptoms between the exposure periods, the number of subjects with the most pronounced symptoms in the first (N_1) and second (N_2) condition, and the significance probabilities (P-value) according to the Wilcoxon signed rank test.

Facial skin symptoms	No filter — inactive filter				No filter — active filter				Inactive filter — active filter			
	Difference	N_1	N_2	P-value	Difference	N_1	N_2	P-value	Difference	N_1	N_2	P-value
Heat or burning sensation or stinging	0.5	8	5	0.10	0.5	10	3	0.8	0.1	5	5	>0.1
Tingling or pricking or itching	0.8	9	5	0.04	1.0	11	3	0.008	0.1	10	2	0.03
Sensation of tightness or dryness	0.2	6	4	>0.1	0.5	9	4	0.05	0.3	8	5	0.08
Tenderness or pain	0.4	5	1	>0.1	0.7	6	1	0.03	0.3	3	1	>0.1
Redness or flushing	0.1	6	4	>0.1	0.1	7	4	>0.1	0.0	5	5	>0.1
Blisters or acne	0.3	5	4	>0.1	0.0	3	4	>0.1	–0.4	2	5	>0.1
Desquamation	0.7	4	4	>0.1	0.9	5	4	0.09	0.2	5	3	>0.1

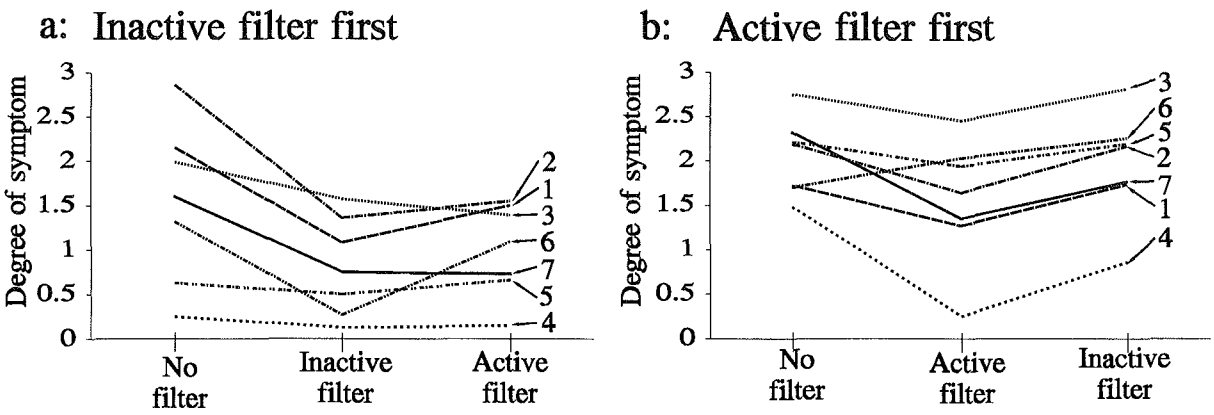

Figure 2. Severeness (degree) of symptoms in the various exposure periods, plotted as a function of time. (a = group that had an inactive filter first, b = group that had an active filter first, 1 = heat or burning sensation or stinging, 2 = tingling, pricking or itching, 3 = sensation of tightness or dryness, 4 = tenderness or pain, 5 = redness or flushing, 6 = blisters or acne, 7 = desquamation)

statistically significant. For tingling, pricking or itching the significance probability was 6%, and for the other symptoms it was higher than 10%.

Dermatological findings — differences between the exposure periods

Some of the subjects did not undergo all of the dermatological examinations. The 15 subjects who were examined both after the period with an active filter and after the one with an inactive filter were included in the results. Because only 11 of these persons were examined in the period without any filter, the results for this period have not been included.

For each individual, the degrees of the different findings were summed for all the facial regions, and the average values were calculated for all of the subjects. The results are given in table 3. In the period with the active filter, some findings were more pronounced and some were less pronounced than in the period with the inactive filter.

Skin symptoms — electric and magnetic fields

We evaluated whether the reduction in the severeness of the symptoms of each subject correlated with the electric field reduction caused by the filters. Similarly, we evaluated whether the reduction in symptom severity correlated with the magnitude of the magnetic fields, the frequency of the fields from the VDU, and the electrical potential of the subjects. Plots of symptoms versus the various field variables revealed large individual differences, and for most plots the variation between the subjects was greater than the variation that might have been due to the field variable.

Table 3. Degree of dermatological findings summed over all 18 facial regions. Average values for 15 subjects are shown.

Dermatological findings	Inactive filter		Active filter	
	Degree of dermatological findings	Subjects with different findings (N)	Degree of dermatological findings	Subjects with different findings (N)
Erythema	2.6	9	3.1	10
Edema	0.0	—	0.0	—
Desquamation	0.9	3	1.7	7
Papules	2.4	5	2.7	7
Pustules	1.7	2	1.7	2
Plaques	0.4	1	0.0	—
Telangiectasies	3.3	10	3.1	10

Skin symptoms — workhours, time near a visual display unit and climate

We compared the symptoms for long-lasting workdays and short-lasting ones. For each person we defined the limit between short and long workdays equal to the median duration of his or her workdays during the five last weeks of the study, and we calculated the average severeness of the symptom for short and long workdays. With the use of these individual mean values, the average relative difference between long and short workdays was calculated for all of the subjects. Similarly, the effect of the period of time the subjects were sitting in front of a VDU (VDU time), the time they worked within 2 m of a VDU (time near a VDU), and room temperature were analyzed.

A high room temperature did not result in more pronounced symptoms than a low temperature did. As indicated in table 4, some symptoms were worse with a short workday and some were worse with a long workday. Similar results were obtained for the time spent in front of a VDU. Most of the symptoms were more pronounced when, however, the period of time near a VDU was long than when it was short. This effect was statistically significant for three symptoms.

The limits chosen between short and long periods of time and low and high temperature may have influenced the result of the analysis. Therefore, we also performed the analysis by defining the limits as the average value of the actual variable for all of the subjects for the second

Table 4. Difference in the severeness of symptoms between the conditions, the number of subjects with most pronounced symptoms in the first (N_1) and second (N_2) condition, and the significance probabilities using Wilcoxon signed rank test. (VDU = visual display unit)

Facial skin symptoms	Long — short workdays[a]			Long — short time near VDU[b]			Long — short VDU time[c]		
	Difference	N_1	N_2	Difference	N_1	N_2	Difference	N_1	N_2
Heat or burning sensation or stinging	0.1	10—4	0.09	0.3	12—2	0.009	0.1	9—5	>0.1
Tingling or pricking or itching	−0.7	7—8	>0.1	0.3	12—4	0.02	0.2	11—5	>0.1
Sensation of tightness or dryness	0.7	8—6	>0.1	0.2	12—4	0.007	0.0	11—5	>0.1
Tenderness or pain	0.0	5—3	>0.1	0.0	5—3	>0.1	−0.2	4—4	>0.1
Redness or flushing	0.0	6—6	>0.1	0.2	9—5	0.08	0.1	8—4	>0.1
Blisters or acne	−0.0	4—5	>0.1	0.0	6—3	>0.1	−0.0	5—4	>0.1
Desquamation	−0.2	3—6	>0.1	0.2	4—6	>0.1	−0.1	2—7	>0.1

[a] Range of individual limits 5.2—8.0 h.
[b] Range of individual limits: short and long periods of time near a VDU 3.0—8.0 h.
[c] Range of individual limits 2.0—8.0 h.

week of the period with the active filter and that with the inactive filter. For some of the symptoms the result differed from the results indicated in table 4. The tendencies were, however, the same. The differences between the long and short periods of time near a VDU tended to be more marked than when individual limits were used, and the results were statistically significant for five symptoms.

The relative indoor humidity varied with the outdoor humidity. On days with cold (temperatures below 0°C) and dry air, the relative humidity measured indoor was lower than on rainy days. Because we did not measure the indoor humidity daily, we instead determined whether there might be any relation between symptoms and outdoor absolute humidity and outdoor temperature. No relations were found.

Physical and psychosocial factors — exposure periods

Different factors might have influenced the skin symptoms, and some of these might, by chance or by reasons that could not be controlled, have influenced the symptoms more in one exposure period than in another. The physical and psychosocial factors that were registered by the individuals were somewhat worse (ie, more likely to cause more pronounced symptoms) in the period with no filter than in the periods with filters. The subjects more frequently reported stale air, too much work, and tasks that were too difficult. Only nonsignificant differences were registered between the two periods with a filter. The dust content in the subjects' offices varied between the different measurements, and, in particular, it increased significantly with cigarette smoke in the room. Thus the measurements cannot be expected to be representative for the respective exposure periods, and no comparison can be made between the different periods.

Statistically, there was a correlation between the time the subjects worked within 2 m of a VDU and the symptoms. Therefore, we studied the variation of this factor. When one symptom at a time was considered, and including only persons that had registered that particular symptom, the result was a longer time near a VDU in the period with an active filter than in the period with an inactive one. This was the case for most symptoms (including tingling, pricking or itching). For all of the symptoms the time near a VDU was longest when no filter was used.

We also determined whether the difference in the time course of the symptoms for the group with an inactive filter first compared with the group with an active filter first (figure 2) can be explained by differences in the time occupied near a VDU. For the group with an inactive filter first the times were as follows: 6.3 h with no filter, 6.0 h with an inactive filter, and 5.7 h with an active filter. For the other group the numbers were slightly different: 6.6 h with no filter, 5.9 h with an active filter, and 5.6 h with an inactive filter.

Discussion

Design of the study

The main intention of the study was to evaluate the effect of reducing static and low-frequency electric fields from the subjects' VDU on skin symptoms. We wanted the inactive filters to have a minimal effect on these fields so that the difference between active and inactive filters with respect to the fields would be as large as possible. The measurements showed, however, that the inactive filters were far more active than expected. The electrical conductivity of the insulation covering the cut of the metal wire in the ground cable was probably sufficiently large to eliminate the static field almost completely and to reduce the ELF field.

By mounting the filters, we introduced changes in the visual properties and probably also a placebo effect. Therefore, changes in symptoms caused by the filters relative to the situation without any filter might have been due to visual factors and the placebo effect in addition to the reduced electric fields.

The placebo effect might have varied with time after the filter was mounted. Then the difference in the effect of the active and inactive filters would depend on which filter the subject had used first and last. In order to reduce this effect as much as possible for the whole group of subjects, half of them should have had the active filter before the inactive one and half should have used the filters in reverse order. Due to an error, the filter to be used first and last, was chosen at random for each subject, and more persons had an inactive filter first than an active filter first. However, when only those who had registered a particular symptom were considered, the number of participants with an inactive filter first was nearly equal to the number with an active filter first.

Time-dependent placebo effect

Comparing the group that had an active filter first with the one that had an inactive filter first might reveal information about the placebo effect. Figure 2 suggests that the effect of the inactive filter depended on whether the subjects had this filter before or after the active filter. The group with an inactive filter first had their symptoms reduced in the period with an inactive filter, whereas the group that had the inactive filter at the end of the study apparently had no advantage from it. This difference might be explained by a time-dependent placebo effect. If the placebo effect was most efficient in the period immediately after the filter was mounted (ie, when the

subjects were most aware of the change introduced by the filter) such results would be obtained.

The apparent lack of effect of the inactive filter for the group that used this filter at the end of the study cannot be explained by the time occupied near a VDU. Actually, this group had the greatest reduction in time near a VDU from the period with no filter to that with an inactive filter. As an average per day, the reduction was 1.0 h, while it was only 20 min for the group that apparently had an advantage from the use of the inactive filter (ie, the group that used an inactive filter before an active one).

Effect of the electric fields

Symptoms reported in association with exposure to electric and magnetic fields would be expected to be less pronounced with the use of active filters than with the use of inactive ones. Heat or burning sensation or stinging, tingling, pricking or itching, and the sensation of tightness are among the most commonly reported symptoms (1, 2). These symptoms were reduced by the active filter relative to the inactive one, but the differences were small and statistically significant for one of them only. However, one should keep in mind that, for example, only one subject was responsible for the small difference in the mean value of the symptom tingling, pricking or itching. The statistical analysis was based on rank analysis, and 10 subjects were better in the period with the active filter than in the period with the inactive filter and only two were worse. Thus the statistical significance of the result for this symptom indicates that a real difference between the two periods is more likely to explain the result than mere chance would.

One reason the mean value of the symptoms differed so little between the two periods with filters may be that the inactive filter also reduced the static field and partly also the ELF field. If some individuals were sensitive to these fields only, their symptoms would not change much when switching from an active to an inactive filter (or reverse).

Skin symptoms registered by VDU operators may also be related to physical factors other than electric and magnetic fields (6) and to psychological (16) and psychosocial factors (17). In this study, the relation between the period of time spent near a VDU and the symptoms might have been caused by electric or magnetic fields or by other stress factors associated with the VDU or personal computers in general. Nevertheless, it is likely that at least some of the subjects suffered from skin symptoms provoked by factors other than electric fields or in addition to electric fields. Then the effect of reducing the fields would have been limited.

In provocation studies performed in laboratories, sham exposures have provoked symptoms and have therefore indicated the influence of psychological factors (9, 18). Most of these studies have not revealed any effect of electric and magnetic fields. One reason may be no sensitivity to these fields. Another explanation may be a masking effect caused by psychological and possibly other factors due to the special test situation in provocation studies. In order to reveal whether electrical or magnetic fields are capable of provoking symptoms, studies have to be designed so that the effects of psychological and other factors are minimized or eliminated.

We might not have succeeded in eliminating the placebo effect since more subjects used an inactive filter before the active one than vice versa. Provided that the placebo effect was time-dependent, a possible difference between the effect of the inactive and active filters might have been partly masked. Because more time was spent near a VDU in the period with an active filter than in the period with inactive filter, the observed reduction in symptoms while using an active filter cannot be explained by a difference in time near a VDU. In fact, if differences in this time variable played a role, it might have reduced the observed differences in symptoms, and not created them. The other psychosocial and physical factors that were registered probably had no influence on the results.

If electric fields give rise to skin symptoms, we would expect that the persons with the greatest reduction of electric fields would also have the greatest reduction of symptoms. However, it turned out that individual responses were so large and the number of subjects was so small that it was impossible to demonstrate any proportionality between the skin symptoms and the electric fields or any threshold values for effect. In other parts of this study, individual variation could be minimized by using each person as his or her own control. This method of approach could not be used in the study of individual field and symptom changes.

Dermatological findings — subjective symptoms

In contrast to symptoms registered by the subjects, the dermatological findings were not more pronounced in the period with the inactive filter than in the period with the active filter. Even for corresponding subjective symptoms and dermatological findings (for redness or flushing and erythema and for desquamation) consistent results were not obtained. There may be several reasons for this discrepancy. The situation at the end of an exposure period when the dermatological examination was done might not have been representative for the last week of this period. In addition the methods used by the dermatologist differed from the way the subjects evaluated their symptoms. Furthermore, not all of the indi-

viduals were included in the results from the dermatological examinations.

Contradictions between subjectively registered symptoms and dermatological findings may indicate, however, that subjective symptoms may not be accompanied by objective signs. This possibility agrees with results from a study in which 809 office employers participated. No relation was found between objectively registered findings and VDU work. However, subjective symptoms increased with increasing use of a VDU (19). Thus, even if subjective symptoms may be related to VDU work or exposure to electric or magnetic fields, dermatological examinations may not confirm this relation.

Concluding remarks

Skin symptoms were more reduced in the period with an active filter than in the period with an inactive filter. The differences were small and statistically significant for tingling, pricking or itching only. The analysis seems to indicate that several factors masked an otherwise potential greater difference. Among the physical and psychosocial factors, electric fields were the only ones that could explain the observed reduction of tingling, pricking or itching.

Days with long periods of time spent near a VDU gave rise to more pronounced symptoms than days with short periods of time near a VDU. This finding may be due to different physical stress factors related to the VDU or the computer. Electric and magnetic fields are possibly among these factors.

Relatively weak tendencies were shown in this study, and few persons were participating. Therefore, more studies are required to confirm or deny the role of electric fields.

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