Psychological Effects of Occupational Exposure to Electromagnetic Fields

* Yousefi HA. PhD, ** Nasiri P. PhD

* Dept. of Occupational Health, School of Public Health, Isfahan University of Medical Sciences, Iran
** Dept. of Occupational Health, School of Public Health, Tehran University of Medical Sciences, Iran

(Received 22 Oct 2005; accepted in revised form 1 Feb 2006)

Abstract

**Background:** In psychological studies, exposure to electromagnetic field is one of the hazardous factors, which has adverse effects on mental health. Exposure to electromagnetic field due to daily use of electricity makes this study so important. The goal of this study was to determine the relationship between psychological symptoms and occupational exposure to electromagnetic field among workers at High Voltage Substations.

**Methods:** Sampling included 103 workers at High Voltage Substations in Tehran city. The prevalence of psychological symptoms was evaluated among electrical workers and the SCL90-R questioner completed during an interview. The control group was not occupationally exposed to electromagnetic fields or not residence of transmission line.

**Results:** This study indicated increased symptoms including depression, anxiety, hostility, paranoia, interpersonal-sensitivity, and obsession-compulsion among exposed workers. A significant relationship was observed between the exposure of electromagnetic field and psychological symptoms ($P<0.05$).

**Conclusion:** Exposure to electromagnetic field increased the risk of disorders in susceptible workers. For mental disorders, especially depression, the cognitive therapy is suggested.

**Keywords:** Psychology, electromagnetic fields, occupational exposure, Iran

Introduction

The production, transmission, distribution, and use of electricity generate electromagnetic fields having a frequency of 50-60 Hz in the range of extremely low frequency electromagnetic fields. Epidemiological studies have suggested that occupational exposure to electromagnetic field is associated with increased risk of various health effects, particularly neurobehavioral effects, depression and cancer. Much of the epidemiological debates about the possible link between working around sources of EMFs has focused on exposure definition (1,2).

The potential for an association between EMFs and mental disorder is biologically plausible. The studies showed somewhat increased relative risks but shared a number of methodological problems including the lack of a standard measure for mental disorder and lack of control for possible confounding (3).

Asanova has postulated a link between exposure to EMFs and mental and subjective state, based on observation among switchyards electrical workers (4).

Furthermore, several reports have found that exposure to electric fields effects on the social behavior of baboons (5).
The hypothesis that exposure to such fields increases the risk of psychological effects among high voltages substation operators, has been controversial ever since a link was reported more than two decades ago (6,7).

Materials and Methods
The study population of 103 subjects was obtained from a cohort of 110 men in the original study. Workers were employed full time at any of electric high voltages substation in Tehran, Capital of Iran with at least 10 years of continuous employment. Women were excluded because they rarely worked in jobs with the exposure of interest after exclusions due to lack of availability of records. Assignment of exposure to magnetic fields workers in the electric utility industry experience complicated patterns of exposure to EMFs, with potentially several measurements including measures of magnetic and electric fields.

To consolidate job titles at 13 substations, 5 categories were constructed based on exposure potential. The 20, 63, 132, 230, 400 kV were chosen as five groups.

The control group was not occupationally exposed to electromagnetic fields or not residence of transmission line (8).

We conducted a study to consider the prevalence of mental disorder for workers whom exposed to EMFs, obtained based on the symptom distress checklist-revised (SCL90-R) questioner completed during an interview (9).

The mean and standard deviation and the 95% CI were derived from conditional logistical regression, \( t \)-student test compare mean models with the SPSS system software.

Results
Measurement of mental disorders demonstrated depression, anxiety, obsession-compulsion, interpersonal sensitivity, hostility, somatization, phobia, paranoia, and psychosis (Table 1).

<table>
<thead>
<tr>
<th>Index</th>
<th>Case (Mean±SE)</th>
<th>Control (Mean±SE)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global symptom</td>
<td>0.89 ± 0.61</td>
<td>0.4 ± 0.43</td>
<td>.0000</td>
</tr>
<tr>
<td>Phobia</td>
<td>0.37±0.41</td>
<td>0.33±0.51</td>
<td>.567</td>
</tr>
<tr>
<td>Depression</td>
<td>.94±.8</td>
<td>.35±.51</td>
<td>.0000</td>
</tr>
<tr>
<td>Paranoia</td>
<td>1.14±.81</td>
<td>.4±.59</td>
<td>.0000</td>
</tr>
<tr>
<td>Psychosis</td>
<td>.49±.48</td>
<td>.26±.43</td>
<td>.0006</td>
</tr>
<tr>
<td>Somatization</td>
<td>.97±.66</td>
<td>.58±.65</td>
<td>.0007</td>
</tr>
<tr>
<td>Internal sensitivity</td>
<td>1.11±.81</td>
<td>.54±.48</td>
<td>.0000</td>
</tr>
<tr>
<td>Obsession compulsion</td>
<td>1.28±.78</td>
<td>.34±.49</td>
<td>.0000</td>
</tr>
<tr>
<td>Anxiety</td>
<td>.77±.66</td>
<td>.36±.51</td>
<td>.0000</td>
</tr>
<tr>
<td>Hostility</td>
<td>.88±.67</td>
<td>.35±.49</td>
<td>.0000</td>
</tr>
</tbody>
</table>

Our findings show the risk estimates for mental disorder relative to exposure to EMFs in several places (Table 1). There was a monotonic dose-response gradient with recent exposure as a categorical measure. For exposure in the five substations, the highest risk was found in the highest exposure group. The average age of the cases was ranging from 41 to 50 years. In fifty percent of all cases the work experiences had ranging from 15 to 25 years.

Table 2: The average of electric and magnetic field in different high voltage substations

<table>
<thead>
<tr>
<th>Voltage of substation kV</th>
<th>Electric field V/M</th>
<th>Magnetic field µT</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>872</td>
<td>0.82125</td>
</tr>
<tr>
<td>63</td>
<td>977</td>
<td>0.835</td>
</tr>
<tr>
<td>132</td>
<td>1518</td>
<td>2.67875</td>
</tr>
<tr>
<td>230</td>
<td>4144</td>
<td>2.8525</td>
</tr>
<tr>
<td>400</td>
<td>5484</td>
<td>3.785</td>
</tr>
</tbody>
</table>

Assessment of exposure to EMFs was based on measurement of mean strengths of electric and magnetic fields at the substations as a 20, 63, 132, 230 and 400 kV at different places. In-
creased intensity of electric and magnetic fields with substation voltages are shown in Table 2.

**Discussion**

The results of this study provide support for hypothesis that occupational exposure to EMFs is associated with an increased risk of mental disorders. Table 1 presents the average number of mental disorder index compared with the overall number in the original cohort. The average of global symptom index was 0.89 with a SD of 0.610, which compared with the normal range was quite different ($P<.05$). Exposure to EMF at the workplace seemed to have a modestly increased risk of depression, paranoia, psychosis, interpersonal sensitivity, somatization, anxiety, and hostility ($P<.05$). Being shift work was associated with phobia, found from regression. Men employed as electricians operators, and line men, seemed to be at increased risk, broadly consistent with indications of increases in diagnosed mental disorders and several depressive disorders symptoms in operators. This discrepancy in results could be partially explained by a variation in exposure to levels or patterns of EMFs between those groups.

Assessment of exposure to magnetic fields showed highest exposure as 3.78 μT for 400 kV substations, compared with 0.835 μT (63 kV substation) and 0.82 μT (20 kV substation). Also the inconsistent findings across these jobs could be explained by varying exposure levels of other components of EMFs, which were not captured by our technique of assessing exposure (10, 11).

As expected, men currently work in substation 63 kV had a decreased risk of mental disorder, which reflected the healthy worker effect. Asanova first suggested an association of mental disorder with exposure to EMFs (4). Results indicated that the calculated measured strengths of these EMFs at the residences of mental disorder depressed victims differed from those at the residences of controls (1).

Gambreale found that the exposure to EMFs effects on psychological status of human. He found increased rate of suicide in men with occupations in exposure to EMFs (6). Wilson postulated that long term exposure to EMFs contribute to depressive symptoms (12). High exposure to EMFs may cause depression, which, as an intermediate variable, may lead to problems at worker even stopping work (13).

Exposure to EMFs may alter melatonin secretion within days or weeks, supported by studies of users of electric blankets, railway and electric utility workers (14-16).

Consequently, depressive symptoms and related problems may develop between exposure and suicide. An association between exposure to EMFs and suicide was found in younger but not older workers (12, 15). Barisetal showed higher exposure among single workers and workers with mental disorders (1).

These results replicable to the present study population and all cases of this study were married. Knave results indicated that the degree cases of victim’s checklist differed from controls (10).

Exposed groups (cases) had highest degree and developed symptom. Coelho found that the exposure to EMFs effects on performance efficiency of passive affinity as 122%, stress 48%, and stereotype 40% (4). Feldestone results of behavioral test show that the exposure to EMF and sense effects on activity (1, 17).

Work environment can increase mental disorder symptoms. Risk factors in operator Job are high-risk work, risk of cancer, corona, and high risk of headache; fatigue condition is high probability of accident (8, 9, 18).

In conclusion, the results of this study provide evidence for an association between exposure of EMFs and mental disorders, especially among workers with further more job experiences. Exposure to electromagnetic field increased the risk of disorders in susceptible workers. For mental disorders, especially depression, the cognitive therapy is suggested. Consulting and psychotherapy decreased the
Psychological Effects of Occupational...

effects and prevent the mental disorders (19, 20).

Acknowledgments
Our deepest appreciation goes to all of the field’s staff of the project such as Operators of Tehran High Voltage Substations and others for kindly participating, and also all managers for their effort and cooperation. We also would like to give thanks to Dr. Baraheny and Fereidon yaryari for their help with interview and consulting.

References
1. Lovely RH. Recent studies in the behavioral toxicology of ELF electromagnetic fields. In O’Connor. MEA, RLCO Inc; 1988: 327-47.