

Psychological Effects of Occupational Exposure to Electromagnetic Fields

* *Yousefi HA*, ** *Nasiri P*

* *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*

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

Correspondence: Hosein Ali Yousefi, Tel: +98 6688628, Fax: +98 311 6682509, E-mail: yousefi@hlth.mui.ac.ir

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 1: The average number of cases mental disorder index compared with the control group

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

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

Voltage of substation kV	Electric field V/M	Magnetic field μT
20	872	0.82125
63	977	0.835
132	1518	2.67875
230	4144	2.8525
400	5484	3.785

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 $3.78 \mu\text{T}$ for 400 kV substations, compared with $0.835 \mu\text{T}$ (63 kV substation) and $0.82 \mu\text{T}$ (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. Knavé 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

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.
2. Savitz David A. Exposure assessment strategies in epidemiological studies of health effects of electric and magnetic fields. *The Science of the Total Environment*. 1995; **168** (2):143-43.
3. Anonymous. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, American Psychiatric Association; 1994: 345-50.
4. Asanova TP, Rakov AN. The state of health of persons working in the electric field of outdoor 400 & 500 kV switchyards. *N J IEEE Power Eng*. 1974.
5. Coelho AM. Effects of exposure to 30 kV/m electric fields on the social behavior of baboons. *Bioelect*. 1991; **12**: 117-35.
6. Gambreale E. Psychological effects of exposure to ELF electric and magnetic fields on human. *Scand J Work Env H*. 1990; **1**: 51-4.
7. Akbar_Khanzadeh Farhang, Huffman J R. Office Workers' Exposure to Extremely Low Frequency (ELF) Magnetic Fields and Their Perception of Characteristics and Health Effects of ELF Electromagnetic Fields *App Occup and Env Hyg*. 1995; **10**(11): 927-33.
8. Werthimer NL, Leeper E. Adult cancer related to electrical wires near the home. *Int J Epi*. 1982; **11**: 345-56.
9. Derogatis LR. *The Symptom Distress Checklist - revised Clinical Psychometric Research*. Maryland, Johns Hopkins University; 1983.
10. Loomis Dp, Kromhout H, Peipins LA, Kleckner RC et al. Sampling design and field methods of large Randomized, Multisite survey of Occupational Magnetic field Exposure. *Appl Occup Env Hyg*. 1994; **9**(1): 49-52.
11. American Conference of Governmental Industrial Hygienists. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure indices*; 2004: 121-22.
12. Van wijngaarden E, Savitz DA, Kleckner RC, Cai J, Loomis DP. Exposure to electromagnetic fields and suicide among electric utility workers. *Occup Env Med*. 2000; **57** (4): 258-63.
13. Verkasalo Pk, Kaprio J, Varjonen J, Romanoy K et al. Magnetic fields of Transmission lines and Depression. *Am J Epi*. 1997; **146** (12): 1037-45.
14. Ojajarri IA. Occupational exposures and pancreatic cancer. *Occup and Env Med*. 2000; **57**: 316.
15. Graham Charles, Cook Mary R, Cohen Harvey D, Riffle Donald W et al. Human exposure to 60-Hz magnetic fields: neurophysiological effects. *Int J Psychophysio*. 1999; **33**(2): 169-75.
16. Salansky N, Fedotechev A, Bondar A. Responses of the Nervous System to Low Frequency Stimulation and EEG Rhythms. *Clin Impli Neuro & Biobehavioral Rev*. 1998; **22**(3): 395-409.
17. Gavalas Medici R. ELF weak electric field's affect schedule controlled behavior of monkeys. *Nature*. 1976; **261**: 256-58.
18. Butcher J. Electromagnetic fields may cause leukemia in children. *lancet*. 2001; **357**: 777.
19. Kaplan HI, Sadock BJ. *Comprehensive Textbook of Psychiatry*. 5th ed. New York, Williams and Wilkins. 1995; **(2)**: 1074-75.
20. Atkinson RL, Atkinson HI, Sadock BJ. *Comprehensive Textbook of Psychiatry*. Baltimore. Williams and Wilkins; 1995: 1116- 40.