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Household Electromagnetic Fields and Breast Cancer in Elderly Women

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Abstract. *The relationship between the rate of household low-frequency electromagnetic fields (EMF) and incidences of mammary tumors was studied in 1290 clinical case-records of female patients aged 60 and more over a period of 26 years, based on the materials of the Edith Wolfson Medical Center, Israel. The studied material was divided into two groups, each corresponding to a period of 13 years. Group I included patients with mammary tumors under observation from 1978 to 1990, who rarely used EMF-generating appliances . Group II consisted of patients being under observation in the period between 1991 and 2003, characterized by much more extensive use of personal computers (more than 3 hours a day), mobile telephones, television sets, air conditioners and other household electrical appliances generating EMF. 200,527 biopsy and surgery samples were analyzed. Mammary tumors were found in 2824 women (1.4%), of which 1290 cases (45.6%) were observed in elderly women. Most of the observed tumors – 1254 (97.2%) – were epithelial neoplasms. Mammary tumors were found in 585 elderly women in Group I and 705 women in Group II. The case records of these patients showed that 114 elderly women (19.5%) in Group 1 and 360 (51.1%) in Group II were regularly exposed to EMF (mostly from personal computers) for at least 3 hours a day ($\chi^2=57.2$, $p<0.001$). There was a statistically significant influence of EMF on the formation of all observed epithelial mammary tumors in Group II. This influence is most evident for invasive ductal carcinomas, which was the commonest form of cancer in elderly women.*

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Low-frequency electromagnetic fields (EMF) are frequently encountered in everyday life. There is a growing amount of evidence concerning the harmful effects of EMF on the human body, the most dangerous of which is the possible carcinogenic effect (1-8). Cohort and case-control studies estimating the total cancer incidence and mortality in people working under EMF exposure have been carried out in the USA, England, Germany, Canada, Finland and Norway (9-15). Epidemiological studies show that prolonged exposure to EMF can be a high-risk factor for oncological diseases (16-23). Data on the carcinogenic effect of the radiation from personal computers on humans are scarce. The risk of mammary tumors in female operators of personal computers has only been analyzed in two studies (24, 25). The data available at present are not sufficient to draw any definitive conclusions on the carcinogenic hazard of EMF, and further investigations into this issue are required with regard to the prevention of malignant tumors, especially in elderly women.

Materials and Methods

Patients. We studied the incidence and character of mammary tumors in 1290 clinical case-records of female patients aged 60 and more, over a period of 26 years, based on the materials of the Edith Wolfson Medical Center, Israel. Particular attention was paid to the time of their exposure to EMF. All the studied material was divided into two groups, each corresponding to a period of 13 years. Group I included patients with mammary tumors under observation from 1978 to 1990, who rarely used EMF-generating appliances. Group II consisted of patients under observation in the period between 1991 and 2003, who characterized by much more extensive use of personal computers (more than 3 hours a day), mobile telephones, television sets, air conditioners and other household electrical appliances generating EMF.

Morphological studies. In all cases of mammary neoplasms, the biopsy and surgical materials fixed in 10% neutral formalin were subjected to thorough morphological analysis. Three-μm-thick

Table I. *Incidence of breast tumors depending on age and histological structure.*

Types of tumors	Age of patients (years)				
	60-69	70-79	80-89	90 and more	Total
Invasive ductal Ca	448	289	130	12	879
Ca *in situ* and comedo Ca	49	36	7	-	92
Lobular Ca	34	28	14	2	78
Intraductal papilloma	31	21	7	-	59
Colloid Ca	14	16	6	2	38
Fibroadenoma	25	11	-	-	36
Papillary Ca	10	14	9	1	34
Tumors of nipple	10	9	4	-	23
Tubular Ca	6	7	2	-	15
Medular Ca	7	3	-	-	10
Rare tumors of breast	14	10	2	-	26
Total	648	444	181	17	1290

paraffin sections were stained with haematoxylin and eosin. The morphological features of the neoplasms of all patients were analyzed, including the size, multiplicity and presence of metastases in regional lymph nodes and distant organs.

Statistical analysis. To investigate a possible effect of electromagnetic fields on the incidence of mammary gland tumors, statistical analysis was performed using empirical distribution analysis (χ^2 criterion).

Results

Two hundred thousand, five hundred and twenty-seven biopsy and surgical samples were analyzed. Mammary tumors were found in 2824 women (1.4%), of which 1290 cases (45.6%) were observed in elderly women. The age distribution of these cases is presented in Table I.

The tumor sizes varied from 0.3 cm to 12–14 cm in diameter. There were 525 cases of left mammary neoplasms and 765 cases of right mammary neoplasms.

Most of the observed tumors – 1254 (97.2%) – were epithelial neoplasms. Among them, there were 58 cases (4.6%) of benign papillomas and 92 cases (7.3%) of non-invasive intraductal malignant forms of cancer. The histological distribution of infiltrated malignant epithelial neoplasms is shown in Table I.

Fibroadenomas – mixed fibroepithelial mammary neoplasms most frequently found in young women – were only observed in 36 cases (2.7%).

Twenty-six elderly women (2.02%) suffered from rare forms of mammary tumors, such as hemangiomas and lymphomas.

Of seven hundred and ten women operated on for the excision of regional lymph nodes, 302 (42.5%) had secondary neoplasms. Twenty-three patients (3.2%) had metastases in distant organs, such as liver, lungs and bones.

Table II shows that mammary tumors were found in 585 elderly women in Group I and 705 women in Group II. The case records of these patients showed that 114 elderly women (19.5%) in Group I and 360 (51.1%) in Group II were regularly exposed to EMF (mostly from personal computers) for at least 3 hours a day ($\chi^2=57.2$, $p<0.001$). Table II shows the statistically significant influence of EMF on the formation of all the observed epithelial mammary tumors in Group II. This influence is most evident for invasive ductal carcinomas, which is the commonest form of cancer in elderly women.

Discussion

Our studies show that low-frequency EMF facilitate the development of mammary tumors. In most cases, mammary tumors were observed in elderly women regularly exposed to EMF for more than 3 hours a day, implying that the exposure duration plays an important role in the development of mammary tumors.

Data on the carcinogenic effect of the radiation generated by personal computers on humans are scarce. Anisimov *et al.* (26) and Muratov *et al.* (27) studied the influence of personal computer radiation on the development of tumors in mice and rats. The effect of personal computer EMF on the development of spontaneous tumors, urethane-induced carcinogenesis and dipropionate-induced blastomogenesis in mice were studied.

Table II. *Incidence of breast tumors in different groups of patients.*

Types of tumors	Group I		Group II		Statistical coefficients	
	Total number of women with breast tumors	Number of women contacted with EMF (%)	Total number of women with breast tumors	Number of women contacted with EMF (%)	$\chi 2$	*p*
Invasive ductal Ca	370	63 (17.0)	509	258 (50.7)	15.8	<0.0001
Ca *in situ* and comedo Ca	51	11 (21.6)	41	20 (48.8)	21.5	<0.005
Lobular Ca	43	8 (18.6)	35	19 (54.3)	22.8	<0.001
Intraductal papilloma	35	9 (25.7)	24	13 (54.2)	17.7	<0.05
Colloid Ca	11	3 (27.3)	27	14 (51.8)	7.2	<0.05
Fibroadenoma	24	5 (20,8)	12	6 (50.0)	5.7	<0.05
Papillary Ca	15	3 (20.0)	19	10 (52.6)	4.5	<0.05
Tumors of nipple	9	4 (44.4)	14	6 (42.8)	4.2	<0.05
Tubular Ca	9	3 (33.3)	14	6 (42.8)	5.5	<0.05
Medular Ca	6	2 (33.3)	4	3 (75.0)	12.4	<0.05
Rare tumors of breast	12	3 (25.0)	14	7 (50.0)	4.5	<0.05
Total	585	114 (19.5)	705	360 (51.1)	57.2	<0.0001

In all the studies, the radiation generated by personal computers stimulated carcinogenesis, increased the incidence of tumors, and reduced the average latent period of their development.

Our studies and epidemiological and experimental investigations point to the potential carcinogenic hazard of low-frequency EMF. Further detailed studies of the role of EMF in carcinogenesis may be very helpful in the development of measures to prevent mammary tumors in women working with personal computers.

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