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MATHEMATICAL ANALYSIS OF BIBLIOMETRICAL INDICES OF NEUROPHYSIOLOGICAL INVESTIGATIONS OF MICROWAVE RADIATION (MEDLINE-INTERNET)

Summary. Bibliometrical data on investigations carried out in different neurophysiological objects (the brain, the cortex, neurons, nerves) with application of microwaves are presented. Quantitative characteristics of publications of choose subdivisions during 35-year time interval (1966-2000) is considered. Dynamics of number of papers of these trends is analyzed. Conclusion about prospects of investigations of effects of non-ionizing radiation in neurophysiological objects is done.

Keywords. Neurophysiological, bibliometrical, microwave radiation.

Introduction

It is known, that biological effects of non-ionizing radiation of different kinds interested humanity for many centuries [9]. Towards middle of the seventies years of XXth century probably more 3 thousand publications on biological effects of electromagnetic fields and about 2 thousand publications on biological effects of magnetic fields were accumulated [9]. 20 years later the number of publications concerned action of non-ionizing radiation of different kinds is believed to reach 10 thousand [2, 10].

Undoubtedly the nervous system is of great significance in reactions of organism to non-ionizing radiation [1, 2]. Nevertheless bibliometrical investigation of published material on neurophysiological aspects of action of such physical factors was not carried out up to now. Therefore we began bibliometrical analysis on this problem.

Quantitative characteristics of publications of above-mentioned trend were examined in our recent works. Information accumulated in world on neurophysiological effects of non-ionizing radiation during 35-year period in the later half of the XX-th century (1966-2000) was considered. The state of investigations of this trend was analyzed on the base of the database "Medline" accessible through Internet. Preliminary information on general results was presented partly in our another pa-

pers [4, 8]. Quantitative characteristics of publications on neurophysiological effects of electromagnetic fields were considered in our previous paper [5].

The present work is devoted to examination of quantitative characteristics of publications on neurophysiological effects of microwave radiation. Bibliometrical data were obtained according to chosen key words and concerned investigations performed in different neurophysiological objects (the brain, the cortex, neurons, nerves) with application of microwaves.

Materials and methods

Quantitative characteristics of publications on neurophysiological effects of microwave radiation in world during 35-year period in the later half of the XX-th century (1966-2000) were considered. Investigations of this trend were analyzed on the base of the database "Medline" accessible through Internet. The numbers of publications on the present problem were determined on the base of corresponding key words. Bibliometrical data were obtained for works performed with application of microwave radiation in different neurophysiological objects (the brain, the cortex, neurons, nerves).

At statistical analysis of the material the comparisons of sampling fractions of received data from their sum, from the total number of works with application of microwave radiation, and from the total number of works carried out in corresponding neurophysiological objects are used. For calculations of statistical significance of distinctions between indicated data *t*-criterion for selective portions of variants was applied.

Results

It was found that the number of published works carried out in different neurophysiological objects reached 1401300 in 35-yaer period. The numbers of investigations performed in the brain, the cortex, neurons, nerves were 705259, 180602, 237160 and 278279 correspondingly. The total number of works with application of microwave radiation was 6920. Materials concerned investigations in different neurophysiological objects under action of microwave radiation were considered for every year during 35-yaer period.

General characteristics of received totalities are presented in table 1. Sampling fractions of received data from their sum, from the total number of works with application of microwaves and from the total

number of works carried out in corresponding neurophysiological objects are shown in table 2. Statistical comparison of indicated sampling fractions is reflected in table 3. Dynamics of the number of published works performed in different neurophysiological objects and dynamics of the considered sampling fractions are demonstrated in tables 4-7.

Table 1

General data on the number of published works carried out in different neurophysiological objects with application of microwave radiation during 35-year period

Objects	Characteristics of totalities			
	Total number of papers in 35 years	Sampling variance	Average number of papers in 1 year	Standard deviation
1	899	234.22	25.69	2.59
2	225	22.66	6.43	0.81
3	165	17.09	4.71	0.70
4	146	11.26	4.17	0.58
5	1435	640.53	41.00	4.28

Application: 1 - the brain, 2 - the cortex, 3 - neurons, 4 - nerves, 5-sum.

Table 1 shows that investigations made on the whole brain with employment of microwave radiation predominate. This phenomenon is the result of increased interest of specialists of applied sciences to investigation of effects of physical factors in the whole brain [4, 8].

Table 2 demonstrates that sampling fraction from total data in corresponding neurophysiological objects with microwaves (1435) prevails in works carried out in the whole brain. Such result takes place at calculation of sampling fractions from total number of works with microwaves radiation (6920). These facts conforms to above-mentioned supposition.

Moreover similar effect is at the total number of all works of different kinds performed in neurophysiological objects (in the brain - 705259, the cortex - 180602, neurons - 237160, nerves - 278279). Marked increased sampling fraction from all works in neurophysiological objects was observed in investigations on the cortex too. However it is necessary to note, that relatively small part of the number of investi-

gation on the cortex in general totality of neurophysiological works, which can reflect in obtained information.

Table 2

Sampling fractions of received data from their sum, from the total number of works with application of microwave radiation and from the total number of works carried out in corresponding neurophysiological objects

Objects	Characteristics of totalities		
	Sampling fraction from these data (%)	Sampling fraction from total data with microwaves (%)	Sampling fraction from total data in these objects (%)
1	62.65	12.99	0.13
2	15.68	3.25	0.14
3	11.50	2.38	0.07
4	10.17	2.11	0.05
5	100.00	20.74	0.10

Application: as in table 1.

Table 3

Comparison of sampling fractions of received data from their sum, from the total number of works with application of microwave radiation and from the total number of works carried out in corresponding neurophysiological objects

Objects	Comparison of sampling fraction of totalities		
	Comparison of sampling fraction from these data (*U*)	Comparison of sampling fraction from total data with microwaves (*U*)	Comparison of sampling fractions from total data in these objects (*U*)
1 - 2	27.13	22.06	1.14
1 - 3	30.40	25.18	8.00
1 - 4	31.53	26.35	12.06
2 - 3	3.27	3.12	7.04
2 - 4	4.39	4.29	9.93
3 - 4	1.13	1.18	2.86

Application: significant values of coefficients of correlation and statistically significant distinctions between distributions are underlined

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(U>1.96 corresponds to p<0.05, U>2.58 corresponds to p<0.01); the other designations as in table 1.

Results performed in table 3 prove that distinctions between different sampling fractions are statically significant. Really works carried out in the whole brain predominate as sampling fraction from total data in corresponding neurophysiological objects with microwave radiation.

Table 4

Dynamics of the number of published works carried out in different neurophysiological objects with application of microwave radiation during 35-year period

Objects	Indices for different five-year periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	13	60	149	165	178	174	160
2	0	16	36	44	41	52	36
3	0	9	12	27	31	47	39
4	3	12	16	14	32	40	29
5	16	97	213	250	282	313	264

Application: as in table 1.

Table 5

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects with application of microwave radiation during 35-year period from their total number

Objects	Indices for different five-year periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	81.25	61.86	69.95	68.52	60.96	55.59	60.61
2	0	16.49	16.90	16.30	14.09	16.61	13.64
3	0	9.28	5.63	10.00	14.09	15.02	14.77
4	18.75	12.37	7.51	5.19	10.96	12.78	10.98
5	100	100	100	100	100	100	100

Application: as in table 1.

Table 6

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects during 35-year period from the total number of works with application of microwave radiation

Objects	Indices for different five-years periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	5.58	12.79	18.29	17.56	14.88	10.85	10.32
2	0	3.41	4.42	4.18	3.43	3.24	2.32
3	0	1.92	1.47	2.56	3.43	2.93	2.51
4	1.29	2.56	1.96	1.33	2.68	2.5	1.87
5	6.87	20.68	26.14	25.63	24.42	19.52	17.02

Application: as in table 1.

Table 7

Dynamics of the sampling fractions (%) of published neurophysiological works with application of microwaves during 35-year period from the total number of works carried out in corresponding neurophysiological objects

Objects	Indices for different five-year periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	0.03	0.09	0.19	0.17	0.15	0.12	0.10
2	0	0.09	0.17	0.18	0.14	0.15	0.09
3	0	0.07	0.06	0.09	0.07	0.08	0.06
4	0.02	0.06	0.05	0.04	0.07	0.07	0.05
5	0.02	0.08	0.14	0.13	0.12	0.11	0.08

Application: as in table 1.

Dynamics of the observed bibliometrical indices during 35-year period is presented in tables 4-7.

The increase of the numbers of published works carried out in different neurophysiological objects with application microwaves developed during 35-year period (table 4). But this increase was non-linear. The greatest values took place in periods 1981-1985, 1986-1990, and 1991-1995.

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Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects during 35-year period from their total number has complex and had non-linear character (table 5).

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects during 35-year period from the total number of works with application of microwaves displayed non-linear fluctuations too (table 6). The greatest values for works in the whole brain were in year periods 1976-1980, 1981-1985, and 1986-1990.

It is interesting that the sampling fractions of the works on neuronal level showed steady essential increase in both situations (tables 5 and 6).

Dynamics of all sampling fractions (%) of published neurophysiological works with application of microwave radiation during 35-year period from the total number of works carried out in corresponding neurophysiological objects had non-linear increase (table 7). The greatest values of works carried out in the whole brain and the cortex were in year periods 1976-1980, 1981-1985, 1986-1990, and 1991-1995.

Conclusion

The results of the present bibliometrical investigations makes it possible to analyse quantitative characteristics of published works performed with application of microwave radiation in different neurophysiological objects during 35-year period of later half of XX-th century. The whole brain, the cortex, neurons and nerves were selected for examination on this trend. The total number of publications was considered for every year during period 1966-2000. Dynamics of the number of published works carried out in different neurophysiological objects and dynamics of the corresponding sampling fractions were studied.

It was established, that predominance of investigations of effects of microwaves on the whole brain existed. Such investigations are suitable for specialists of applied sciences. Works on neuronal level have the slight number. The reason of this fact is their methodical complexities.

It was found that significant increase of the number investigations with application of microwaves during 35-year period and moreover the sampling fractions (%) of published neurophysiological works from the total number of works performed with this factor and those carried out in corresponding neurophysiological objects existed.

Obtained information on published works with microwaves is differ from information on works with electromagnetic fields considered in our previous paper [5]. First, the number of publications on microwave radiation was less than the number of publications on electromagnetic fields of another kinds. Secondly, dynamics of quantitative characteristics of publications of above-mentioned trends is different. The number of works on other electromagnetic fields had steady increase during 35-year period [5]. The number of works on microwaves had the greatest values in middle of analysed time period, which is conditioned by their extensive employment in this part of period [9].

Fundamental investigations of neurophysiological effects of non-ionizing radiation are played no enough attention to. However, in the future they will hold a leading position in solution of the problem of biological action of these factors [1, 3, 6, 7].

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