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MATHEMATICAL ANALYSIS OF BIBLIOMETRICAL INDICES OF NEUROPHYSIOLOGICAL INVESTIGATIONS OF ACTION OF ELECTRIC FIELDS (MEDLINE-INTERNET)

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

Keywords: bibliometric indices, neurophysiology, electric fields, holistic brain, cerebral cortex, neurons, nerves, non-ionizing radiation

Introduction

Electromagnetic phenomena were observed already in antiquity [17]. Biological effects of electromagnetic fields (EMF) of different kinds have known for many centuries also, although sense organs for these factors are absent Technological progress led to proliferation of large number of sources of electromagnetic irradiation and in consequence increased interest of researchers to their influence on animals and humans. In the middle of XX century period of intensive investigation of biological effects of non-ionizing radiation arose. Action of EMF of wide frequency and intensity range is examined, including magnetic and electric fields (EF).

Undoubtedly the nervous system is of great significance in reactions of organism to different EMF [6]. Neurophysiological alterations made by EMF were considered in series of our works [1-7, 10, 13-15].

Bibliometrical analysis of published material on neurophysiological aspects of action of such physical factors was not carried out up to now. Therefore we began bibliometrical research on this problem. Quantitative characteristics of published works on above-mentioned trend were examined in our investigations. Information accumulated in world on neurophysiological effects of non-ionizing radiation during 35-year period in the later half of the XX century (1966-2000) was considered.

Preliminary information on general results was presented in our

recent papers [8, 16]. Then quantitative characteristics of published works on neurophysiological effects of EMF, of individually microwaves, and magnetic fields were considered in detail [9, 11, 12].

The present work is devoted to examination of quantitative characteristics of published works on influence of EF on different neurophysiological objects (the whole brain, the cortex, neurons, nerves).

Materials and methods

Quantitative characteristics of published works on neurophysiological effects of EF in world during 35-year period in the later half of the XX-th century (1966-2000) were considered. Investigations were carried out on the base of the database "Medline" accessible through Internet. The numbers of published works on the present problem were determined by means of corresponding key words.

At statistical analysis of the material the comparisons of sampling fractions of obtained data from their sum, from the total number of works with application of EF, 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

In considered 35-yaer period the total number of published works carried out in different neurophysiological objects reached 1401300. The numbers of works performed in the brain, the cortex, neurons, nerves were 705259, 180602, 237160 and 278279 correspondingly. Number of works on effect of non-ionizing radiation was 21606, and from them works with application of EF was 3369 (15.59%). Number of neurophysiological works on influence of non-ionizing radiation was 5935, and from them only 699 was on action of EF (11.78%).

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

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Table 1 shows that investigations made on the whole brain and nerves with employment of EF predominate. Reason of such a phenomenon is increased interest of specialists of applied sciences to examination of effects of physical factors in these neurophysiological objects [8, 16].

Table 1

General data on the number of published works carried out in different neurophysiological objects with application of EF 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	232	89.53	6.63	1.59
2	70	20.94	2.00	0.77
3	176	22.97	5.03	0.81
4	221	38.10	6.31	1.04
5	699	507.50	19.97	3.81

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

Table 2 demonstrates that sampling fraction from total data in corresponding neurophysiological objects with EF (699) prevails in works carried out in the whole brain and nerve. Similar result was found at calculation of sampling fractions from total number of works with EF (3369). These facts conform to above-mentioned supposition.

Table 2

Sampling fractions of received data from their sum, from the total number of works with application of EF 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 EF (%)	Sampling fraction from total data in these objects (%)
1	33.19	6.89	0.03
2	10.01	2.08	0.04
3	25.18	5.22	0.07
4	31.62	6.56	0.08
5	100.00	20.75	0.05

Application: as in table 1.

Interesting phenomenon was observed at analysis of number of these works performed in different neurophysiological objects (in the brain - 705259, the cortex - 180602, neurons - 237160, nerves - 278279). In contradistinction to previous results the greatest sampling fractions from total number neurophysiological works were at works carried out nerve and neurons. By the way the number of investigations performed out in the whole brain predominate in general totality of neurophysiological works.

Table 3

Comparison of sampling fractions of received data from their sum, from the total number of works with application of EF 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 EF (U)	Comparison of sampling fractions from total data in these objects (U)
1 - 2	10.92	9.93	0.76
1 - 3	3.31	2.87	7.58
1 - 4	0.64	0.53	8.93
2 - 3	7.61	7.06	5.12
2 - 4	10.28	9.40	5.96
3 - 4	2.67	2.34	0.72

Application: statistically significant distinctions between distributions are underlined ($U>1.96$ corresponds to $p<0.05$, $U>2.58$ corresponds to $p<0.01$); the other designations as in table 1.

Data of statistical analysis represented in table 3 prove existence and peculiarity of distinctions between different sampling fractions described above. Indeed, published works carried out in corresponding neurophysiological objects with EF make different sampling fractions from their sum, from the total number of works with application of EF and from the total number of works in these neurophysiological objects.

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

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The considerable increase of the numbers of published works carried out in all used neurophysiological objects with application EF gradually developed during 35-year period (table 4).

Table 4

Dynamics of the number of published works carried out in different neurophysiological objects with application of EF 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	2	4	12	20	38	57	99
2	1	1	2	5	5	14	42
3	3	5	10	16	36	42	64
4	0	8	15	24	39	60	75
5	6	18	39	65	118	173	280

Application: as in table 1.

Table 5

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects with application of EF 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	33.33	22.22	30.77	30.77	32.20	32.95	35.36
2	16.67	5.56	5.13	7.69	4.24	8.09	15.00
3	50.00	27.78	25.64	24.62	30.51	24.28	22.86
4	0.00	44.44	38.46	36.92	33.05	34.68	26.79
5	100	100	100	100	100	100	100

Application: as in table 1.

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects during 35-year period from their total number was complex and unequal (table 5). The least propitious periods for investigation of effects of EF on the cortex were in 1971-1995.

Pattern of 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 EF were une-

qual too (table 6). Investigations of effects on the cortex were less presented in 1971-1995.

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 EF

Objects	Indices for different five-years periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	3.92	4.55	4.72	5.59	5.80	6.64	8.97
2	1.96	1.14	0.79	1.40	0.76	1.63	3.80
3	5.88	5.68	3.94	4.47	5.50	4.89	5.80
4	0	9.09	5.91	6.70	5.95	6.99	6.79
5	11.76	20.45	15.35	18.16	18.02	20.14	25.36

Application: as in table 1.

Table 7

Dynamics of the sampling fractions (%) of published neurophysiological works with application of EF 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	0.004	0.006	0.015	0.021	0.032	0.040	0.064
2	0.007	0.006	0.009	0.021	0.017	0.040	0.105
3	0.040	0.036	0.052	0.055	0.087	0.072	0.095
4	0.000	0.032	0.050	0.063	0.082	0.103	0.119
5	0.007	0.015	0.026	0.035	0.050	0.059	0.086

Application: as in table 1.

As distinct from described results dynamics of sampling fractions (%) of published neurophysiological works with application of EF from the total number of works on these objects had other peculiarities (table 7). In all cases the pronounced increase of the numbers of published works took place.

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Conclusion

The present bibliometrical investigations concern quantitative characteristics of published works performed with application of EF in different neurophysiological objects during 35-year period of later half of XX century. Researches of effects of EF on the whole brain, the cortex, neurons and nerves were separately considered. The total number of published works was for period 1966-2000. Dynamics of the number of published works was analyzed.

It was established the following main events.

First, the published works on effects of EF were less than the same with on influence of other kinds of non-ionizing radiation (look at our other works [9, 11, 12]).

Secondly, the published works on effects of EF upon the whole brain and nerves prevail, what differs from the same on action of other physical factors (look in works [9, 11, 12]). Similar data were observed at study of sampling fractions (%) from total data in different neurophysiological objects with EF and sampling fractions (%) from total number of works with EF. The point is that, such investigations are suitable for specialists of applied sciences. Researches on the cortex and on neuronal level are extremely difficult and are important for fundamental science. However at analysis of sampling fractions (%) from total number of corresponding neurophysiological works another phenomenon were revealed. Sampling fractions (%) of works on nerve and neurons were in the lead, which was conditioned by distinction of startling total number of these works.

Thirdly, gradual increase of the number of published works with application of EF during 35-year period takes place. But dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects from their total number and from the total number of works with application of EF were complex and unequal. In both cases the least propitious periods for investigation of effects of EF on the cortex were in 1971-1995, what was absent at observation data with other factors [9, 11, 12]). However pattern of dynamics of all sampling fractions (%) of published neurophysiological works with application of EF from the total number of works on these objects had the pronounced increase.

Thus, obtained information showed distinction between results of bibliometrical analysis of published works on neurophysiological aspects of action of EF and other kinds of physical factors. Special feature of investigations of neurophysiological effects of EF consists in predominance of works carried out in nerves on a level with works in the whole brain, which is accounted to relative simplicity and accessibility of these objects. Neurophysiological researches of influence of EF belong mainly to specialists of applied sciences. For fundamental investigations of effects of EMF observations of events on the cortex and on neuronal level are necessary. Exactly such investigations can help to understand origin and organization of reactions on non-ionizing radiation including EF [8, 16].

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