UDK 577.359

R.A. Chizhenkova

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

Bibliometrical data on investigations carried out in different neurophysiological objects (the brain, the cortex, neurons, nerves) with application of magnetic fields are presented. Quantitative characteristics of publications of choose subdivisions during 35-year time interval (1966-2000) be 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

Influence of electromagnetic environment interested humanity for many centuries [11]. Towards the seventies years of XXth century more 3 thousand publications on biological effects of electromagnetic fields (EMF) and about 2 thousand publications on biological effects of magnetic fields (MF) were accumulated [11]. 20 years later the total number of publications concerned action of these factors of different kinds is believed to be 10 thousand [2, 12]. In 2000 their number reached 21606 [4, 10].

Now it was established, what leading role in reactions of organism on EMF belongs to the nervous system [1, 2]. Nevertheless before our investigations bibliometrical analysis of neurophysiological aspects of action of EMF was not realized. Series of our recent works were devoted to namely problem of quantitative characteristics of published material on neurophysiological effects of action of electromagnetic factors. Information accumulated in world on these data during 35-year period in the later half of the XX-th century (1966-2000) was considered. The state of this scientific trend was examined on the base of the database "Medline" accessible through Internet. Preliminary information on general results was presented in our recent papers [4, 10]. Then quantitative characteristics of publications on neurophysiological effects of EMF were considered in our previous paper [5] and analogous material on influence of microwaves in our another paper [6].

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

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 were carried out 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 MF 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 MF, 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 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 investigations performed in the brain, the cortex, neurons, nerves were 705259, 180602, 237160 and 278279 correspondingly. The number of works with application of MF was 5316. Materials concerned investigations in different neurophysiological objects under action of MF 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 MF 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.

 ISSN 1562-9945

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 MF predominate. This phenomenon is the result of increased interest of specialists of applied sciences to investigations of effects of different physical factors in the whole brain [4, 10].

Table 2 demonstrates that sampling fraction from total data in corresponding neurophysiological objects with MF (1949) prevails in works carried out in the whole brain. Such result takes place at calculation of sampling fractions from total number of works with MF (5316). These facts conform to above-mentioned supposition.

Similar effect is among the total number of these works performed in different neurophysiological objects (in the brain - 705259, the cortex - 180602, neurons - 237160, nerves - 278279). Increased sampling fraction from all works in neurophysiological objects was observed in investigations on the cortex too (besides on the whole brain). However it is necessary to note, that relatively small part of the number of investigation on the cortex was 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 MF 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 with MF (%)	Sampling fraction from total data in these objects (%)
1	48.49	17.78	0.13
2	16.83	6.17	0.18
3	7.80	2.86	0.06
4	11.49	4.21	0.08
5	100.00	36.67	0.14

Application: as in table 1.

Results performed in table 3 prove that distinctions between different sampling fractions are statically significant.

Table 3

Comparison of sampling fractions of received data from their sum, from the total number of works with application of MF 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 MF (U)	Comparison of sampling fractions from total data in these objects (U)
1 - 2	19.96	18.97	4.93
1 - 3	28.00	27.38	9.69
1 - 4	24.38	23.56	6.70
2 - 3	8.04	8.40	11.53
2 - 4	4.42	4.59	9.27
3 - 4	3.62	3.82	2.86

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.

 ISSN 1562-9945

Really works carried out in the whole brain and in some cases in the cortex predominate as sampling fraction from total data in corresponding neurophysiological objects with MF.

Table 4

Dynamics of the number of published works carried out in different neurophysiological objects with application of MF 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	5	11	26	80	182	252	389
2	3	2	9	19	52	94	149
3	2	4	3	12	29	44	58
4	0	5	12	14	49	66	78
5	10	22	50	125	312	456	674

Application: as in table 1.

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

The marked increase of the numbers of published works carried out in different neurophysiological objects with application MF always developed during 35-year period (table 4).

Table 5

Dynamics of the sampling fractions (%) of published works carried out in different neurophysiological objects with application of MF 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	50.00	50.00	52.00	64.00	58.33	55.26	57.72
2	30.00	9.09	18.00	15.20	16.67	20.61	22.11
3	20.00	18.18	6.00	9.60	9.29	9.64	8.61
4	0	22.73	24.00	11.20	15.70	14.47	11.57
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 MF

Objects	Indices for different five-years periods						
	1966-70	1971-75	1976-80	1981-85	1986-90	1991-95	1996-2000
1	8.93	8.03	8.97	15.03	19.80	18.74	19.36
2	5.36	1.46	3.10	3.58	5.48	6.99	7.42
3	3.57	2.92	1.03	2.26	3.06	3.27	2.89
4	0	3.65	4.14	2.24	5.16	4.91	3.88
5	17.86	16.06	16.21	23.11	33.50	33.91	33.55

Application: as in table 1.

Table 7

Dynamics of the sampling fractions (%) of published neurophysiological works with application of MF 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	0.01	0.02	0.03	0.08	0.15	0.18	0.25
2	0.02	0.01	0.04	0.08	0.18	0.27	0.37
3	0.03	0.03	0.01	0.04	0.07	0.08	0.09
4	0	0.02	0.04	0.04	0.10	0.11	0.12
5	0.01	0.02	0.03	0.07	0.13	0.15	0.21

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). Kinds 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 MF were unequal too (table 6). The rise of the sampling fractions of works on neuronal level was absent in both situations (tables 5 and 6). However dynamics of all sampling fractions (%) of published neurophysiological works with

 ISSN 1562-9945

application of MF from the total number of works on these objects had similar increase (table 7).

Conclusion

The present bibliometrical investigations makes it possible to analyse quantitative characteristics of published works performed with application of MF 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 was studied.

It was established the following main events.

First, the predominance of investigations of effects of MF on the whole brain existed. Such investigations are suitable for specialists of applied sciences. Works on neuronal level have the slight number.

Secondly, significant increase of the number investigations with application of MF 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 were observed.

Thirdly, obtained information on published works with MF differed from such things with microwaves considered in our previous paper [6]. The number of works with MF had steady increase during 35-year period. The number of works with microwaves had the greatest values in middle of analysed time period, which is conditioned by their extensive employment in this part of period [11].

Though now fundamental investigations of neurophysiological effects of electromagnetic radiation are played no enough attention to, undoubtedly, in the future they will hold a leading position in solution of the problem of biological action of these factors [1, 3, 7, 9].

REFERENCES

1. Chizhenkova R.A. Slow potentials and spike unit activity of the cerebral cortex of rabbits exposed to microwaves // Bioelectromagnetobiology. - 1988. - V. 9. - № 3. - P. 337-345.
2. Chizhenkova R.A. Neuronal activity under microwave exposure // Electromagnetic fields: biological effects and hygienic standardization / Eds.: M.H. Repacholi, N.B. Rubtsova, and A.M. Muc. - Geneva, 1999. - P. 389-395.

3. Chizhenkova R.A. Pulse flows of populations of cortical neurons under microwave exposure of different intensity // Bioelectrochemistry. - 2004, - V. 63. - № 1-2. - P. 343-346.
4. Chizhenkova R.A. Bibliometrical review of neurophysioligical investigation of action of non-ionized radiation in second half of the XXth century // Biophysics. - 2005. - V. 50. - Supplement. - № 1. - P. 163-172.
5. Chizhenkova R.A. Mathematical analysis of bibliometrical indices of neurophysiological investigations of action of electromagnetic fields (Medline-Internet) // Intellectual systems for decision making and problems of computational intelligence. (ISDMCI'2008). - Evpatoria. - 2008. - V. 2. - P. 107-109.
6. Chizhenkova R.A. Mathematical analysis of bibliometrical indices of neurophysiological investigations of action of microwave radiation (Medline-Internet) // Intellectual systems for decision making and problems of computational intelligence. (ISDMCI'2009). - Evpatoria. - 2009. - V. 1. - P. 7-8.
7. Chizhenkova R.A. Pulse flows of populations of cortical neurons under microwave exposure: the number of burst activity // Radiational biology. Radioecology. - 2010. - V. 50. - № 2. - P. 201-210 (in Russian).
8. Chizhenkova R.A., Safroshkina A.A. Effect of low-intensity microwaves on the behavior of cortical neurons // Bioelectrochemistry and Bioenergetics. - 1993. - V. 30. - № 1. - P. 287-391.
9. Chizhenkova R.A., Safroshkina A.A. Electrical reactions of the brain to microwave irradiation // Electro- and Magnetobiology. - 1996. - V. 15. - № 3. - P. 253-258.
10. Chizhenkova R.A., Safroshkina A.A., Slashcheva N.A., Chernukhin V.Yu. Bibliometrical analysis of neurophysiological aspects of action of non-ionized radiation // Uspekhi sovremennoy biologii. - 2004. - V. 124. - № 5. - P. 472-479 (in Russian).
11. Kholodov Yu.A. Reactions of nervous system on electromagnetic fields - Moscow: Nauka, 1975. - 207 p. (in Russian).
12. Merkulova L.M., Kholodov Yu.A. Reactions of excitable tissues of organism on pulsed magnetic fields - Cheboksary: Universitet, 1996. - 174 p. (in Russian).

 ISSN 1562-9945