

ЭКОЛОГИЯ / ECOLOGY

DOI: <https://doi.org/10.23649/JAE.2023.38.6>

OCCUPATIONAL IMPACT ON SOME DIAGNOSTIC INDICES OF WORKERS OF AGRO-INDUSTRIAL COMPLEX

Research article

Boiko O.V.<sup>1,\*</sup>, Dotsenko Y.I.<sup>2</sup>, Mukhamedzyanova R.I.<sup>3</sup>, Kim V.S.<sup>4</sup>, Shiryaeva N.Y.<sup>5</sup>, Tabolina A.V.<sup>6</sup>, Abramova A.A.<sup>7</sup>, Selezneva T.Y.<sup>8</sup>, Avtorkhanova P.M.<sup>9</sup>

<sup>2</sup> ORCID : 0000-0002-6016-7246;

<sup>3</sup> ORCID : 0000-0001-7445-0598;

<sup>4</sup> ORCID : 0000-0002-9153-3800;

<sup>5</sup> ORCID : 0009-0004-9979-314X;

<sup>6</sup> ORCID : 0009-0006-8014-4574;

<sup>7</sup> ORCID : 0000-0002-0629-1529;

<sup>8</sup> ORCID : 0000-0002-8724-1768;

<sup>9</sup> ORCID : 0000-0002-8063-1763;

<sup>1,2,3</sup> Astrakhan State Medical University of the Ministry of Health of Russia, Astrakhan, Russian Federation

<sup>4,5,6,7,8,9</sup> Astrakhan Clinical Hospital of the Southern District Medical Center of the Federal Medical and Biological Agency of Russia, Astrakhan, Russian Federation

\* Corresponding author (ooyko08[at]rambler.ru)

**Abstract**

Existing physical and neuropsychic stress that accompanies professional activity of workers of an agro-industrial complex reduce the functional capacity of the nervous system and leads to a significant change in working capacity. Objective. To study the state of the central nervous system of workers engaged, which is necessary to preserve their professional longevity and quality of life. Materials and methods. Workers were examined with a psychophysiological testing device *UPFT-1/130 Psikhofisiolog*; Anfimov tables were used to test the functional state of their central nervous system. Results. Studies of the functional state of visual and auditory analyzers and a visuomotor reaction, which reflect the general functional state of the CNS during an 8-hour shift, demonstrated no significant changes in the most labile indices of the central nervous system. Conclusion. Applying functional diagnostic methods in the course of preliminary medical examinations while employing a candidate and periodic medical check-ups of workers allows to identify the presence or absence of pathological changes in the CNS.

**Keywords:** central nervous system, workers of agro-industrial complex, analyzers, visuomotor reactions.

ВОЗДЕЙСТВИЕ ПРОФЕССИОНАЛЬНОЙ ДЕЯТЕЛЬНОСТИ НА НЕКОТОРЫЕ ДИАГНОСТИЧЕСКИЕ ПОКАЗАТЕЛИ ОРГАНИЗМА РАБОЧИХ АГРОПРОМЫШЛЕННОГО КОМПЛЕКСА

Научная статья

Бойко О.В.<sup>1,\*</sup>, Доценко Ю.И.<sup>2</sup>, Мухамедзянова Р.И.<sup>3</sup>, Ким В.С.<sup>4</sup>, Ширяева Н.Ю.<sup>5</sup>, Таболина А.В.<sup>6</sup>, Абрамова А.А.<sup>7</sup>, Селезнева Т.Е.<sup>8</sup>, Авторханова П.М.<sup>9</sup>

<sup>2</sup> ORCID : 0000-0002-6016-7246;

<sup>3</sup> ORCID : 0000-0001-7445-0598;

<sup>4</sup> ORCID : 0000-0002-9153-3800;

<sup>5</sup> ORCID : 0009-0004-9979-314X;

<sup>6</sup> ORCID : 0009-0006-8014-4574;

<sup>7</sup> ORCID : 0000-0002-0629-1529;

<sup>8</sup> ORCID : 0000-0002-8724-1768;

<sup>9</sup> ORCID : 0000-0002-8063-1763;

<sup>1,2,3</sup> Астраханский Государственный Медицинский Университет Минздрава России, Астрахань, Российская Федерация

<sup>4,5,6,7,8,9</sup> Астраханская клиническая больница Южного окружного медицинского центра ФМБА России, Астрахань, Российская Федерация

\* Корреспондирующий автор (ooyko08[at]rambler.ru)

**Аннотация**

Существующее физическое и нервно-психическое напряжение в процессе профессиональной деятельности рабочих агропромышленного комплекса снижает функциональную способность нервной системы и ведет к существенному изменению работоспособности. Цель. Изучить состояние центральной нервной системы у рабочих, занятых переработкой природного газа и конденсата, что необходимо для сохранения их профессионального долголетия и качества жизни. Материалы и методы. Для обследования рабочих использовали устройство психофизиологического тестирования УПФТ-1/130 «Психофизиолог», для корректурного теста применяли таблицы Анфимова. Результаты. Исследования функционального состояния зрительного и слухового анализаторов, зрительно-моторной реакции, отражающих общее функциональное состояние ЦНС при 8-часовой смене продемонстрировали отсутствие существенных изменений со стороны наиболее лабильных показателей центральной нервной системы. Вывод. Использование функциональных методов диагностики в ходе предварительных медицинских осмотров при

приеме на работу, а также при проведении периодических медицинских обследований рабочих позволяет идентифицировать наличие, либо отсутствие патологических изменений со стороны ЦНС.

**Ключевые слова:** центральная нервная система, рабочие агропромышленного комплекса, анализаторы, вазомоторные реакции.

### Introduction

It is known that tension in the CNS and centers responsible for autonomic reactions is one of the important links that ultimately form psychosomatic diseases. The existing neuropsychic tension, directly related to the professional activity of workers of the agro-industrial complex, leads to a change in the functional state of their organisms [1], [2], [3], [4], [5]. In this regard, it is necessary to identify maladaptive disorders at the early stage of formation in order to subsequently implement preventive measures [6], [7], [8].

### Research methods and principles

The examination involved workers (operators, machinists) of the agro-industrial complex main and auxiliary facilities. Inclusion criteria: males, 30-40 years old (average age: 36.4±0.4 years). Exclusion criteria: occupational history of extreme conditions (firefighters, EMERCOM rescuers, etc.).

The study group was examined during routine medical check-ups with standard methods of examination, which allowed to describe the state of the body functional systems that are most often and constantly involved in the labor process.

The functional state of visual and auditory analyzers was assessed by the speed of reaction to light and sound stimuli and the critical flicker fusion frequency, for which a psychophysiological testing device *UPFT-1/130 Psikhofisiolog* (Limited Liability Company *Medikom MTD*, Taganrog) was used. The general state of psychophysiological functions was studied with the Anfimov table test. The weighted average skin temperature was measured with the Postnikov and Smoliansky table test.

The studies were carried out during the working day, 3 times in an 8-hour shift: at the end of the first hour, after 4 hours and at the end of the 8th hour during the day and night shifts.

Statistical analysis of the results was performed with Statistica 12 software (StatSoft, USA). The quantitative data distribution was analyzed using the Shapiro-Wilk test. In case of conformity to the normal distribution law, a parametric or nonparametric method of statistical analysis was chosen. In case of normal distribution of quantitative variables, the central tendencies and the spread of characteristics were described using the mean value (M) and mean square deviation (m).

### Main results

The current labor schedule of workers at the agro-industrial complex is the following: employees work 8 hours in the daytime for two days, then they work 8 hours at nighttime for two days as well. After that, four days are given for rest.

The study of CNS functions allowed to determine the degree of fatigue during the working shift. The tables show the results of one brigade (14 people). The results of examination of other brigades do not have statistically reliable differences with the former. The functional state of the CNS during a working shift was examined with the Landolt ring test (Table 1). Such parameters as the time required to perform the test, the test performance velocity, and the rate of errors made by an examined worker were determined in the course of the study.

Table 1 - Changes in the CNS state during a 8-hour shift according to the Landolt ring test

DOI: <https://doi.org/10.23649/JAE.2023.38.6.1>

No.	Start of shift			Mid shift			End of shift			V <sub>1</sub> - V	V <sub>2</sub> - V	T <sub>1</sub> - T	T <sub>2</sub> - T	ER <sub>1</sub> - ER	ER <sub>2</sub> - ER
	V	T	ER	V <sub>1</sub>	T <sub>1</sub>	ER <sub>1</sub>	V <sub>2</sub>	T <sub>2</sub>	ER <sub>2</sub>						
1.	236	68	0	250	62	1	250	65	2	-14	-14	-6	-3	1	2
2.	218	67	1	208	70	0	208	78	1	10	10	3	11	-1	0
3.	250	45	4	234	68	2	200	78	2	16	50	23	33	-2	-2
4.	124	87	0	124	69	0	120	89	1	0	4	2	2	0	1
5.	224	68	1	200	70	1	192	78	2	24	32	2	10	0	1
6.	250	67	2	240	73	1	235	80	2	10	15	6	13	-1	0
7.	222	85	0	220	87	0	208	87	0	2	14	2	2	0	0
8.	216	72	0	210	80	1	200	72	0	0	10	-2	0	1	0
9.	250	145	0	228	145	0	230	150	1	22	20	0	5	0	1
10.	169	90	0	165	87	1	160	87	2	4	9	-3	-3	1	0
11.	120	165	0	80	185	1	100	165	0	40	20	20	0	1	0
12.	159	100	1	150	102	1	150	105	2	9	9	2	5	0	1
13.	176	90	0	170	92	0	168	92	1	6	8	2	2	0	1
14.	256	65	0	250	62	1	236	68	1	6	20	-3	3	1	1
TOTAL:										135	207	48.	80.	1.0	8.0
M±m										9.6	17.	3.4	5.7	0.0	0.5

	4±3 .46	7±3 .86	2± 2.2	± 2.4 7	7±0 .24	7± 0.2 3
P	<0. 05	<0. 05	>0. 05	<0. 05	>0. 05	<0. 05

Note: *V* is the test performance velocity, *T* is the test performance time, *ER* is the error rate

The physiological results of the testing show that during the 3-time study, fatigue was recorded mainly at the end of the working shift, and in case of working in the night shift – partially in the mid-shift testing too.

Evaluation of a visuomotor reaction (Table 2) did not reveal reliable differences. The CNS state restored while the workers were resting between shifts. This conclusion is based on the fact that in repeated studies, the indices always corresponded to the ones of the start of the shift.

Table 2 - Changes in a visuomotor reaction during a 8-hour shift

DOI: <https://doi.org/10.23649/JAE.2023.38.6.2>

No.	Latent Period			MS-SOS	EOS-SOS	Error rate			MS-SOS	EOS-SOS
	SOS	MS	EOS			SOS	MS	EOS		
1.	443	400	501	-43	8	0	0	1	0	1
2.	331	328	330	-2	-3	0	1	0	1	0
3.	450	400	466	-50	16	1	1	1	0	0
4.	296	300	383	4	87	0	0	1	0	1
5.	278	300	301	22	23	0	1	0	1	0
6.	432	400	398	-32	34	0	0	2	0	2
7.	482	500	465	18	-17	1	0	0	-1	-1
8.	329	300	265	-28	-64	0	1	0	1	0
9.	414	450	490	36	76	1	1	2	0	1
10.	580	559	570	-21	-10	0	0	0	0	0
11.	326	330	364	4	38	1	0	1	-1	0
12.	501	510	510	9	9	0	0	0	0	0
13.	329	330	340	1	11	0	1	0	1	0
14.	466	430	446	-36	-20	1	0	1	-1	0
TOTAL:				-19	120	-	-	-	1.0	4.0
M±m				- 1.35±7 .47	8.57±1 0.7	-	-	-	0.07±0 .19	0.28±0 .19
P				>0.05	>0.05	-	-	-	>0.05	>0.05

*V* is the test performance velocity, *T* is the test performance time, *ER* is the error rate.

An intensifying excitatory process in the nervous system has a certain effect on thermoregulation in various forms of labor. Our studies of the weighted average skin temperature revealed a certain dependence during an 8-hour shift: changes in the skin temperature between the start and the end of the shift (Table 3, 4) were found statistically reliable ( $P < 0.05$ ).

Table 3 - Changes in the workers' weighted average skin temperature during an 8-hour shift

DOI: <https://doi.org/10.23649/JAE.2023.38.6.3>

No.	Forehead skin		Palmar surface of finger		Dorsum of finger		Dorsum of hand	
	MS-SOS	EOS-SOS	MS-SOS	EOS-SOS	MS-SOS	EOS-SOS	MS-SOS	EOS-SOS
1.	0.2	-0.4	2.2	1.4	1.1	1.0	1.2	1.6
2.	0	-0.2	-3.0	0.8	-0.7	0.5	-3.4	1.2
3.	0.6	0.1	-0.9	0.7	0.2	0.9	2.0	2.5
4.	0.1	0.4	0.5	0.3	0.6	1.0	2.1	0.4

5.	0.7	1.2	0	-0.2	-0.5	-1.9	-0.6	-0.4
6.	2.7	2.4	2.4	8.4	1.3	0.2	1.1	2.7
7.	-1.4	-0.8	0.8	1.4	0.2	1.5	1.0	1.4
8.	1.8	1.1	1.0	1.4	2.5	2.7	0.9	1.3
9.	-0.4	0	7.3	0.1	4.4	3.7	2.0	0.6
10.	-0.1	0.1	-0.2	0.2	-1.7	0.9	-0.9	0.1
11.	0.5	0.1	1.0	2.4	2.0	2.0	0.1	1.0
12.	0.5	0.3	6.1	4.2	3.6	4.5	4.7	3.5
13.	0	-0.1	8.7	4.4	7.5	4.2	6.4	1.8
14.	-0.6	0	-1.6	0.8	-0.5	0.2	-1.6	-0.2
Total:	4.5	4.2	24.3	41.9	16.0	26.4	15.9	27.5
M±m	0.32±0.2 6	0.3±0.21	1.73±0.9	2.99±0.9 4	1.14±0.7 7	1.88±0.5 7	1.13±0.6 4	1.96±0.7 5
P	>0.05	>0.05	>0.05	<0.05	>0.05	<0.01	>0.05	<0.05

Note: SOS is the start of shift, MS is the mid shift, EOS is the end of shift (EOS-SOS is the skin temperature difference)

Table 4 - Workers' weighted average skin temperature during an 8-hour shift

DOI: <https://doi.org/10.23649/JAE.2023.38.6.4>

Measurement point	Number of examined workers	Start of shift	Mid shift	End of shift
		M±m	M±m	M±m
Forehead skin	14	33.60±0.18	33.91±0.18	34.0±0.11
Palmar surface of finger	14	30.85±0.88	32.47±0.76	37.05±0.33
Dorsum of finger	14	30.28±0.83	31.72±0.53	32.24±0.41
Dorsum of hand	14	31.02±0.46	31.95±0.33	32.22±0.30

### Discussion

The level of functional capacity of the central and autonomic nervous systems is the biological foundation of important qualities of a professional activity, which influence this activity and are important for its performance. If the production environment is good, it is difficult to discover a relationship between the employees' health and the existing working conditions at the enterprise. At the same time, the lability of CNS indices and a subsequent increase in the level of non-occupational pathology can be regarded as stages of latent, slowly developing changes in workers' organisms. The absence of significant disorders of the central nervous system in the agro-industrial complex workers demonstrates their high professional training and good adaptation to production conditions.

### Conclusion

Applying adequate methods of functional diagnostics allows to reveal pre-pathological changes in the human body or to establish their absence, which is necessary for timely preventive measures, and can also be used in the course of preliminary medical examinations when hiring potential employees.

### Конфликт интересов

Не указан.

### Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

### Conflict of Interest

None declared.

### Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

### Список литературы / References

1. Kryuchkova E.N. Influence of Factors of Electroplating Production on the Immunoreactivity of the Body of Workers / E.N. Kryuchkova, L.I. Antoshina, A.V. Sukhova [et al.] // Hygiene and Sanitation. — 2021. — 100(9):959-963. — DOI: 10.47470/0016-9900-2021-100-9-959-963.
2. Dotsenko Yu.I. Indicators of Immunity in Workers Engaged in the Processing of Natural Gas and Condensate / Yu.I. Dotsenko, O.V. Boiko // Hygiene and Sanitation. — 2023. — 102(1):55-62. — DOI: 10.47470/0016-9900-2023-102-1-55-62

3. Sean M. Lawson. Azman Prevalence of Hearing Loss among Noise-exposed Workers within the Mining and Oil and Gas Extraction Sectors, 2006-2015 / Lawson Sean M., Elizabeth A. Masterson [et al.] // *Am J Ind Med.* — 2019 Oct;62(10):826-837. — DOI: 10.1002/ajim.23031.
4. Лазарев Н.В. Вредные вещества в промышленности. Справочник для химиков, инженеров и врачей / Под ред. Н. В. Лазарева и Э.Н. Левиной // *Органические вещества: в 3 томах.* — Л., Химия, 1976.
5. Heinzerling A. Risk Factors for Occupational Heat-related Illness among California Workers, 2000-2017 / Amy Heinzerling, Rebecca L. Laws, Matt Frederick [et al.] // *Am J Ind Med.* — 2020 Dec;63(12):1145-1154. — DOI: 10.1002/ajim.23191.
6. Boiko O.V. Long-term Immunity Alterations in the Employees of the High Hydrogen Sulfide Content Gas Condensate Processing Facility / O.V. Boiko, Yu.I. Dotsenko // *Extreme Medicine.* — April 23, 2021: 23-28. — DOI: 10.47183/mes.2021.041
7. Uyba V.V. Industrial Medicine: Its Role and Development Prospects in the FMBA System of Russia / V.V. Uyba, B.I. Laver, V.N. Kulyga // *Medicine of Extreme Situations.* — 2019; 21(2): 261-267.
8. Kurl'yand'sky B. A. Strategic Approaches to Ensuring the Safety of Production and Use of Chemicals for Human Health / B. A. Kurl'yand'sky // *Russian Chemical Journal.* — 2004;58(2):8-15.
9. Boiko O.V. Age-related Changes in Immunological, Morphological and Biochemical Indices of Male Reproductive System / O.V. Boiko, A.Kh. Akhmineeva, N.I. Gudinskaya // *Advances in Gerontology.* — 2014. — 27(1):50-53
10. Sean M. Lawson. Prevalence of Hearing Loss among Noise-exposed Workers within the Mining and Oil and Gas Extraction Sectors, 2006-2015 / Sean M. Lawson, Elizabeth A. Masterson, Amanda S. Azman // *Am J Ind Med.* — 2019 Oct;62(10):826-837. — DOI: 10.1002/ajim.23031.
11. Boyko V.I. Occupational Hygiene and Health of Workers Employed in the Processing of Natural Gas / V.I. Boyko, Yu.I. Dotsenko, O.V. Boyko [et al.] // *Gigiena i Sanitaria [Hygiene and Sanitation, Russian Journal].* — 2017. — 96(6): 541-8. — DOI: 10.18821/0016-9900-2017-96-6-541-548
12. Chirkin A.A. Diagnostic Handbook of Therapist / A.A. Chirkin, A.N. Okorokov, I.I. Goncharik. — Minsk: "Belarus" Publishing, 1992.

#### **Список литературы на английском языке / References in English**

1. Kryuchkova E.N. Influence of Factors of Electroplating Production on the Immunoreactivity of the Body of Workers / E.N. Kryuchkova, L.I. Antoshina, A.V. Sukhova [et al.] // *Hygiene and Sanitation.* — 2021. — 100(9):959-963. — DOI: 10.47470/0016-9900-2021-100-9-959-963.
2. Dotsenko Yu.I. Indicators of Immunity in Workers Engaged in the Processing of Natural Gas and Condensate / Yu.I. Dotsenko, O.V. Boiko // *Hygiene and Sanitation.* — 2023. — 102(1):55-62. — DOI: 10.47470/0016-9900-2023-102-1-55-62
3. Sean M. Lawson. Azman Prevalence of Hearing Loss among Noise-exposed Workers within the Mining and Oil and Gas Extraction Sectors, 2006-2015 / Lawson Sean M., Elizabeth A. Masterson [et al.] // *Am J Ind Med.* — 2019 Oct;62(10):826-837. — DOI: 10.1002/ajim.23031.
4. Lazarev N.V. Vrednye veshchestva v promyshlennosti. Spravochnik dlya himikov, inzhenerov i vrachej [Harmful Substances in Industry. Handbook for chemists, engineers and doctors] / ed. by N.V. Lazarev, E.N. Levina // *Organicheskie veshchestva [Organic Substances]: in 3 vol.* — L.: Chemistry, 1976 [in Russian].
5. Heinzerling A. Risk Factors for Occupational Heat-related Illness among California Workers, 2000-2017 / Amy Heinzerling, Rebecca L. Laws, Matt Frederick [et al.] // *Am J Ind Med.* — 2020 Dec;63(12):1145-1154. — DOI: 10.1002/ajim.23191.
6. Boiko O.V. Long-term Immunity Alterations in the Employees of the High Hydrogen Sulfide Content Gas Condensate Processing Facility / O.V. Boiko, Yu.I. Dotsenko // *Extreme Medicine.* — April 23, 2021: 23-28. — DOI: 10.47183/mes.2021.041
7. Uyba V.V. Industrial Medicine: Its Role and Development Prospects in the FMBA System of Russia / V.V. Uyba, B.I. Laver, V.N. Kulyga // *Medicine of Extreme Situations.* — 2019; 21(2): 261-267.
8. Kurl'yand'sky B. A. Strategic Approaches to Ensuring the Safety of Production and Use of Chemicals for Human Health / B. A. Kurl'yand'sky // *Russian Chemical Journal.* — 2004;58(2):8-15.
9. Boiko O.V. Age-related Changes in Immunological, Morphological and Biochemical Indices of Male Reproductive System / O.V. Boiko, A.Kh. Akhmineeva, N.I. Gudinskaya // *Advances in Gerontology.* — 2014. — 27(1):50-53
10. Sean M. Lawson. Prevalence of Hearing Loss among Noise-exposed Workers within the Mining and Oil and Gas Extraction Sectors, 2006-2015 / Sean M. Lawson, Elizabeth A. Masterson, Amanda S. Azman // *Am J Ind Med.* — 2019 Oct;62(10):826-837. — DOI: 10.1002/ajim.23031.
11. Boyko V.I. Occupational Hygiene and Health of Workers Employed in the Processing of Natural Gas / V.I. Boyko, Yu.I. Dotsenko, O.V. Boyko [et al.] // *Gigiena i Sanitaria [Hygiene and Sanitation, Russian Journal].* — 2017. — 96(6): 541-8. — DOI: 10.18821/0016-9900-2017-96-6-541-548
12. Chirkin A.A. Diagnostic Handbook of Therapist / A.A. Chirkin, A.N. Okorokov, I.I. Goncharik. — Minsk: "Belarus" Publishing, 1992.