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REMOTE CONSEQUENCES OF PESTICIDE POLLUTION ON THE LEVEL OF DEVELOPMENT OF COGNITIVE FUNCTIONS

Abstract. The purpose of this study is to identify the characteristics of the state of short-term memory, sustainability and concentration of attention among rural residents living in places of long-term pesticidal pollution. The study of cognitive functions in residents was performed using the special Neurosoft computer base program. A significant decrease (by 20%) in the number of people with a high level of development of short-term memory by numbers and images was revealed. An increase of 18% in the number of people with poorly developed cognitive abilities is shown both when remembering information on numbers and images, as well as when concentration and stability of attention is on the desired object. At the same time, the memory capacity of residents with a high level of development of the function of memorizing information, both for numbers and images, was at the same level as the benchmarks and ranged from 61% to 67% of the amount of information proposed for memorization. The study showed that living in a zone of long-term pesticidal pollution worsens cognitive functions - memory and attention, upsets the balance of the main nervous processes - excitation and inhibition, and increases the risk of developing nervous disorders.

Keywords: pesticides, pollution, living environment, human health, cognitive functions.

Introduction. Most pesticides used are to varying degrees toxic to humans and warm-blooded animals. Pesticides accumulate in the liver, kidneys and heart, bind to blood proteins and are carried throughout the body, metabolized and excreted at different rates from the body. Many studies have shown that pesticides have a mutagenic, carcinogenic and toxic effect, directly or indirectly inhibiting the nervous system of a living organism [1,2]. Pesticide metabolites have the ability to accumulate, especially in the adipose tissue of a living organism and slowly destroy the cells of the mucous membranes, tissues, organs, disrupting the interaction and functions of internal organs. As a result, the level of public health is falling, the incidence of blood, digestive organs, mental and endocrine disorders, as well as cancer pathologies is growing [3-5].

On the territory of Kazakhstan, there is the problem of the disposal of obsolete and disposable pesticides widely used in the Union, in particular, dust - DDT. According to various estimates, pesticides belonging to the group of persistent organic pollutants (POPs pesticides), mainly DDT, make up 10-15% of all stored obsolete pesticides. The potential and real environmental and toxicological hazard of such pesticides remains quite high [6]. Directly on the territory of the Talgar region near the city of Almaty, the population of which we examined, pollution of abandoned storage facilities with organochlorine pesticides (metabolites 2,4 DDD, 4,4 DDT, 4,4 DDE and isomers of α -HCH, β -HCH and γ -HCH), the concentrations of which are significantly higher than the MPC, the presence of obsolete and unusable pesticides in warehouses was revealed [7]. It should also be taken into account that the territory adjacent to the storage sites of unused pesticides has a high level of pollution and has long been a source of secondary environmental pollution with pesticides [8].

The purpose of this study is to identify the characteristics of the state of short-term memory, sustainability and concentration of attention among rural residents living in places of long-term pesticidal pollution.

Object and research methods. The control group consisted of 102 residents of 2 villages of the Almaty region located in and near the Altyn Emel nature reserve. This is 54 residents. Basshee and 48 inhabitants with. Taukaraturyk of Almaty region. The experimental group included 149 residents aged 20 to 70 years, living the last 10 years on the ground or in the immediate vicinity of the former pesticidal storage facilities and warehouses of the Almaty region (date from 2018 and 2019). These are residents from. Beskainar (44 people), Kyzylkairat (41 people), Belbulak (43 people) and s. Amangeldy (21 people - brigade 1 and 2).

To identify the state of cognitive functions, the amount of short-term memory was determined by numbers, images, stability and concentration. At the same time, the number of correct answers, the number of errors, the search time for numbers or an image, the amount of memory, as well as the accuracy of reproduction were taken into account. Depending on the accuracy of the responses, a high, medium, and low level of reproduction was determined. For this, tests were used according to the basic program of a computer complex for psychophysiological testing NS-PsychoTest Neurosoft LLC Russia, 2012 [9, 10].

The results were statistically processed using the Microsoft Excel program, while M is the arithmetic mean, SD is the standard deviation, m is the standard error of the arithmetic mean. Data processing was carried out taking into account the unpaired Fisher-Student test and was considered reliable at $p \leq 0.05$.

In human studies, they were guided by the decision of the LEC of the Kazakh-Russian Medical University (KRMU), protocol No. 52 of September 5, 2017.

Research results. Cognitive functions are the most complex functions of the brain, which include memory, attention, reaction speed, the ability to assimilate and preserve skills [11]. In chronic pesticide poisoning in humans, various functional and dynamic cognitive impairment is often noted - a decrease in memory, instability of attention, and a low reaction rate [4, 5]. A study of the cognitive sphere of the brain activity of residents of rural settlements living in places especially contaminated with pesticides showed the following.

Control group. In the test “Memory for numbers”, more than half (55.61%) of the respondents showed a high level of reproduction of numbers with memorization of 62.55% of numerical information. In the test “Memory for images”, more than 51.80% of respondents showed a high level of reproduction of images in short-term memory and memorized 70.40% of information in the form of images (figure 1, 2). **Introduction** Most pesticides used are to varying degrees toxic to humans and warm-blooded animals. Pesticides accumulate in the liver, kidneys and heart, bind to blood proteins and are carried throughout the body, metabolized and excreted at different rates from the body. Many studies have shown that pesticides have a mutagenic, carcinogenic and toxic effect, directly or indirectly inhibiting the nervous system of a living organism [1,2]. Pesticide metabolites have the ability to accumulate, especially in the adipose tissue of a living organism and slowly destroy the cells of the mucous membranes, tissues, organs, disrupting the interaction and functions of internal organs. As a result, the level of public health is falling, the incidence of blood, digestive organs, mental and endocrine disorders, as well as cancer pathologies is growing [3-5].

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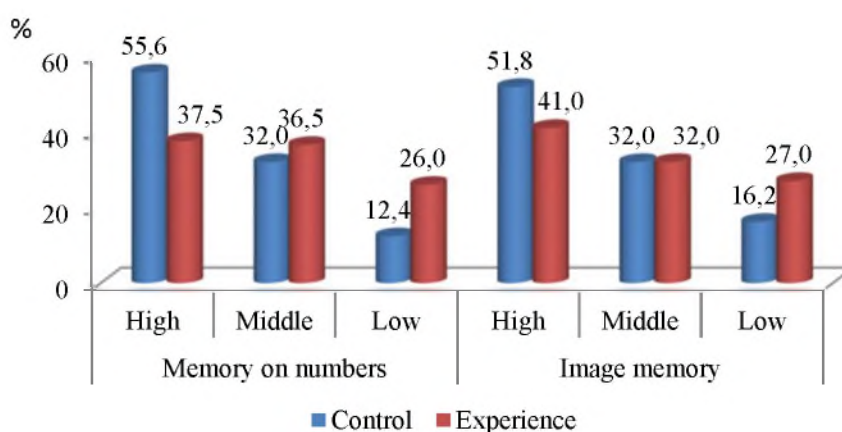


Figure 1 - The number of respondents in the control and experimental groups (%) with different levels of development of short-term memory

More than a third of participants (35-36%) showed an average level of memorization of information - the amount of memorization of numerical information ranged from 42.10%, images - 39.6%. The remaining respondents (28%) when memorizing both numerical and figurative information showed a minimum level of memorizing information, ranging from 18 to 20% (figure 2).

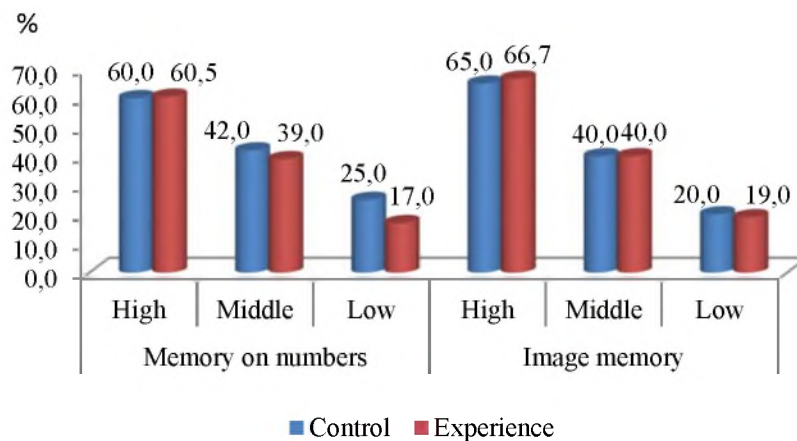


Figure 2 - The volume of memorized information (%) among the respondents in the control and experimental groups in the tests “Memory for numbers” and “Memory for images”

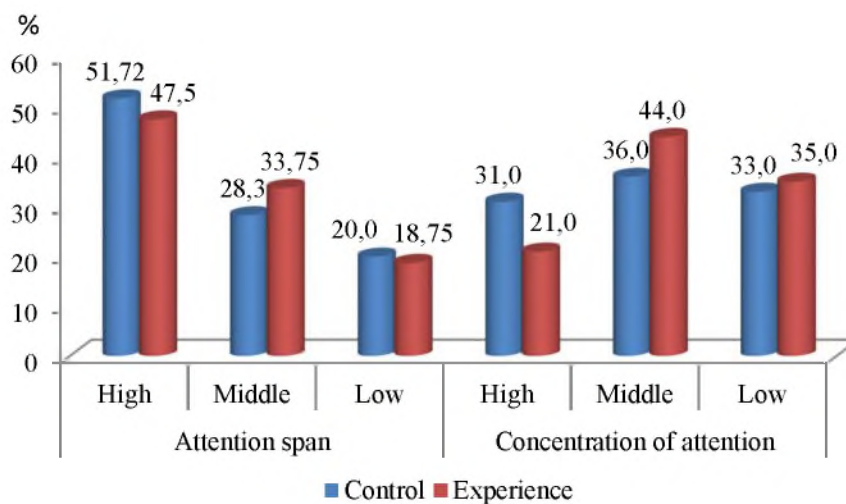


Figure 3 - Stability and concentration of attention (%) among respondents in the control and experimental groups in the test “Attention Assessment”

Experienced group. The number of test participants with a high level of memory development for numbers and images amounted to 37.50% of the total number (figure 1). The amount of information they memorized was 60.54% for numbers and 66.77% for images (figure 2). The number of people with an average level of development of short-term memory ranged from 34 to 35% - for numbers and images, with a memory volume of 30 to 40% of the total amount of information. The remaining respondents, comprising from 28 to 29% of the total number of respondents in the experimental group, showed a low level of memory development both in numbers and in remembering images. Moreover, the amount of information they memorized ranged from 17% to 19% (figure 1.2).

A comparative assessment of the state of cognitive functions among participants in the experimental and control groups showed that the number of people with a high level of information reproduction on numbers and images living in places of pesticidal pollution is significantly (20%) less than in the control group. Nevertheless, the amount of memorized information in people with a high level of memory development was at the same level in both the experimental and control groups. Accordingly, the number of people with a low level of memory development in the experimental group was significantly larger compared to the control data. At the same time, the volume of memorized information in both groups did not exceed 20% level.

An objective assessment of attention as one of the main characteristics of a person's cognitive functions includes the state of concentration (concentration) and absent-mindedness, mobility, and stability of this reaction when presenting various kinds of objects, which plays a leading role in human life [12]. A high level of attention stability was shown by more than half (51.72%) of the residents of the control group, but only 31% showed the ability to concentrate, the rest of the subjects were divided between medium (from 30% to 36%) and low (from 20 to 33%) , respectively, stability and concentration (figure 3).

In the experimental group of respondents with a high level of attention stability, less than half of the participants (47.5%) were identified, and only 21% of the total number were able to concentrate. The remaining respondents were distributed at an average level (from 33 to 43% of participants) and at a low level, their number was from 18.75% in terms of attention stability and 35% in terms of concentration. As can be seen from the data presented, the number of respondents from the experimental group with a high level of stability and concentration of attention is 10% less than in the control group. The number of people with a low level of ability to concentrate and sustain attention in the experimental group reaches 35% of the total number examined, the number of respondents with an average level of 44% and above.

The results of a study of the main cognitive functions of rural residents living in places of non-utilized pesticidal storages and depots showed that the number of people with a high level of development of short-term memory is 20% less, while with a low level of information storage, it is 18% more than in the control population. At the same time, the memory capacity of respondents with a high level of development of the function of memorizing information, both for numbers and images, was at the same level as the control data (from 61% to 67%). When assessing attention as one of the main indicators of cognitive functions, a decrease of 5% and 10% in the number of persons in the experimental group with highly developed ability to concentrate and sustain attention was revealed, compared with the data in the control group. Both memory and attention assessment showed a decrease in the number of individuals with a high level of development of cognitive functions living in places of pesticidal pollution. An increase in the number of persons with poorly developed opportunities for memorization, concentration and stability of attention, reflecting the main properties of the nervous system - excitation and inhibition in the central nervous system, was also noted.

Human health is a reliable indicator of the ecological well-being of the environment. With pesticidal contamination, prerequisites appear for increasing the incidence of, primarily, the respiratory system and disorders of the nervous system, directly cognitive functions [13]. Recent studies show the negative impact of pesticidal pollution on the nervous system, are characterized by a neurotoxic and psychotropic effect caused by direct or indirect effects on M- or N-cholinergic receptors, which leads to an increase in diseases in children with attention deficit hyperactivity disorder [14].

On the territory of the Talgar district of the Almaty region to date, there are 64 destroyed storages of insecticides and herbicides, the metabolic products of which regularly pollute the environment, accumulate in vegetables and fruits, water and plants serving as animal feed [15]. Long-term residence in these places led to an increase in the number of people (up to 30%) with a low level of development of memory and attention, the amount of memorization of information which does not exceed 1/5 of the proposed level.

Conclusion: Living in a zone of perennial pesticidal pollution is one of the factors that worsen cognitive functions - memory and attention, upsets the balance of the main nervous processes – excitation and inhibition, and increases the risk of developing nervous disorders.

The study was carried out as part of the implementation of the scientific and technical program No. BR05236379 "Comprehensive assessment of the impact of unused and prohibited pesticides on the genetic status and health of the population of Almaty region."

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ПЕСТИЦИДТІК ЛАСТАНУДЫҢ ТАНЫМДЫҚ ФУНКЦИЯЛАРДЫҢ ДАМУ ДЕҢГЕЙІНЕ ҰЗАҚМЕРЗІМДІ ӘСЕРІ

Аннотация. Зерттеудің мақсаты – ұзақмерзімді пестицидтермен ластанған жерде тұратын ауыл тұрғындарының қысқамерзімді есте сақтау күйінің, тұрақтылығы мен назарының шоғырлануын анықтау. Резиденттердегі танымдық функцияларды зерттеу арнайы Neurosoft компьютерлік база бағдарламасы арқылы жүргізілді. Сан мен суреттер бойынша қысқамерзімді есте сақтау қабілеті жоғары адамдардың айтарлықтай төмендегені (20%-ға) байқалды. Танымдық қабілеті нашар дамыған адамдардың 18%-ға артуы сан мен суреттер туралы ақпаратты есте сақтау кезінде де, зейіннің шоғырлануы мен тұрақтылығы барысында да байқалады. Сонымен қатар, сан мен суреттер бойынша да ақпаратты сақтау функциясының даму деңгейі тұрғындардың жоғары есте сақтау қабілеті көрсеткіштерімен деңгейлес және сақтау үшін ұсынылған ақпарат көлемі 61%-дан 67%-ға дейінгі аралықты көрсетті. Зерттеу көрсеткендей, ұзақмерзімді пестицидтік ластану аймағында өмір сүру танымдық функцияларды – есте сақтау мен назарды шоғырландыру жағдайын нашарлатады, негізгі жүйке үдерістерінің – қозу мен тежелудің тепе-теңдігін бұзады, жүйке бұзылыстарының даму қаупін арттырады.

Пайдаланылатын пестицидтердің көпшілігі әртүрлі дәрежеде адамдарға және жылықанды жануарларға улы болып келеді. Пестицидтер бауырда, бүйректе және жүректе жинақталады, қан протеиндерімен байланысады және бүкіл денеде жүреді, әртүрлі мөлшерде метаболизденеді және организмнен шығарылады. Көптеген зерттеулер пестицидтер тірі организмнің жүйке жүйесін тікелей немесе жанама түрде төмендететін мутагендік, канцерогендік және уытты әсерге ие екендігін көрсетті. Пестицид метаболиттері, әсіресе тірі ағзаның жабысқақ тінінде жиналып, шырышты қабықтардың, ұпалардың, ағзалардың жасушаларын баяу бұзады, ішкі ағзалардың өзара әрекеті мен функцияларын бұзады. Нәтижесінде халықтың денсаулығының деңгейі төмендейді, қанның, ас қорыту органдарының, психикалық және эндокриндік аурулардың, сондай-ақ онкологиялық патология төмендейді.

Қазақстан аумағында Одақта кеңінен қолданылатын ескірген және жойылатын пестицидтерді көму мәселесі кездеседі, атап айтқанда, тозақ – ДДТ. Түрлі бағалауға сәйкес, тұрақты органикалық ластағыштар тобына жататын пестицидтер (ТОЛ (тұрақты органикалық ластағыш) пестицидтер), негізінен ДДТ, барлық ескірген пестицидтердің 10-15% құрайды. Мұндай пестицидтердің ықтимал және нақты экологиялық және токсикологиялық қауіптілігі айтарлықтай жоғары. Біз қарастырған Алматы қаласы маңындағы Талғар ауданының аумағында, қараусыз қалған қоймалар органохлорлы пестицидтермен (метаболиттер 2,4 ДДД, 4,4 ДДТ, 4,4 ДДЕ және α -ГХЦП, β -ГХЦП және γ -ГХЦП изомерлерімен) ластанғаны анықталды, концентрациясы ШПК-ден едәуір асатын, қоймаларда ескірген және пайдалануға жарамсыз пестицидтердің болатыны анықталды. Пайдаланылмаған пестицидтер сақталатын қоймаға жақын орналасқан аумақтың ластану деңгейі жоғары және ұзақ уақыт қоршаған ортаны пестицидтермен ластанудың көзі болып саналады.

Түйін сөздер: пестицидтер, ластану, қоршаған орта, адам денсаулығы, таным қызметі.

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ОТДАЛЕННЫЕ ПОСЛЕДСТВИЯ ПЕСТИЦИДНОГО ЗАГРЯЗНЕНИЯ НА УРОВЕНЬ РАЗВИТИЯ КОГНИТИВНЫХ ФУНКЦИЙ

Аннотация. Цель данного исследования – выявить особенности состояния краткосрочной памяти, устойчивости и концентрации внимания у жителей сельской местности, проживающих в местах многолетнего пестицидного загрязнения. Исследование когнитивных функций у жителей проводили с использованием специальной компьютерной базовой программы «Нейрософт». Выявлено значительное уменьшение (на 20%) числа людей с высоким уровнем развития краткосрочной памяти на числа и образы. Показан рост на 18% числа людей со слаборазвитыми когнитивными способностями как при запоминании информации на числа и образы, а также при концентрации и устойчивости внимания на требуемом объекте. При этом объем памяти у жителей с высоким уровнем развития функции запоминания информации как на числа, так и на образы был на одном уровне с контрольными показателями и составлял от 61% до 67% от объема предлагаемой к запоминанию информации. Исследование показало, что проживание человека в зоне многолетнего пестицидного загрязнения ухудшает когнитивные функции – память и внимание, нарушает баланс основных нервных процессов – возбуждения и торможения, увеличивает риск развития нервных расстройств.

Большинство применяемых пестицидов в разной степени токсично для человека и теплокровных животных. Пестициды накапливаются в печени, почках и сердце, связываются с белками крови и разносятся по организму, подвергаются метаболизму и выводятся с разной скоростью из организма. Во многих исследованиях показано, что пестициды обладают мутагенным, канцерогенным и токсическим эффектом, прямо или косвенно угнетают нервную систему живого организма. Метаболиты пестицидов обладают свойством накапливаться, особенно в жировой ткани живого организма и медленно разрушают клетки слизистых оболочек, ткани, органы, нарушая взаимодействие и функции внутренних органов. В результате этого падает уровень здоровья населения, растет заболеваемость крови, органов пищеварения, психических и эндокринных расстройств, а также онкологических патологий.

На территории Казахстана существует проблема захоронения устаревших и подлежащих утилизации ядохимикатов, широко применяемых при Союзе, в частности дуста – ДДТ. По различным оценкам, пестициды, относящиеся к группе стойких органических загрязнителей (СОЗ-пестициды), преимущественно ДДТ, составляют 10-15 % от всех хранящихся устаревших пестицидов. Потенциальная и реальная эколого-токсикологическая опасность таких пестицидов остается достаточно высокой. Непосредственно на территории Талгарского района близ г. Алматы, население которого было нами обследовано, установлено загрязнение заброшенных хранилищ хлорорганическими пестицидами (метаболитами 2,4 ДДД, 4,4 ДДТ, 4,4 ДДЭ и изомерами α -ГХЦГ, β -ГХЦГ и γ -ГХЦГ), концентрации которых значительно превышают ПДК, на складах выявлено наличие устаревших и непригодных к применению пестицидов. Необходимо также учитывать, что территория, прилегающая к местам складирования неиспользованных пестицидов, имеет высокий уровень загрязнения и долгое время служит источником вторичного загрязнения окружающей среды пестицидами.

Ключевые слова: пестициды, загрязнение, среда проживания, здоровье человека, когнитивные функции.

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