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PATHOGENETIC BACKGROUND OF PHYSICAL ACTIVITY INCREASE REASONABILITY IN OLDER ADULTS WITH NEUROTIC DISORDERS

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The purpose of the study was to investigate the impact of pathogenetically determined measures of physical activity increase on the habilitation of motor functions and the psychosomatic state of older adults with neurotic disorders. 35 patients aged 63–75 years with neurotic disorders due to brain degenerative-dystrophic damage were included in a comprehensive dynamic examination. 18 people had Parkinson's disease and 17 patients had manifestations of psychomotor disorders in the late post-stroke period. The selected cohort underwent a thorough dynamic examination, including a valid evaluation of psychosomatic dysfunction and the degree of motor deficit. A complex diagnostic examination was performed before and after the targeted physical habilitation measures were used. Physical activity exercises were performed individually not less than 6 times per week and 2–3 times per day depending on the person's well-being. The data obtained indicate a significant improvement in motor qualities and motor activity in older adults with neurological disorders according to all used psychomotor indexes. These results also highlight positive change dynamics, including normalization and restoration of the psychosomatic state of the examined older adult patients with psychoneurotic disorders as a result of implementing physical habilitation measures, characterized by improved self-care and performance of various operational activities. Motor dysfunction was evident elimination in older adults with neurotic disorders, as well as the expressed improvement of psychomotor skills and the restoration of the ability to conditioned reflex activity after a complex of rehabilitative physical influence, indicating a systemic sanogenetic effect on physical muscle activity. The authors consider it reasonable to recommend the implementation of the developed physical habilitation techniques for older adults patients with neurotic disorders, as well as for military personnel and civilians with post-traumatic stress disorders, into the daily practice of specialized rehabilitation centers, which will contribute to their self-service status improvement and the performance of various types of operational activities as a result of their fine motor skills and psychosomatic state restoration.

Key words: physical rehabilitation, neurotic disorders, motor deficit, psychosomatic disorders, physical exercises, pathophysiological mechanisms, sanogenetic mechanisms.

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ПАТОГЕНЕТИЧНЕ ОБҐРУНТУВАННЯ ДОЦІЛЬНОСТІ АКТИВАЦІЇ ФІЗИЧНОЇ АКТИВНОСТІ В ОСІБ ПОХИЛОГО ВІКУ З НЕВРОТИЧНИМИ РОЗЛАДАМИ

Метою дослідження було визначення реабілітаційного впливу патогенетично зумовлених заходів активізації фізичної активності на рухові функції та психосоматичний стан осіб похилого віку з невротичними розладами. Комплексному динамічному обстеженню підлягали 35 хворих віком 63–75 років з невротичними розладами внаслідок дегенеративно-дистрофічного ураження мозку. 18 осіб з них мали хворобу Паркінсона; 17 пацієнтів мали прояви психомоторних порушень у пізньому постінсультному періоді. Обраний контингент підлягав динамічному обстеженню, яке включало валідну оцінку психосоматичних дисфункцій і ступеня дефіцитарності рухових якостей. Комплексне діагностичне обстеження проводилося до та після застосування орієнтованих заходів фізичної реабілітації. Заняття з фізичної активності проводилися індивідуально не менше 6 разів на тиждень і 2–3 рази на день залежно від самопочуття особи. Отримані дані свідчать про суттєве покращення рухових якостей та моторної активності в осіб похилого віку з неврологічними розладами за всіма досліджуваними показниками психомоторики. Отримані результати висвітлюють позитивну динаміку змін, виражену нормалізацією та відновленням психосоматичного стану обстежених пацієнтів похилого віку з психоневротичними розладами внаслідок запровадження заходів фізичної реабілітації, що характеризується покращенням стану їх самообслуговування та виконання різних видів оперативної діяльності. Чітке усунення моторних дисфункцій в осіб з невротичними розладами, а також виражене вдосконалення психомоторних навичок і відновлення здатності до умовно-рефлекторної діяльності внаслідок застосування комплексу реабілітаційного фізичного впливу свідчать про системний саногенетичний вплив фізичної м'язової активності на організм хворих. Автори вважають доцільним рекомендувати впровадження розроблених методик фізичної реабілітації для пацієнтів похилого віку з невротичними розладами, а також для військовослужбовців та мирних жителів країни з посттравматичними стресовими розладами, у практику роботи спеціалізованих реабілітаційних центрів, що сприятиме покращенню стану їх самообслуговування та виконання різних видів оперативної діяльності внаслідок відновлення їх дрібної моторики та психосоматичного стану.

Ключові слова: фізична реабілітація, невротичні розлади, моторний дефіцит, психосоматичні порушення, фізичні вправи, патофізіологічні механізми, саногенетичні механізми.

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Complex physical exercises are one of the leading non-pharmacological ways of treating patients with functional disorders of the nervous system due to

their activation of both ascending and descending mechanisms of neuronal regulation and interaction between cortical, subcortical, and peripherally located

neurons, which, in turn, due to accelerated high-frequency impulses, restore the functional, biochemical, and plastic vital activity of an individual cell, a group of cells that compose a reflex field, or an individual organ. Physical culture measures are effective for overcoming central nervous system disorders in people with psychoneurotic disorders and are able to eradicate the motor function deficit. These complex effects have every reason for widespread use in practical neurology, since they cover physical, psychological, professional, and social aspects of the habilitation effect [4, 7, 11].

The developed methodology for examining persons with neurotic disorders, the strategy and tactics of physical habilitation for this contingent of patients' development depended mainly on the patient's psychosomatic state spectrum of disorders. Such a concept is based on modern medical principles outlined in the International Classification of Functioning, Limitations of Life and Health (ICFL) [6].

Extremely important is to implement effective measures to increase physical activity in older adults with neurotic disorders to improve their psychomotor qualities and psychosomatic state. Each person's active involvement in the process of physical activity self-stimulation is of special importance to ensure the success of restoring their psychomotor qualities. Therefore, physical habilitation becomes an important component of comprehensive care of persons with different pathological conditions, especially with central nervous system degenerative-dystrophic lesions [5].

Individual physical activity activation is a part of measures for older adults with neurotic disorders in comprehensive neurorehabilitation and involves physical exercises used to restore or to compensate for deficient or lost motor functions, to achieve physical independence and activity, and to improve both the psychosomatic state and working capacity [6, 10, 13].

Physical activities are known to determine the functional activity of the central nervous, cardiovascular, and respiratory systems, as well as have an impact on metabolic processes throughout the whole organism [4, 9, 12]. Physical training activities contribute also to person's stress resistance and improved adaptation which all together restores their working capacity [5, 15].

The data of empirical research and clinical experience on the efficacy of physical culture rehabilitation measures are in favor of further developments in qualified assistance of older adults with psychomotor disorders of neurological genesis [3–5, 9, 11, 12]. Most existing programs and corrective techniques do not consider the etiological factors of a specific pathological condition and its pathogenesis, including the personal characteristics of psychomotor disorders and the initial psychosomatic state of elderly patients with psychoneurotic disorders, which significantly affects the efficacy of the restorative rehabilitation process.

Therefore, the rationale for using physical rehabilitation measures to improve personal psychomotor qualities and psychosomatic condition in older patients with psychoneurotic disorders is not in doubt and has a complete pathogenetic background. Comprehensive research on implementing physical rehabilitation in older adults with neurotic disorders remains highly relevant, as its detailed mechanisms and clinical application can significantly improve the functional reserves of the central nervous and musculoskeletal systems.

The purpose of the study was to investigate the pathogenetically determined measures of physical activity increase habilitation impact on motor functions and psychosomatic state of older adults with neurotic disorders.

Materials and methods. 35 patients aged 63–75 years were involved in a comprehensive dynamic examination performed at the “Mental Rehab” Medical Centre (Odessa). These patients had signs of neurotic disorders due to brain degenerative-dystrophic damage: 18 people (51.4 %) had Parkinson's disease, and 17 patients (48.6 %) had manifestations of psychomotor disorders in the late post-stroke period.

These persons independently applied to the Centre to overcome the motor dysfunctions and to improve self-service. The study's methodological basis included modern, scientifically based concepts in the theory and methodology of physical culture, the restorative effect of physical exercises on a person's psychosomatic state, and the biological, medical, and social determinants of rehabilitation.

All personal information gathered during this study was processed in compliance with the European Parliament and Council's Regulation EU 2016/679 of 27 April 2016 on the protection of natural persons concerning the processing of personal data and on the free movement of such data (General Data Protection Regulation). Patients were informed of the objectives of the study, the aims of their physical rehabilitation and other types of medical examination together with the potential use of the data collected in these clinical examinations for scientific research. Personal data were kept confidential and informed consent was obtained, and participation in the study was voluntary.

All examined patients were combined into one group, since they had similar psychosomatic disorders and moderate motor dysfunctions. The selected cohort underwent a thorough dynamic examination, including a valid evaluation of psychosomatic dysfunction and the degree of motor deficit. Differential diagnosis aimed at habilitation tactics in the examined patients was performed using the ICFL and the International Classification of Medical Procedures [1, 2].

We studied the anamnesis, checked the pathogenetic aspects of psychoneurotic disorders and the nature of their clinical manifestation before physical rehabilitation measures initiation. The

peculiarities of each person's psychosomatic state were also determined. Complex clinical analysis determined the involvement of different brain parts (i.e., cortical associative zones, sensory systems, cerebellum, etc.) and the functional activity of the autonomic nervous system to evaluate the complexity of neural regulation at the brainstem, spinal, and peripheral levels, as well as muscle tone. These data allowed differential diagnosis and estimation of the degree of preservation of functional reserves in different CNS structures, vegetative-trophic support, and personal psychomotor skills.

A thorough study of patients' psychosomatic state and individual characteristics allowed identification of the central nervous regulation dysfunctions responsible for musculoskeletal system functioning, as well as to select an adequate method of physical rehabilitation for the selected contingent of older adults.

Complex diagnostic examinations were performed before and after the targeted physical habilitation measures used and included the following methods:

1. 10-meter walk test – determination of movement speed.

2. Balance tests included (a) Berg balance scale (fall risk assessment), (b) keeping one leg standing (coordination and balance tests), (c) four-square walking test.

3. Manual muscle strength testing scale.

4. Modified Self-care Assessment Scale.

5. Personal functional activity assessment using Barthel Scale of Daily Living.

Clinical dynamic observations included analysis of posture, gait, limbs and facial muscles, involuntary movements, responses to questions, presence of eye contact and social adaptation. Attention was paid to such signs as abnormal speech, impaired coordination and balance, abnormal postures or spontaneous movements, and spatial ignoring. These observations supplemented the data of clinical examination and allowed adjustment of physical habilitation programs in accordance with the individual needs of the patient and dynamic changes in his psychomotor skills. To evaluate the efficacy of the measures used to increase physical activity in older adults with neurotic disorders, valid methods were used, which allowed determination of personal psychosomatic state dynamics and indices of motor qualities.

Physical activity exercises were performed individually not less than 6 times per week and 2–3 times per day depending on the person's well-being. The aim of these exercises was to evaluate the dynamics of personal psychosomatic state and psychomotor indicators within the framework of adaptive habilitation using physical culture methods.

Older adults with neurotic disorders were given the following targeted physical exercises for the upper limbs and shoulder girdle to increase their physical activity and muscle tone (Table 1).

Table 1

Targeted physical exercises for older adults with neurotic disorders

Physical exercises	Frequency, mode	Methodological guidelines and application options
Flexion and extension exercise for healthy arm	4–5 times	With radiocarpal and elbow joints involvement
Flexion and extension exercise for affected arm	3–4 times	Extension using the healthy arm
Respiratory exercise	3–4 min	
Shoulder girdle exercise when raising and lowering the shoulders	3–4 times	Alternate shoulder extension and extension options (arms passive). Combine with breathing phases
Elbow joints active pronation and supination with the arms bent	6–10 times	Assist with supination
Respiratory exercise	3–4 min	
Active exercises for the hand and fingers with the forearm in a vertical position	3–4 times	To support, assist and enhance extension.
Passive movements for all upper limb joints	3–4 times	Rhythmically, in increasing volume depending on the person's condition
Respiratory exercise	3–4 min	
Shoulders active circular movements	4–5 times	With the help and regulation of breathing phases
Hand and fingers passive movements	2–3 times	If possible, reduce rigidity
Respiratory exercise	3–4 min	

In some cases, when implementing a complex of physical activities for the examined patients, a rehabilitation specialist was involved, and if necessary, an occupational therapist, clinical psychologist, speech therapist, and other specialists.

The data obtained were calculated statistically using the parametric Bonferroni criterion. $p < 0.05$ was accepted as the index of significant differences.

Results of the study. The results demonstrate changes in motor activity and psychosomatic state in

the surveyed group before and after applying health-improving physical culture measures.

The provided physical training sessions significantly determined the changes in motor activity indexes in examined older adults with neurotic disorders. The speed of movement in these individuals significantly increased: before implementing the health-improving exercise complex, it was 20.9 ± 0.3 m/s, and after, 16.5 ± 0.2 m/s (Table 2).

Table 2

Motor activities and psychosomatic state indexes dynamics in older adults with neurotic disorders after complex of exercises implementation

Tests performed	Motor activity indexes (M±m)		
	Before physical exercises	After physical exercises	Statistic criteria, P
1. Motor activity indexes			
10 m walking test, m/s	20.9±0.3	16.5±0.2*	<0.05
Berg scale (option A)	36.5±1.3	44.7±1.1*	<0.05
One-leg standing with eyes open (option B), points	35.4±1.6	43.7±1.5*	<0.05
Standing on one leg with eyes closed (option B), points	31.3±1.4	39.8±1.3*	<0.05
Stepping in four squares (option C), points	17.8±1.7	13.3±1.4*	<0.05
Muscle strength manual determination, points	39.8±1.3	55.4±1.2*	<0.05
2. Psychosomatic state indexes			
Self-service scale, points	4.0±0.3	5.5±0.2*	<0.05
Barthel Daily Activity Scale, points	53.5±1.2	64.4±1.1*	<0.05

Notes: * – $p < 0.05$ – statistical differences of the investigated index compared with the same in older adults with neurotic disorders after physical exercise implementation.

According to the Berg scale (option A), which allows evaluation of balance quality, a significant improvement was observed – the investigated index after the adaptive physical habilitation complex use increased on 22.5 % ($p < 0.05$). Balance test to option “B” demonstrated an improvement in balance maintenance on one leg with open and closed eyes, which is confirmed by a significant difference (on 23.5 %) in the index before and after the physical activity measures application ($p < 0.05$).

The stepping in four squares test (option C) also showed a reliable difference in balance quality among the examined persons: after physical exercise, this index decreased by 33.8% ($p < 0.05$), indicating improved balance in older adults with neurotic disorders.

Physical exercise implementation resulted in significant improvement in manual muscle strength in the examined persons; the investigated index increased on 39.2 % ($p < 0.05$).

We also estimated the psychosomatic state changes of the investigated patients after the implementation of complex physical exercises (Table 2).

Before the health-improving measures were implemented, the self-service scale average index was equal to 4.0 ± 0.32 points, but after physical exercises we registered a considerable (on 37.5 %; $p < 0.05$) increase.

Studies using the Barthel Daily Activity Scale also confirmed improved adaptive capabilities in the examined patients while performing various operational activities. The average index of personal functional capacity was equal to 53.5 ± 1.2 points, and after measures, physical habilitation implementation in increases on 20.4 % ($p < 0.05$), which indicates an increase in the level of personal independence and efficiency in performing everyday tasks.

Discussion. Thus, the data analysis indicates a significant improvement in motor qualities and motor activity in older adults with neurological disorders

across all psychomotor indices used, namely walking speed, balance and coordination, and manual muscle strength. The results also highlight positive changes, including normalization and restoration of the psychosomatic state of the examined older adult patients with psychoneurotic disorders as a result of implementing physical habilitation measures, characterized by improved self-care and performance of various operational activities. The data obtained correlate with other authors' results, which highlight the positive impact of physical culture measures on motor activity and psychosomatic state of the elderly persons [2, 5, 6, 9-11].

To discuss the data obtained, we would like to highlight the following aspects. First, the results indicate a positive impact on motor and psychosomatic properties and clinical manifestations in older adults with moderate impairment of motor functions in cases of neurotic disorders. The apparent elimination of motor dysfunctions in people with neurotic disorders, as well as the expressed improvement of their psychomotor skills and the restoration of conditioned-reflex activity as a result of a complex of habitual physical influence use, allows us to declare the systemic sanogenetic effect of physical muscle activity on patients' bodies.

From a fundamental point of view, it's important to consider that such muscle apparatus of the examined patients' physical activation triggers cascade chain processes of receptor-neuronal, humoral, biochemical, and hormonal nature in the human body, the final result of which is a directed downward regulatory influence on organs and target cells that are involved in a specific pathological process, as also indicated by [6, 8]. The methods used to activate personal physical activity in elderly patients with signs of psychomotor disorders took into account the general patterns of excitation and inhibition processes, as well as the initial psychophysiological state of the examined patients according to psychomotor indexes. In this way,

neurotransmitter processes are activated, and biochemical processes of protein synthesis are intensified, including those responsible for peptidergic mechanisms of motor and psychoneurological deficit restoration [6].

Second, the physical activity methods selected for this study ensure the fastest and most effective adaptation to physical and mental stress and provide a sufficient level of stress resistance, which contributes to improved vital activity and harmonious interaction with the environment. Therefore, the effective restorative impact of the applied physical exercises provides elderly patients with psychoneurotic disorders the opportunity to adapt to the complex conditions of modern society, succeed in various areas of operational activity and social communication, etc., which together increases the personalized opportunities for maintaining their own psychosomatic health.

Thirdly, let us recall that older adults with neurotic disorders selected for the study had a deficit of psychomotor qualities of an average degree; therefore, their motor activity restoration was a priority task. Understanding the anatomical, biochemical, and pathophysiological peculiarities of the selected pathology in each specific patient, as well as their age-related functional limit, we consider it appropriate to note that the efficacy of implemented methods of physical habilitation was achieved due to the prevention of pathological process progression in subcortical brain structures, as well as due to the restoration of cortical-subcortical neuronal and neurotransmitter interactions. We prevented muscle contracture formation, normalized tone, and increased limb muscle strength. The observed improvements in metabolic and perfusion microcirculatory processes in tissues support the restoration of internal organ function. We are confident that the restoration and/or improvement of hand fine motor skills and large-amplitude motor skills result from the applied physical motor complexes and the sanogenetic mechanisms listed above.

Fourthly, a personalized choice of physical activity system is important in rehabilitation medicine. We emphasize that oriented physical exercises are a natural, psychophysiological

adequate way to activate a person's own physical activity and therefore have become widely used as a preventive and therapeutic tool to improve motor qualities, psychosomatic state, and human performance in neurotic disorders [2, 4, 14]. We used postural and orthostatic exercises as part of a complex of adaptive habilitation measures, allowing the patient to maintain semi-vertical and vertical positions even with limb and trunk muscle paresis.

The arsenal of adaptive physical education techniques included exercises aimed at eliminating atonic and spastic paresis, passive and active limb movements, breathing, and coordination exercises. At the same time, their complexity and volume were gradually increased, resulting in faster neurodynamic processes in cerebral psychofunctional systems, normalization and restoration of functional stability of both the musculoskeletal and vestibular apparatus, as confirmed by data [9, 13].

Therefore, the results demonstrate significant improvements in motor activity and psychosomatic state indices in older adults with neurotic disorders as a result of pathogenetically justified, comprehensive physical habilitation measures, which we consider a contribution to rehabilitation medicine for patients with motor deficits and psychoneurological disorders. Taking into account the post-traumatic stress disorder development in military personnel and civilians during the ongoing war, we consider it appropriate to recommend the developed methods of physical habilitation for the indicated contingents of victims, which will contribute to their self-service status improvement and the performance of various types of operational activities as a result of their fine motor skills and psychosomatic state restoration.

Limitations. We did not include patients with acute circulatory disorders in our clinical observations. We excluded patients over 75 years of age due to a complete loss of regulatory and adaptive activity. Patients with severe neurological impairments, severe motor deficits, tremors, cognitive impairments, and mental disorders were also excluded from these studies. We also excluded data on three patients who developed acute cerebrovascular accidents and cardiac arrhythmias during physical exercise.

Conclusions

1. Methodological approaches to adaptive physical culture activities providing for neurotic disorders in older adults are regulated by the nature of central nervous system disorders, individual typological characteristics, motor deficiency expression, and the stage of recovery process.

2. The results of valid motor quality testing in older adults with neurological disorders before and after the use of exercises to activate their physical activity indicate their psychomotor skills and muscle strength indexes significant improvement.

3. The specified contingent psychosomatic state dynamics evaluation after the specialized physical exercises implementation revealed an improvement in self-care indexes and the ability to perform various types of daily activities.

4. The evident elimination in older adults with neurotic disorders, as well as the expressed improvement of psychomotor skills and the restoration of the ability to conditioned reflex activity after a complex of habitual physical influence, indicates the systemic sanogenetic effect of physical muscle activity.

5. Muscle apparatus physical activation in examined patients initiates cascade chain processes of receptor-neuronal, humoral, biochemical, and hormonal mechanisms in the human body; the final result of which is a directed downward regulatory influence on organs and target cells that are involved in a specific pathological process mediating

6. To achieve the efficacy of physical exercise implementation in older adults with neurotic disorders, it's necessary to develop individually oriented training programs that determine the volume and intensity of physical activity, take into account the nature of the psychomotor disorders and the initial level of the person's psychophysical state.

7. We consider it reasonable to recommend the implementation of the developed physical habilitation techniques for older adult patients with neurotic disorders, as well as for military personnel and civilians with post-traumatic stress disorders, in the daily practice of specialized rehabilitation centers, which will contribute to their self-service status improvement and the performance of various types of operational activities as a result of their fine motor skills and psychosomatic state restoration.

Prospects for further research include intensive clinical observations to determine the efficacy and composition of physical habilitation methodological support in patients with neurological disorders across a wider age range, as well as an original method for testing the efficacy of physical habilitation in injured and wounded military personnel at the rehabilitation stage.

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