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PSYCHOSOMATIC MECHANISMS OF REGULATION OF EXTERNAL RESPIRATION FUNCTION IN CHILDREN WITH BRONCHIAL ASTHMA WHEN LISTENING TO AUDIO SIGNALS OF VARIOUS COMPONENT COMPOSITION

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Summary

In the treatment of bronchial asthma (BA), an integrated approach is used that includes both drugs and alternative methods that influence the psycho-emotional state of the patient. In this regard, one of the most powerful methods of psycho-emotional influence on a person is musical influence.

***The aim of the research** is to study the effectiveness of influence of audio signals of different amplitude-frequency range on the central mechanisms of regulation of ventilatory capacity of bronchi of patients with asthma.*

***Material and methods.** Twenty-five children between the ages of 9 and 14 with clinically diagnosed BA participated in the study. Three melodies with different component composition were used. Their amplitude-frequency characteristics were analyzed using the Matlab environment. The sound energy fraction of the studied musical compositions in one-third octave frequency bands throughout the duration of the audio signal was calculated. Statistical processing of the data was performed using IBM SPSS Statistics software.*

***Results.** The results of the study indicate that the most effective musical influence is provided by the audio excerpt from The Magic Flute by W. A. Mozart. It was found that the main spirographic indicators of bronchopulmonary obstruction increase under the influence of music, and correspondingly there are changes in the integral characteristics of bioelectrical activity of the brain.*

***Conclusion.** The results of the study show reliable normalization of spirography indicators in children with bronchial asthma under the influence of selected musical melodies of a certain frequency. Effectiveness of sound influence on central regulation mechanisms of bronchial ventilatory capacity can be used for preventive and therapeutic purposes.*

***Key words:** Bronchial Ventilatory Function; Amplitude-frequency Characteristics; Electroencephalography; Bioelectrical Activity of the Brain; Absolute Power Spectral Density.*

Introduction

Bronchial asthma (BA) is one of the most common chronic inflammatory diseases of the respiratory tract (predominantly allergic), and its main symptom is breathlessness due to narrowing of the bronchial lumen resulting in chronic airflow limitation and bronchial mucosal edema. Asthma is incurable, but treatment can slow the progression of the disease [1, 2, 3]. Currently, the basis of asthma treatment is pharmacological agents, which allow to achieve a high level of disease control. On the other hand, it is recognized that psychological factors play an important role in the pathogenesis of BA [3, 4, 5]. In particular, the psychological component is expressed in childhood. Psychological disorders associated with BA include anxiety, depression, and panic attacks, as well as behavioral factors such as poor social adjustment and lack of self-control. These symptoms worsen the course of the underlying disease and are associated with higher rates of hospitalization and worsening control of asthma manifestations, and significantly affect the quality of life, ability to work, and social activity of patients [5].

Pathological process of asthma involves nervous, endocrine and immune systems, which integrate vital processes of the body. Insufficiency of organ mechanisms of autoregulation and BA resistance causes predisposition to realization of central pathogenic influences. Impaired function of the central nervous system in patients with BA is noted both during exacerbation and in the post-attack period.

Therefore, in the treatment of BA an integrated approach is used, including drugs and methods influencing the psycho-emotional state of the patient [6, 7, 8].

Recently, considerable efforts have been made in the development of psychological methods of influence capable of dealing with the problems of the psycho-emotional component of BA. Effectiveness of such psychological methods of influence as hypnosis, cognitive-behavioral and relaxation therapy has been proved in clinical practice. These methods of influence on psycho-emotional state lead to improvement of quality of life and decrease of anxiety level and control of BA symptoms [7, 9, 10].

The emotional reaction of a person is reflected in a change of the indicators of the brain electroencephalogram (EEG), which is manifested in a change of the ratio of such basic rhythms as delta, alpha and beta [11, 12, 13]. The objectification of the psycho-emotional state of the patient is, as it is known, the assessment of the level of alpha brain activity, since it is known that such a psycho-emotional state as anxiety is associated with the depression of the alpha rhythm [11, 14]. These waves decrease during anxiety and depression. And increase in power of such EEG signals as alpha and theta rhythms testifies to normalization of psychosomatic status of a patient [11, 14, 15].

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One of the methods of the most powerful psycho-emotional influence on a person is musical influence [16, 17]. Therefore, this method can be included in relaxation therapy and can be part of a psycho-educational complex program for treatment and rehabilitation of children with BA [8, 10].

Previously, music as a therapeutic method was used to sing or play musical compositions on wind instruments with the aim of training the muscles responsible for the functioning of the respiratory system. Music hasn't been used to influence the psychological status of children with asthma [7, 8, 9, 10].

The research of the influence of audio signals (musical fragments) on the human body in order to improve the psycho-emotional status of listeners began to be systematically undertaken since 2012 under the guidance of Professor Vitaliy Didkovskyi and Larysa Kalashnikova at the Department of Acoustics and Multimedia Electronic Systems of the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» jointly with the Department of Respiratory Diseases and Respiratory Allergies in Children of the Institute of Pediatrics, Obstetrics and Gynecology of the National Academy of Medical Sciences of Ukraine under the direction of Serhiy Bartenev.

The obtained results showed an increase in the attention of the listeners – students of the Department of Acoustics and Multimedia Electronic Systems – while listening to specially selected musical fragments during the breaks between the first and second, and especially between the third and fourth university classes.

In addition, in 2016, on the basis of the Institute of Pediatrics, Obstetrics and Gynecology, studies began to examine the effect of audio signals on the course of BA in children. The main results of this work are presented in this article.

We have proposed a non-drug method that promotes activation of reserve and adaptive abilities of the body with asthma, which allows us to study the effectiveness of therapeutic music effects on the ventilatory function of the bronchi in asthma.

The purpose of this work is to study the effectiveness of influence of different amplitude-frequency range audio signals on the central mechanisms of ventilatory capacity regulation of bronchi in patients with BA.

Material and methods

According to the objective of our research, we studied both the spectral characteristics of the brain bioelectric activity and the functional indicators of the bronchial tree under the influence of audio signals. This study is a continuation of the scientific work [18] to justify the effectiveness of the musical correction method of the bronchial ventilation function.

The study included 25 people – children aged 9 to 14 years with clinically diagnosed bronchospasm accompanied by moderate respiratory failure of obstructive type due to bronchospasm. The children were treated in the Pulmonology Department of the Institute of Pediatrics, Obstetrics and Gynecology of the National Academy of Medical Sciences of Ukraine. The study was conducted in accordance with the principles of biomedical ethics. The research was conducted in accordance with the Declaration of Helsinki of the World Medical Association. The approval of the Commission on Bioethics and Deontology (CBD) of the State Institution «Institute of Pediatrics, Obstetrics and Gynecology named after Academician O. M. Lukyanova of the National Academy of Medical Sciences of Ukraine» was granted at the meeting of CBD No. 2 on 07.02.2020 and the official letter of CBD No. 2.6-04/280 confirming the approval was issued on 28.05.2021.

Musical fragments used to influence the psycho-emotional state of the examined persons for correction of the respiratory function are the following: ocean noise – audio fragment 1, Lullaby by W. A. Mozart – audio fragment 2, The Magic Flute by W. A. Mozart – audio fragment 3. Suggested musical fragments are audio stimuli of different compositional structure, varying in melodic component and playback speed. Mozart's music was chosen as a stimulus signal based on the fact known from literature that Mozart's music helps most people with strong psycho-emotional stress [19]. This phenomenon is called the «Mozart effect». The peculiarities of the effect of Mozart's music on the electrical activity of the brain have been studied in two directions: the frequency of the rhythmic change and the actual frequency of the sound. However, in the literature there are no data on the relationship between the amplitude-frequency characteristics of Mozart's works and the psychosomatic functions of the body.

In the present study, the amplitude-frequency composition of the used audio signals is investigated. The spectral analysis was carried out using the Matlab application software package, which calculated the sound energy fraction of the studied musical compositions in the one-third octave frequency bands throughout the duration of the audio signal.

To study the electrophysiological indicators of the central nervous system, the method of electroencephalography (EEG) was used [18]. The EEG was recorded monopolarly using the computerized electroencephalograph Neuroscope-416 (NPF Biola, Ukraine) and silver cup electrodes placed in the leads according to the international system «10-20» on 16 channels (Fp1, Fp2, F3, F4, F7, F8, T3, T4, T5, T6, C3, C4, P3, P4, O1, O2). EEG recording was performed in the 0.5 to 70.0 Hz passband. A ground electrode was placed on the subject's forehead.

The absolute power spectral density (PSD) was used as a quantitative parameter of the electroencephalogram. The spectral analysis of EEG was performed using the fast Fourier transform algorithm to calculate the PSD in standard ranges of physiological frequencies of the main brain rhythms: alpha, beta, theta, and delta [2, 20]. Licensed software of the Neuroscope-416 computer electroencephalograph was used for EEG registration and processing.

At the time of EEG recording, the patient was in the soundproof chamber in a state of quiet wakefulness with eyes closed. The study was performed in a comfortable environment, in the morning, in a sitting position. At the beginning of each study, 3 minutes of EEG were recorded

in a state of quiet wakefulness, with eyes closed, in the absence of any sound stimuli. These data were considered background. During the next part of the study, the EEG was recorded while the subject listened to the different audio stimuli. The signals were reproduced binaurally, and the sound sources were amplified using vacuum headphones. The sequences of audio signals generated on the computer were the load options. Each audio signal was listened to three times by the subject during a ten-minute period of quiet wakefulness with eyes closed and no sound signals between audio stimuli.

To assess the functional state of the respiratory system, the method of spirography was used – the method of graphic registration of changes in lung volumes during natural and forced respiratory movements [21].

An open type spirographic complex Spiro-Spectrum (KhAI-Medika, Ukraine) was used in the study. The basic requirements for spirographic examinations [2, 21] were observed. Calculation of spirographic indicators and their normative values was carried out using the software Spirokom-Standard.

Functional changes in BA are associated with a decrease in the main spirometric velocity indicators that reflect the degree of bronchial obstruction (BO), namely

– Forced vital capacity (FVC) of the lungs – the volume of air expired (in liters) during the fastest and most forceful exhalation.

– Forced Expiratory Volume (FEV1) – the volume of air (in liters) exhaled in the first second of forced exhalation.

– Forced expiratory flow (FEF) after exhalation of 25 %, 50 %, 75 % of FVC, calculated from the beginning of exhalation (FEF25, FEF50, FEF75, respectively, liters/second).

– Tiffno Index (FEV1/FVC, %).

These indicators are diagnostic criteria for bronchial obstruction (BO) and are used to determine the severity of BO [2].

The calculation of velocity indicators is of great importance in identifying signs of bronchial obstruction. A decrease in Tiffno index and FEV1 is a characteristic symptom of diseases associated with a decrease in bronchial patency.

FEF indicators are used in the diagnosis of early manifestations of BO. FEF75 reflects the patency of the large bronchi. FEF25-50 indicates the state of patency of small bronchi and bronchioles, which characterizes the early stages of impaired ventilatory function.

Statistical Analysis. Independent samples t-test and Mann-Whitney U-test, as appropriate for the type of data being analyzed, were used to assess statistical significance. Data were analyzed using IBM SPSS Statistics 19 software. The precision of the differences in EEG PSD levels (background and music exposure) for each subject was assessed by the Mann-Whitney U test. The statistical reliability of the Mann-Whitney U-test indicators was set at $p=0.05$. Reliability of values of EEG PSD levels for the whole group of subjects was assessed by Student's criterion ($p<0.05$) [20, 22, 23].

Results

In order to analyze the contribution of the mentioned audio signals to the physiological response, a fraction of the total sound energy of each frequency band of the studied musical fragments was used. This indicator combines all musical works into one group – sound stimuli of different amplitude-frequency range.

The percentage of the sound energy of the selected musical compositions in one-third octave frequency bands was calculated using the Matlab software (Fig. 1).

According to the sound energy values of the musical fragments, all the studied frequencies of the sound range can be divided into three groups: low (LF), medium (MF) and high (HF) frequencies according to the frequency range perceived by the human ear. For low frequencies, typical frequencies are approximately from 50 Hz to 315 Hz, for medium frequencies, typical frequencies are approximately from 315 Hz to 3 kHz, and for high frequencies, typical frequencies are approximately from 3 kHz to 16 kHz.

There is a graph of the sound energy fraction distribution in one-third octave bands during the audio exposure time (Fig. 1).

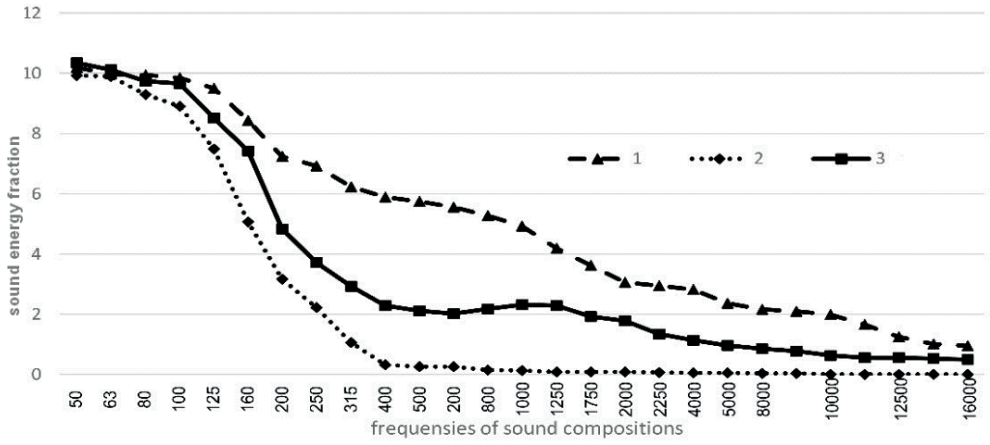

Fig. 1. Graph of sound energy fraction distribution in one-third octave bands during the period of audio exposure. Ordinate: fraction of sound energy. Abscissa: frequency of sound compositions. Graph: line 1 – audio fragment 1, line 2 – audio fragment 2, and line 3 – audio fragment 3

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From the graphs in Figure 1, it can be seen that in musical fragment 1, the percentage of low-frequency sound energy dominates over the medium and high frequencies that are also present in this musical fragment. In musical fragment 2, the low-frequency component dominates against the background of the absence of medium and high frequencies. Musical fragment 3 does not contain high frequency audio signals, but this fragment contains low and medium frequencies with a low percentage of sound energy.

The clinical and psychological study of the influence of music on the ventilatory function of the lungs was carried out in two stages. In each stage, boys and girls between the ages of 9 and 14 were included in the research.

Twenty-five children with clinically diagnosed BA participated in the first stage of the research. According to spirography, at the time of the study the children were diagnosed with obstructive impairment of the ventilatory function of the bronchopulmonary system of moderate severity.

First of all, the musical influence on the indicators of electrical activity of the brain was studied, namely the PSD of brain rhythms (alpha, beta, delta and theta rhythms) in relation to the background EEG values when listening to the studied audio signals. The results of this series of studies are presented in Table 1.

After listening to each piece of music, the effect of the selected pieces of music on bronchial ventilatory function was studied.

Table 1

Change of PSD of the brain rhythms under the audio signals influence (n=25, M±m)

Indicators	Average values of PSD indicators											
	Under the audio signal influence											
	№ 1				№ 2				№ 3			
	Main brain rhythms				Main brain rhythms				Main brain rhythms			
	α	β	θ	δ	α	β	θ	δ	α	β	θ	δ
Before listening	25,3±0,8	39,0 ±1,6	36,3 ±1,5	27,7 ±3,2	18,3±2,1	45,0 ±2,5	18,0 ±1,7	22,3 ±1,5	32,3±1,5	50,3 ±1,9	44,6 ±3,1	35,8 ±0,8
During listening	28,1±0,2	32, 5 ±1,6	34,3 ±1,5	31,4 ±3,2	22,3 ±2,1	42,0 ±2,5	15,0 ±1,7	18,3 ±1,5	47,7±2,5	39,6 ±1,9	36,5 ±3,1	25,3 ±0,8
After listening	27,5±0,9	31,0 ±1,6	32,5 ±1,5	33,7 ±3,2	23,3 ±2,1	36,3 ±2,5	16,0 ±1,7	21,3 ±1,5	43,5 ±2,5	42,3 ±1,9	37,6 ±3,1	26,3 ±0,8

Note: reliability of the differences in the external respiration function indicators of the subjects according to the Student's criterion was p<0,05.

The development of bronchial patency was assessed on the basis of spirographic data, which testify to the effectiveness of the influence of musical audio signals on the autonomic regulation of the smooth muscle tone of the bronchial tree.

Before listening to musical fragments, spirographic indicators of respiratory function were 10-30 % lower than the reference values. After listening to the sound signals, the indicators chosen to characterize the respiratory function normalized in 68±1,1 % of the subjects of the first group (group A). In the subjects of the second group the figures were 32±1,1 % (group B), and there was no reliable improvement of the respiratory function after listening to musical fragments.

In the first group – group A – the influence of the heard sound fragments leads to the normalization of the indicators of the ventilatory function of the lungs, the research results are presented in Table 2.

Distribution of changes in forced breathing indicators in the subjects is shown in Figure 2.

Table 2

Absolute changes in spirography indicators under the influence of the audio signals (n=25, M±m)

Forced exhalation indicators	Average values of forced exhalation indicators	Average values of forced exhalation indicators	Average values of forced exhalation indicators	Average values of forced exhalation indicators	Reference values
		Under the audio signal influence			
		№ 1	№ 2	№ 3	
FVC	63,5±2,17	73,5±2,35	75,5±1,07	88,5±1,07	100-80 %
FEV_1	59,9±2,02	75,9±1,92	71,9±1,25	78,9±2,92	100-80 %
Tiffno index	58,4±2,19	70,4±2,19	66,4±2,19	73,4±2,19	100-75 %
FEF_{25}	45,5±2,32	58,5±2,82	50,5±2,82	69,5±2,82	100-55 %
FEF_{50}	60,2±2,05	65,2±2,05	65,2±2,05	72,2±2,05	100-65 %
FEF_{75}	55,5±1,04	62,5±1,24	58,5±2,14	70,5±1,55	100-60 %

Note: reliability of the differences in the external respiration function indicators of the subjects according to the Student's criterion was p<0,05.

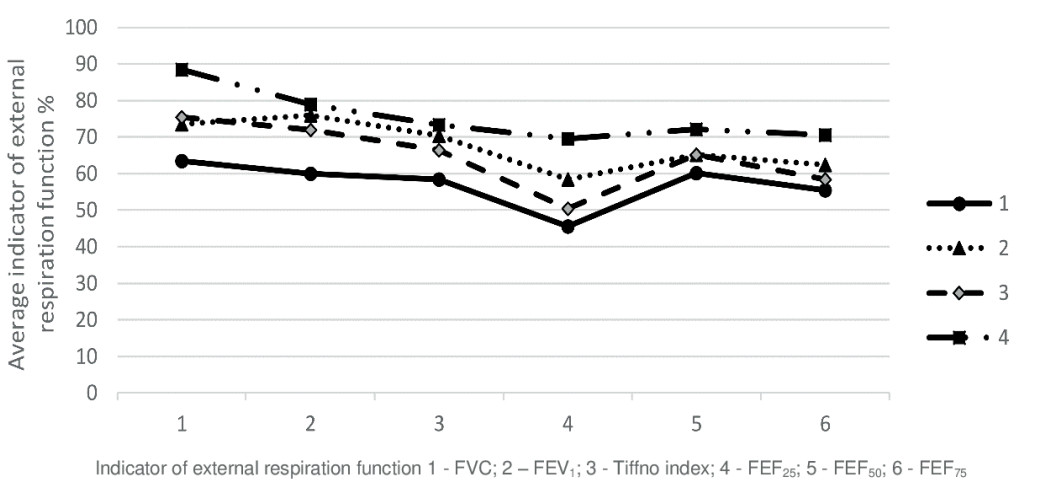

Fig. 2. Comparative analysis of spirography indicators in the examined children before and after influence of various audio signals: 1 – before listening; 2 – audio fragment 1; 3 – audio fragment 2; 4 – audio fragment 3. Abscissa: indicator of external respiration function: 1 – FVC; 2 – FEV1; 3 – Tiffno index; 4 – FEF25; 5 – FEF50; 6 – FEF75. Ordinate: average indicator of forced exhalation.

The analysis of the obtained results showed that only when listening to the musical fragment 3 there were changes of the ventilation indicators to the reference values in 100 % of the examined persons.

At the second stage the specifics of musical influence on children with bronchopulmonary pathology were studied. At this stage of the research, audio fragment 3 was used as a factor of musical influence and it showed the highest efficiency in normalization of ventilation parameters.

At this stage of the study 25 children with bronchial hyperreactivity syndrome, diagnosed with obstructive respiratory failure of mild and moderate severity according to spirometry data, were included. At this stage, we studied the effect of musical fragment 3 on pulmonary ventilation function and indicators of electrical activity of the brain of children who were not initially diagnosed with BA. The results are presented in Table 3.

Table 3

Absolute changes in spirography indicators under the influence of the audio signals, control group – children with hyperreactivity syndrome (n=25, M±m)

Spirography indicators	Average spirography values (n=25)	Average spirography values Group I (n=16)	Average spirography values Group II (n=9)	Reference values
		Under audio signal 3 influence		
FVC	70,2±2,07	67,5±3,76	80,1±2,23	100-80 %
FEV_1	58,0±1,64	57,8±2,47	79,4±3,03	100-80 %
Tiffno index	63.4±2,19	66,4±2,19	73,4±2,19	100-75 %
FEF_{25}	53,6±1,97	54,8±2,25	58,5±2,82	100-55 %
FEF_{50}	57,5±1,52	54,8±2,25	67,1±3,05	100-65 %
FEF_{75}	61,4±2,06	59,4±1,95	69,4±2,37	100-60 %

Note: reliability of the differences in the external respiration function indicators of the subjects according to the Student's criterion was p<0,05.

As a result of the study, two groups of children were identified according to their response to the influence of the audio signal 3. The first group (group I) included 16 children in whom no statistically significant deviations from clinically normative spirographic indicators were found. Children of this group were not diagnosed with BA. Various forms of somatic changes in the bronchopulmonary system were observed in the anamnesis of the children. Children of this group did not show statistically significant changes in the value of PSD of brain rhythms under the influence of the studied musical fragment.

Children of the second group (group II), which consisted of 9 children, showed a statistically significant improvement of spirographic indicators. BA was diagnosed in children of this group.

Analysis of the obtained results showed that only when listening to musical fragment 3, 100 % of the examined persons showed improvement of standard spirometric indicators of ventilation to the reference values.

Analysis of PSD of brain rhythms in children of this group, when listening to musical fragment 3, shows that the value of PSD of α-rhythm increases on average by 46.5±3.6 %. The change of PSD of other rhythms in relation to EEG values is less pronounced, and for θ-rhythm it shows a decrease by 14.5±2.8 %, and for δ-rhythm by 12.3±3.5 %. Beta activity of the brain (β rhythm) decreased by 22.5±2.1 %.

Discussion

It is known that among all EEG rhythms the most stable characteristics of psycho-emotional state of a person are changes in PSD of α and β brain rhythms. It was established that α-rhythm is inhibited during emotional experience, and the amplification of β-rhythms power occurs against the background of development of stressful situation for the individual. As for δ and θ rhythms, despite the lack of data on functional value of frequencies of these rhythms in emotional behavior of a person, there are facts that let us consider these rhythms as EEG correlates of psychophysiological orientation of a person. It is known that the increase of power of θ-rhythm is the indicator of emotional excitation, and the increase of power of δ-rhythm against the background of depression of PSD of α-rhythm reflects the development of stress reaction. Thus, it is possible to use the changes of electrical characteristics of brain activity as indicators of realization of psycho-emotional reaction of the body to musical influence.

The effectiveness of the studied musical fragments as a psycho-emotional factor was assessed by the changes of the PSD of the main brain rhythms, primarily α and β rhythms.

According to the results of the study, audio fragment 1, where the high-frequency components of the audio signal are insignificant and the energy of the audio signal is concentrated mainly in low and medium frequencies, practically doesn't change the PSD of the studied brain rhythms: α, β, θ and δ rhythms changed in 1.1; 0.83; 0.94; 1.13 times, respectively.

Audio fragment 2, where mainly low frequencies are present, like the first audio fragment, practically did not change the PSD of the studied brain rhythms. PSD of brain rhythms β, θ and δ changed in 0.9; 0.8; 0,8 times, respectively. Under the influence of this audio signal, the change of α-rhythm is expressed more significantly in 1.2 times, which corresponds to the increase of PSD rhythm by 20.0 %±2.2 % (p=0.05).

Audio Fragment 3, an excerpt from The Magic Flute by W. A. Mozart, has the most effective musical influence. It does not contain high frequency sound signals, but this fragment contains low and medium frequencies with a low percentage of sound energy. When listening to audio fragment 3, the most significant change in PSD of the studied brain rhythms is noticed: α, β, θ and δ rhythms changed in 1.49; 0.69; 0.81; 0.74, respectively.

PSD of α-rhythm increased on average by 49.0±2.0 % ($p<0.05$), and at the same time β-rhythm decreased by 31.0±3.6 % ($p<0.05$). Under the influence of this audio fragment, PSD of other brain rhythms changed in this way: PSD of θ and δ rhythms decreased by 19.0±3.1 % ($p<0.05$) and by 29.0±0.8 % ($p<0.05$), respectively.

Since the indicators of psycho-emotional state of a person are first of all changes in PSD of α- and β-rhythms of the brain, it can be concluded that audio fragment 3 leads to the decrease of emotional stress through the increase of PSD of α-rhythm and on the other hand through the decrease of PSD of β-rhythm. A combined change in the activity of these rhythms leads to a balance between excitation and inhibition in emotional experiences.

In accordance with the purpose of this research, we studied the effectiveness of the influence of the studied musical fragments as a psycho-emotional factor on the ventilatory function of the bronchi in patients with BA.

Before listening to musical fragments, spirographic indicators of respiratory function were 10-30 % lower than control indicators. The spirographic data show an improvement of bronchial patency in 68,0±1,1 % of subjects (group A) against the background of exposure to sound signals. Musical influence led to normalization of ventilatory function to varying degrees (Fig. 3.). When listening to audio fragment 3, a significant improvement of standard spirometric ventilation indicators towards the reference indicators was observed in 100 % of the examined group A.

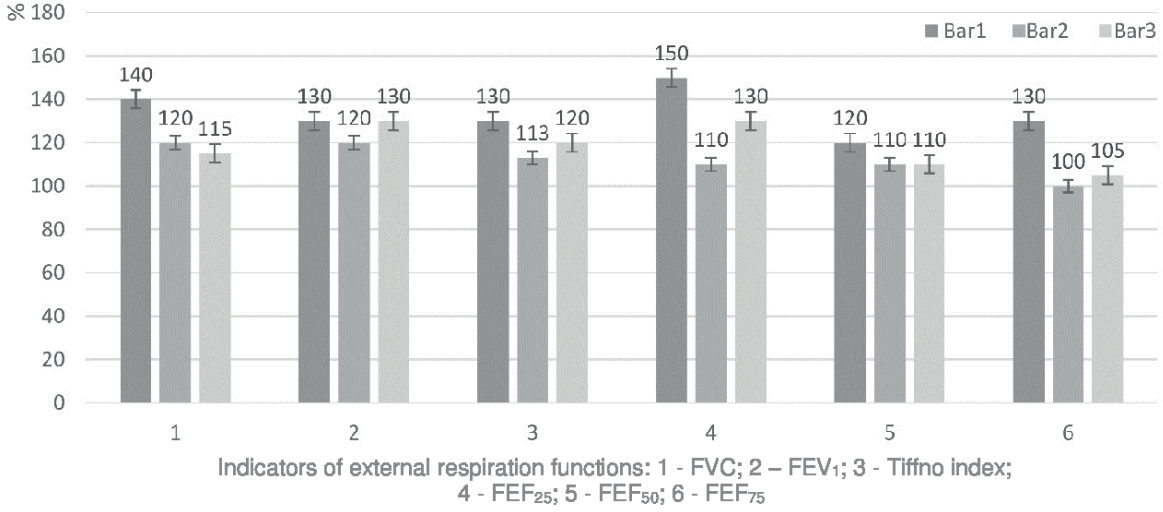

Fig. 3. Relative changes in spirographic indicators under the influence of the audio fragments. Abscissa: 1 – FVC; 2 – FEV1; 3 – Tiffno index; 4 – FEF25; 5 – FEF50; 6 – FEF75. Bar 1 indicates audio fragment 3, bar 2 indicates audio fragment 1, bar 3 indicates audio fragment 2.

The study of the specifics of the musical influence on children diagnosed by spirometry with obstructive respiratory failure of mild and moderate severity was carried out using the audio fragment 3, which, as it turned out, not only increased the spirographic indicators in 100 % of the subjects, but also significantly increased all

the studied spirographic indicators in the direction of the reference values.

An improvement in respiratory function was noted in patients diagnosed with BA (Fig. 4).

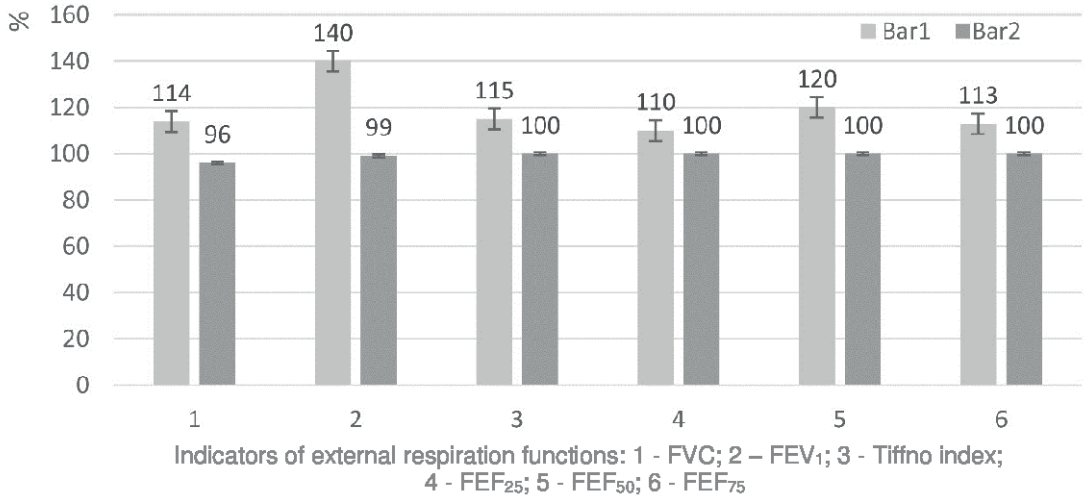

Fig. 4. Relative changes in spirographic indicators under the influence of audio fragments in the group of children who, according to spirometry data, were diagnosed with obstructive ventilation failure of mild and moderate severity. Abscissa: 1 – FVC; 2 – FEV1; 3 – Tiffno index; 4 – FEF25; 5 – FEF50; 6 – FEF75. Bar 1 indicates children diagnosed with BA (Group B), bar 2 indicates children without BA.

It was found that in children of this group, after listening to audio fragment 3, there was a significant improvement in spirographic indicators against the background of an increase in PSD of alpha brain rhythm, which may indicate a decrease in psycho-emotional stress. On the other hand, there was a decrease in PSD rhythms responsible for such sensations as fear, anxiety and depression.

Thus, a change in the activity of the main brain rhythms (alpha and beta rhythms) under the influence of sound signals with a predominance of low and medium frequencies (audio fragment 3) causes a balance between excitation and inhibition in emotional experience and contributes to the normalization of the external respiratory function in children with BO.

Conclusions

1. For the first time in Ukraine a systematic study of the effect of audio signals on the human body with a recreational purpose, namely for the treatment of bronchial asthma in children, was started.

2. Audio influence causes change of absolute power spectral density of brain rhythms in children suffering from bronchial asthma with predominance of neurovegetative and psychosomatic disorders.

3. Reliable normalization of spirographic indicators in children with bronchial asthma under the influence of selected musical melodies of certain frequency proves a positive effect on the reflex chain consisting of sequentially interacting central and autonomic nervous systems. The result of this interaction is the expansion of the smooth muscles of the bronchi and the relief of bronchospasm.

4. Changes in activity of α and β rhythms under the influence of sound signals with predominance of low and medium frequencies (audio fragment 3) contribute to normalization of external respiratory function in children with bronchial asthma by reducing psycho-emotional stress.

5. In the future, when developing rehabilitation programs for children with different degrees of severity of bronchial asthma, it is possible to introduce music therapy into the programs in order to influence the psycho-emotional status of the patient.

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ПСИХОСОМАТИЧНІ МЕХАНІЗМИ РЕГУЛЮВАННЯ ФУНКЦІЇ ЗОВНІШНЬОГО ДИХАННЯ У ДІТЕЙ З БРОНХІАЛЬНОЮ АСТМОЮ ПРИ ПРОСЛУХУВАННІ АУДІО СИГНАЛІВ РІЗНОГО КОМПОНЕНТНОГО СКЛАДУ

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Резюме.

Для лікування бронхіальної астми (БА) використовується комплексний підхід, який включає як медикаментозні, так і альтернативні методи, що впливають на психоемоційний стан пацієнта. У зв'язку з цим, одним з методів найпотужнішого психоемоційного впливу на людину є музичний вплив.

Метою даної роботи є вивчення ефективності впливу звукових сигналів різного амплітудно-частотного діапазону на центральні механізми регуляції вентиляційної здатності бронхів хворих на БА.

Матеріал та методи дослідження. У дослідженні взяли участь 25 дітей віком від 9 до 14 років з клінічно виявленою БА. Використано три мелодії різного компонентного складу. Їх амплітудно-частотні характеристики аналізували в середовищі Matlab. Розраховували частку звукової енергії досліджуваних музичних композицій у третиноктавних смугах частот протягом всієї тривалості звукового сигналу.

Статистичну обробку даних проводили за допомогою програмного забезпечення IBM SPSS Statistics.

Дослідження проводили відповідно до Гельсінської декларації Всесвітньої медичної асоціації. Схвалення Комісії з біоетики та деонтології (КБД) ДУ «Інститут педіатрії, акушерства та гінекології імені академіка О. М. Лук'янової НАМН України»

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Результати дослідження. Результати дослідження свідчать про те, що найефективніший музичний вплив здійснюється аудіо уривком із «Чарівної флейти» В. А. Моцарта. Встановлено, що під впливом музики підвищуються основні спірографічні показники бронхолегеневої обструкції і, відповідно, змінюються інтегральні характеристики біоелектричної активності головного мозку.

Висновки. Результати дослідження свідчать про достовірну нормалізацію показників спірографії у дітей, хворих на бронхіальну астму під впливом обраних музичних мелодій певної частоти. Ефективність впливу звуку на центральні механізми регуляції вентиляційної здатності бронхів може бути використана з профілактичною та лікувальною метою.

Ключові слова: вентиляційна функція бронхів; амплітудно-частотні характеристики; електроенцефалографія; біоелектрична активність мозку; абсолютна спектральна густина потужності.

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