

The main aspects of physical therapy in children with bronchial asthma

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Purpose. The study of clinical features of the course of bronchial asthma and the study of the effectiveness of the use of therapeutic measures with the involvement of physical therapy in children living in Zaporizhzhia and from the Zaporizhzhia region, taking into account their physical development and indices of the initial vegetative tonus and vegetative provision.

Materials and methods. According to the set task, the first group of observation included 87 children with bronchial asthma (BA) living in Zaporizhzhia, 57 of which were boys and 30 girls, and the second group consisted of 40 children with BA from the Zaporizhzhia region, 24 of which were boys and 16 girls. As a comparison, 56 practically healthy children (31 boys and 25 girls) who formed the control groups (CGs) were examined. Thus, 29 of them (16 boys and 13 girls) from Zaporizhzhia made the CGI and 27 children (15 boys and 12 girls) from Zaporizhzhia region were included in CGII. The average age of the examined children was 11.40 ± 3.68 years. To evaluate the effectiveness of physical therapy in children with bronchial asthma, their catamnesic observation has been conducted for at least 2 years. Statistical data processing was performed by commonly used methods of variation statistics of the licensed software package Statistica for Windows 13 (StatSoft Inc., № JPZ804I382130ARCN10-J).

Results. Bronchial asthma in children, irrespective of place of residence, clinical course and severity, was characterized by a mild and moderate persistent course in 50.57 % and 40.23 % of urban and 47.50 % and 45.00 % of regional patients with obstructive type of violation of bronchial conduction. Physical development of children with bronchial asthma, grown up in the conditions of district centers, had more often harmonious physical development (85.00 %) than patients from the city (56.32 %) ($P < 0.05$), and, on the contrary, disharmonious prevailed in urban patients (43.68 %) and was less common in regional (15.00 %) patients, mainly in boys (59.65 % vs. 16.67 %, $P < 0.05$). In all patients with bronchial asthma, unlike healthy children from control group, eutonia (34.48 % and 42.50 %) was rarely recorded but more often sympathicotonia (33.33 % and 32.50 %) and vagotonia (32.18 % and 25.00 %) with a significant difference with the control group of the regional children with asthma for the hypersympathicotonic version of vegetative provision and in urban areas for sympathoasthenic, asthenosympathetic and hyperdiastolic variants.

Conclusions. The use of physical therapy in the treatment of children with bronchial asthma has significantly reduced complaints, disease symptoms, accelerated remission and increased its duration to 24 months and reduced the risk of transformation of the disease into more severe forms.

Ключові слова:

фізична терапія,
бронхіальна астма,
фізичний розвиток,
вегетативний
тонус, вегетативне
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Основні аспекти фізичної терапії дітей із бронхіальною астмою

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Мета роботи – вивчення клінічних особливостей перебігу бронхіальної астми та дослідження ефективності лікувальних заходів із залученням засобів фізичної терапії в дітей, які проживають в м. Запоріжжя та Запорізькій області, враховуючи їхній фізичний розвиток і показники вихідного вегетативного тону та вегетативного забезпечення.

Матеріали та методи. Враховуючи мету дослідження, в I групу спостереження залучили 87 дітей із бронхіальною астмою (БА), які проживають у м. Запоріжжя, із них 57 хлопців і 30 дівчат; II група – 40 дітей із БА з Запорізької області, з них – 24 хлопці і 16 дівчат. Для порівняння обстежили 56 практично здорових дітей (31 хлопець і 25 дівчат), які утворили контрольні групи (КГ). Так, з-поміж них 29 дітей (16 хлопців та 13 дівчат) із м. Запоріжжя увійшли у КГІ, 27 дітей (15 хлопців і 12 дівчат) із Запорізької області утворили КГІІ. Середній вік обстежених дітей становив $11,40 \pm 3,68$ року. Для оцінювання ефективності фізичної терапії в дітей із БА виконали катамнестичне спостереження тривалістю не менше ніж 2 роки. Статистичне опрацювання даних виконали, використовуючи загальноприйняті методи варіаційної статистики ліцензійного пакета програм Statistica for Windows 13 (StatSoft Inc., № JPZ804I382130ARCN10-J).

Результати. Бронхіальна астма в дітей, незалежно від місця проживання, характеризувалась легким і середньотяжким персистентним перебігом у 50,57 % і 40,23 % міських та в 47,50 % і 45,00 % обласних хворих, з обструктивним типом порушення бронхіальної провідності. Фізичний розвиток дітей із БА, які проживали в умовах районних центрів, частіше характеризувався гармонійним фізичним розвитком (85,00 %), ніж пацієнтів з міста (56,32 %) ($p < 0,05$), а дисгармонійний переважав у міських (43,68 %) і рідше виявлений в обласних (15,00 %) пацієнтів, здебільшого у хлопчиків (59,65 % проти 16,67 %, $p < 0,05$). У всіх дітей із БА, на відміну від здорових з групи контролю, вірогідно рідше реєстрували ейтонію (34,48 % та 42,5 % відповідно), частіше – симпатикотонію (33,33 % і 32,50 %) та ваготонію (32,18 % і 25,00 % відповідно) з вірогідною відмінністю від показників груп контролю в обласних дітей із БА за гіперсимпатикотонічним варіантом вегетативного забезпечення, в міських – за симпатикоастенічним, астеносимпатичним і гіпердіастолічним варіантами.

Висновки. Застосування фізичної терапії під час лікування дітей із БА дало можливість вірогідно зменшити скарги, симптоми захворювання, прискорити ремісію та збільшити її тривалість до 24 місяців і знизити ризик трансформації захворювання в тяжчі форми.

Основные аспекты физической терапии детей с бронхиальной астмой

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Цель работы – изучение клинических особенностей течения бронхиальной астмы и эффективности лечебных мероприятий с использованием средств физической терапии у детей, проживающих в г. Запорожье и Запорожской области, учитывая их физическое развитие и показатели исходного вегетативного тонуса и вегетативного обеспечения.

Материалы и методы. В соответствии с поставленной целью, I группу наблюдения составили 87 детей с бронхиальной астмой (БА), проживающие в г. Запорожье, из них 57 мальчиков и 30 девочек; II группа – 40 детей с БА из Запорожской области, из них 24 мальчика и 16 девочек. Для сравнения обследовали 56 практически здоровых детей (31 мальчик и 25 девочек), составившие контрольные группы (КГ). Так, из них 29 детей (16 мальчиков и 13 девочек) из г. Запорожья вошли в КГ I, 27 детей (15 мальчиков и 12 девочек) из Запорожской области – в КГ II. Средний возраст обследованных детей составил $11,40 \pm 3,68$ года. Для оценки эффективности физической терапии у детей с БА проведено их катamnестическое наблюдение не менее 2 лет. Статистическая обработка данных проведена с использованием общепринятых методов вариационной статистики лицензионного пакета программ Statistica for Windows 13 (StatSoft Inc., № JPZ804I382130ARCN10-J).

Результаты. Бронхиальная астма у детей, независимо от места проживания, характеризовалась легким и среднетяжелым персистирующим течением у 50,57 % и 40,23 % городских, а также у 47,50 % и 45,00 % областных пациентов с обструктивным типом нарушения бронхиальной проводимости. Физическое развитие детей с БА, жителей районных центров, чаще характеризовалось гармоническим физическим развитием (85,00 %), чем городских пациентов (56,32 %) ($p < 0,05$), а дисгармоническое преобладало у городских (43,68 %) и реже отмечено у областных (15,00 %) пациентов, преимущественно у мальчиков (59,65 % против 16,67 %, $p < 0,05$). У всех детей с БА, в отличие от здоровых из группы контроля, достоверно реже зарегистрирована эйтония (34,48 % и 42,50 % соответственно), чаще – симпатикотония (33,33 % и 32,50 % соответственно) и ваготония (32,18 % и 25,00 % соответственно) с достоверным отличием от группы контроля у областных детей с БА по гиперсимпатикотоническому варианту вегетативного обеспечения, у городских – по симпатикоастеническому, астеносимпатическому и гипердиастилическим вариантам.

Выводы. Использование физической терапии при лечении детей с БА позволило достоверно снизить частоту жалоб, симптомов заболевания, ускорить ремиссию, увеличить ее длительность до 24 месяцев и снизить риск трансформации заболевания в более тяжелые формы.

Ключевые слова:
физическая терапия, бронхиальная астма, физическое развитие, вегетативный тонус, вегетативное обеспечение, дети.

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At the current stage, the international statistics show that the incidence of bronchial asthma among the children of both Europe and America ranges from 4.5 % to 10.0 %. Today in all countries diagnosis and treatment of bronchial asthma are carried out in accordance with the recommendations of the Global Initiative for Asthma, GINA 2017, and the personified approach to the treatment of severe courses of bronchial asthma involves the use of biological agents as well [1–3].

However, sometimes the use of medication alone does not allow achieving full control of the disease, and even more often the patient's full dependence on the use of drugs is observed. That is, already with the achievement of long-term control over bronchial asthma, with the reduction of the amount of therapy and return to a lower degree of treatment, the practitioner and the patient face the problem of recurrence of symptoms of bronchial asthma exacerbation and return to pre-treatment. Thus, having achieved control at high doses of inhaled glucocorticosteroids or medications for combined baseline control therapy, the transition to monotherapy or low doses of steroids is accompanied by a so-called drugs cessation syndrome. Bronchial asthma is a "heterogeneous disease", with a multiplicity of pathogenetic links forming a chronic inflammation of the bronchi, which leads to bronchospasm and is characterized by various phenotypes [4]. In addition, from the point of view of pathological physiology, bronchial asthma refers to adaptation disease [5].

Therefore, we paid attention to the application of physical therapy in patients with bronchial asthma that allow reflexively to achieve bronchodilation, normalize disorders of vegetative tonus and naturally affect the physiology of the processes of adaptation of the child.

Aim

The study of clinical features of the course of bronchial asthma and the study of the effectiveness of the use of therapeutic measures with the involvement of physical therapy in children living in Zaporizhzhia and from the Zaporizhzhia region, taking into account their physical development and indices of the initial vegetative tonus and vegetative provision.

Materials and methods

According to the set task, the first group of observation included 87 children with bronchial asthma (BA) living in Zaporizhzhia, 57 of which were boys and 30 girls, and the second group consisted of 40 children with BA from the Zaporizhzhia region, 24 of which were boys and 16 girls. As a comparison, 56 practically healthy children (31 boys and 25 girls) who formed the control groups (CGs) were examined. Thus, 29 of them (16 boys and 13 girls) from Zaporizhzhia made the CGI and 27 children (15 boys and 12 girls) from Zaporizhzhia region were included in CGII. The average age of the examined children was 11.40 ± 3.68 years. To evaluate the effectiveness of physical therapy in children with bronchial asthma, their catamnestic observation has been conducted for at least 2 years.

Clinical and instrumental examination to determine the patient's condition and peculiarities of the disease course included the collection of complaints, anamnesis of the disease and life, physical examination, anthropometry, measurement of blood pressure, registration of spirometry and was conducted in the conditions of the clinical base of the Pediatrics Department of the Zaporizhzhia State Medical

Table 1. Indicators of the function of external respiration in children (Me (Q25–Q75))

Groups of children with BA	VC (l)	FVC (l)	FEV1 (l)	FEV1/FVC%	MEF25 (l/s)	MEF50 (l/s)	MEF75 (l/s)
I n = 87	3.00 (2.32–3.51)	2.82 (2.18–3.48)	2.24 (1.78–2.75)	79.73 (65.36–89.5)	3.64 (2.3–4.48)	2.55 (1.85–3.29)	1.70 (1.01–1.97)
CGI n = 29	4.75 (3.89–4.99)	4.35 (3.90–4.69)	4.06 (3.72–4.32)	93.45 (89.70–96.2)	6.89 (6.32–7.44)	5.91 (5.48–6.03)	3.57 (3.24–3.83)
P I – CGI	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	P AD – BA
Zaporizhzhia region							
II n = 40	3.18 (2.78–3.51)	3.15 (2.45–3.45)	2.20 (1.81–2.68)	81.55 (65.36–86.30)	3.49 (2.20–4.48)	2.67 (1.85–3.29)	1.70 (1.01–2.07)
CGII n = 27	4.64 (3.71–4.98)	4.14 (3.67–4.76)	4.1 (3.52–4.52)	92.9 (88.6–95.8)	6.89 (6.36–7.19)	5.72 (5.23–6.35)	3.67 (3.01–3.88)
P II – CGII	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

University – at the Allergology Department of the Zaporizhzhia City Children's Hospital № 5. A physical growth and development was studied by anthropometric measurements (weight, height, head and chest circumference). Tables of central distribution of the main anthropometric indicators for children were used to assess the physical growth. Pulmonary function tests (PFT) were performed on a computer complex with adapted software "Spirokom" TU U 33.1-02066769-005-2002 (Kharkiv). The autonomic nervous system baseline tone was identified according to A. M. Vane (1987) table. The autonomic nervous system activity was assessed by a conventional procedure (N. A. Belokon, M. B. Kubergger, 1987). Statistical data processing was performed by commonly used methods of variation statistics of the licensed software package Statistica for Windows 13 (StatSoft Inc., № JPZ8041382130ARCN10-J). The normal distribution was checked using the Shapiro-Wilk test. When comparing statistical aggregates, parametric (with normal distribution of values) or nonparametric (in the distribution of values other than normal) statistical methods were used. Thus, the median and interquartile intervals were calculated, the two independent groups were compared according to the Mann-Whitney test, by criterion χ^2 , "Fisher exact p, two-tailed", and "2 × 2 Table", and dependent on Wilcoxon's criterion, with $P < 0.05$ the differences were considered statistically admissible.

Results

The analysis of the clinical picture in the examined children with BA showed that regardless of place of residence, about one third of children were hospitalized during the period of exacerbation of the disease, namely 28.74 % of those examined children from Zaporizhzhia and 27.50 % from Zaporizhzhia region. In the remission period 71.26 % and 72.50 % of children with BA, from city and region, respectively, consulted the allergist for an annual check-up. By the clinical course and severity, bronchial asthma was predominantly characterized by a mild and moderate persistent flow (in 50.57 % and 40.23 % of urban and 47.50 % and 45.00 % of regional patients) (Fig. 1).

For further investigation of the function of external respiration (FER) in this group of children, a spirographic study has been conducted and the volumetric and high-speed FER values were determined. Determination of FER parameters occurred according to the requirements of ATS PFT Committee [6]. Taking into account that dynamic pulmonary and volume flows are measured during the forced exhalation therefore when the maximum effort is applied

during the respiratory maneuver, from three attempts of forced exhalation the better one of the obtained values was selected and analyzed. Then, a comparison was made with the individual norm, which was calculated for each patient, taking into account age, sex, and height [7].

The stage of functional disorders was evaluated according to generally accepted indicators: volume and speed parameters of forced exhalation: vital capacity of the lungs (VC); the forced vital capacity of the lungs (FVC), the absolute (FEV1) and the relative (FEV1/FVC) volume of forced exhalation during the first second, the maximal instantaneous expiratory flow (MEF) 25 %, 50 %, 75 %, (MEF 25, MEF 50, MEF 75). The practical assessment of the degree of indicators reduction was carried out on the basis of gradations of normal values and deviations from the norm of the main indicators of the curve "loop flow – volume". If necessary and / or in the absence of signs of reverse bronchial obstruction, a functional-pharmacological test of 200 µg or 400 µg (depending on the child's age) of salbutamol (ventolinum) was performed. Volumetric and high-speed FERs are presented in Table 1.

Registered data showed that in children with bronchial asthma both from Zaporizhzhia, and Zaporizhzhia region there was a decrease in all indicators of FER. It should be noted that although the obstructive type of violation of FER predominated in this group of children, in rare cases a restrictive or mixed type of respiratory failure there was, and in the structure of violations of bronchial patency, only light and moderate disorders prevailed. In children with bronchial asthma, irrespective of place of residence, there occurred a uniform decrease in all indicators of MEF, which testified to the total type of bronchial obstruction. However, among children there were also patients with no changes in parameters of the parameters of the external respiration found even after a short-acting beta-agonist pharmacological test, or the reaction was somewhat ambiguous, while the wide limits of the norm in assessing pulmonary tests made complicated the determination of minimal deviations. Thus, among the urban children with asthma, no FER changes were detected in 15.20 % of children and among regional ones – in 16.38 % ($P > 0.05$). Consequently, the conducted analysis of the results of the spirographic examination of children in general showed that the disorders of the function of external respiration are characteristic for children with bronchial asthma and do not depend on the place of children's residence.

For assessment objectification of the somatic state of children with bronchial asthma and reflection of physiological processes occurring in the body, we analyzed the state of

physical development of the examined children, which most significantly reflected the general health and physiological processes occurring in the child's body. To characterize the physical development of children we calculated the most informative indicators – height, weight, chest measurement, which was compared with age standards. It was found that average physical development, or mesosomatic somatotype, was registered in 50.57 % of sick children from the city and in 82.51 % – from the region (Table 2). Physical development above average (macrosomatic somatotype) was detected at a frequency of 36.78 % in urban children versus 10.00 % of regional children with asthma.

Only the physical development below the average (microsomatic somatotype) level was significantly more often registered in urban than in regional children with allergic diseases (12.64 % vs 5.00 %). Assessment of the harmony of the physical development of the examined children is presented in Table 3. Children with BA, which grew in the conditions of district centers, had more harmonious physical development (85.00 %) than patients from the city (56.32 %) ($P < 0.05$), and the disharmony, on the contrary, prevailed in urban (43.68 %) and was less often found in regional (15.00 %) patients, mainly in boys (59.65 % vs 16.67 %, $P < 0.05$).

The conducted analysis of the indicators of the autonomic nervous system showed that all children with bronchial asthma, irrespective of their place of residence, in contrast to healthy ones, were significantly less likely to be registered in the eutonia, and more often sympathicotonia and vagotonia (Fig. 2). Namely, the eutonia was recorded in 34.48 % of urban patients and in 42.50 % of the regional patients, significantly less often than in urban healthy people (93.10 %) and in regional healthy people (88.89 %).

Regardless of the place of residence, sympathicotonia was significantly more often registered in patients with 33.33 % and 32.50 % than in healthy children (3.45 % and 3.70 %), respectively, in the city and in the region, which was mainly due to cerebral ergotropic, humoral and metabolic influences. Vagotonia, indicating the presence of the humoral way of central regulation with the intensity of adaptation and adaptation mechanisms, was recorded in 32.18 % of urban and 25.00 % of regional children with asthma, more often than in healthy children in Zaporizhzhia (3.45 %) and Zaporizhzhia region (7.41 %).

For the complete description of vegetative homeostasis, we have analyzed the vegetative provision in the examined children. Comparative characteristics of vegetative provision in patients and healthy children, depending on the place of residence are presented in Fig. 3.

In assessing vegetative provision reflecting the support of the optimal level of functioning of the autonomic nervous system, it was found that, unlike healthy children, normal vegetative provision was found only in 12.64 % and 15.00 % of children with BA from Zaporizhzhia and Zaporizhzhia region against 86.21 % and 85.19 % of healthy urban and regional residents.

In patients, regardless of their place of residence, all types of vegetative provision were available. A reliable difference with the control group was observed in the registration of excessive inclusion of the sympathicoadrenal system, which was characterized by a hypersympathicotonic version of vegetative provision, only in children from the Zapo-

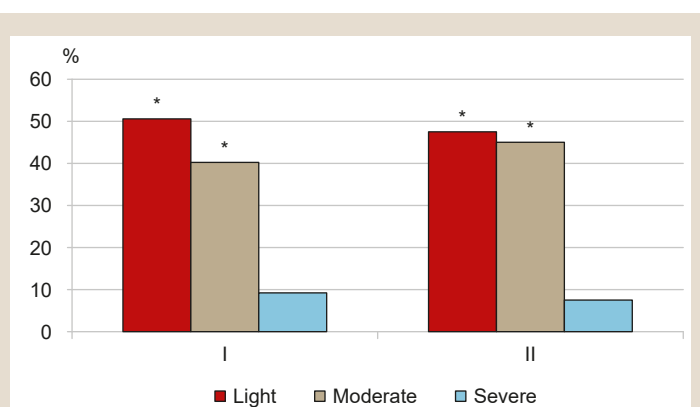


Fig. 1. Stages of severity of persistent bronchial asthma in children.

*: $P < 0.05$, the reliability of the difference within each group of patients examined between the mild to moderate and severe severity of the disease.

Table 2. Physical development of children with allergic diseases (abs / %)

Diagnosis	Children	n	Low ¹	Medium ²	High ³
Zaporizhzhia city					
BA	Girls	30	5 / 16.67	21 / 70 ^{1,3}	4 / 13.33
	Boys	57	6 / 10.53 ³	23 / 40.35 ¹	28 / 49.12
	Total number	87	11 / 12.64 ³	44 / 50.57 ¹	32 / 36.78
Zaporizhzhia region					
BA	Girls	16	1 / 6.25	13 / 81.25 ^{1,3}	2 / 12.5
	Boys	24	1 / 4.17	21 / 87.5 ^{1,3}	2 / 8.33
	Total number	40	2 / 5	33 / 82.5 ^{1,3}	4 / 10
P_B city-region			>0.05	<0.05	>0.05
P_T city-region			>0.05	<0.05	<0.05

^{1,3}: $P < 0.05$ – the significance of the differences between groups of children with low and high physical development; P_B : the significance of the differences between boys from the city and region, P_T : the significance of the differences between all the children examined from the city and region.

Table 3. Assessment of the harmony of physical development of children with allergic diseases (abs / %)

Diagnosis	Children	n	Harmonic	Disharmonic
Zaporizhzhia city				
BA	Girls	30	26 / 86.67*	4 / 13.33
	Boys	57	23 / 40.35	34 / 59.65
	Total number	87	49 / 56.32	38 / 43.68
Zaporizhzhia region				
BA	Girls	16	14 / 87.5*	2 / 12.5
	Boys	24	20 / 83.33*	4 / 16.67
	Total number	40	34 / 85.00*	6 / 15.00
P_B city-region			<0.05	<0.05
P_T city-region			<0.05	<0.05

*: $P < 0.05$ – the significance of the differences between groups of children; P_B : the significance of the differences between boys from the city and region, P_T : the significance of the differences between all examined children from city and region.

rizhzhia region (32.5 % vs 3.7 %). Children with BA, living in Zaporizhzhia, had sympathetic asthenia (16.09 %) and asthenosympathetic (19.54 %) variants of vegetative provision more often than healthy children (0.00 % and 3.45 %). The most disadaptable version of vegetative provision (hyperdiastolic) occurred in 21.84 % of patients in the city and wasn't registered at the appropriate control group.

Subsequently, during the treatment and physical therapy of children with BA, the patients were divided into two observation groups (OG): the first group (OG1) included 50

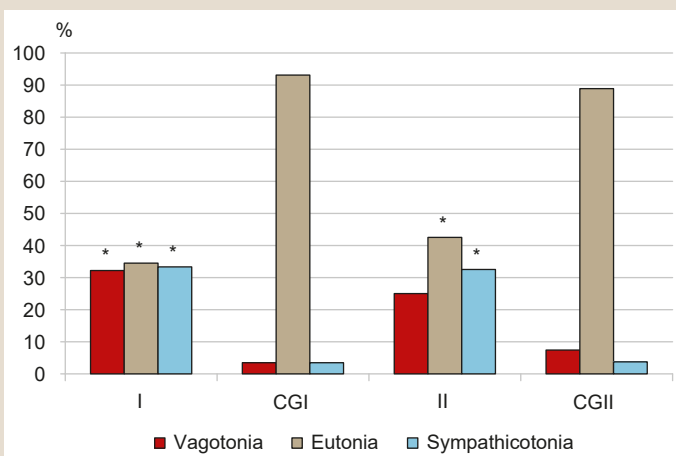


Fig. 2. Outgoing vegetative tone in children.

*: P < 0.05 when compared to healthy ones.

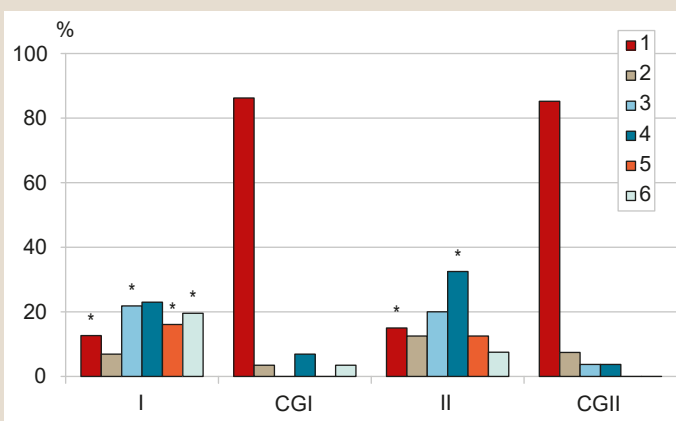


Fig. 3. Vegetative provision in children.

1: normal; 2: asymphticotonic; 3: hyperdiastolic; 4: hypersymphticotonic; 5: symphticoasthenic; 6: asthenosymphtic; *: P < 0.05 – in comparison with healthy children from control groups.

children who were receiving basic control therapy based on the “Unified clinical protocol of primary, secondary (specialized) medical aid”, approved by the Order of the Ministry of Health of Ukraine No. 868 dated 08.10.2013 and recommendations of the Global Initiative for Asthma, GINA 2017; the second group (OG2) included 77 children who received basic medical control therapy and physical therapy.

Physical therapy included non-medicated methods of treatment, namely: breathing exercises, therapeutic physical exercises, cold water treatment, health resort (mountain-climatic) treatment with speleotherapy, which are capable of increasing the adaptive-compensatory possibilities of the child’s body, reducing the sensitivity of irritative receptors to the effect of overcooling, excessive moisture or drying, to stabilize the membranes of mast cells to factors that cause non-specific degranulation, to normalize the function of the autonomic nervous system and blood supply to the tissues, contribute to the mobilization of protective-adaptive processes, accelerate the regression of chronic allergic inflammation. They combined well with baseline therapy and allowed to reduce the incidence of clinical manifestations of the disease and increase

the duration of the remission period. Physical therapy is described below [8,9].

Speleotherapy (halotherapy) is one of the most popular methods of Alternative medicine and it was used for bronchial asthma children. The main factors of halochambers environment are a finely dispersed sodium chloride aerosol as well as negative air ions. Halo-aerosol treatment efficacy on bronchial airways is due to the effect on inflammatory component and sputum rheological properties resulting in an increased mucociliary clearance velocity. The generally accepted duration of the procedure for bronchial asthma children, taking into account the disease severity and child’s age, is 30 minutes with a gradual increase in time to 45–60 minutes within 20 days [10].

Physiotherapy exercises included performing exercises for flexion, extension, abduction, adduction, limb rotation, as well as trunk leaning and bending forward, especially for chest and abdominal muscles therapy training. The exercises were performed in both a vertical position and sitting on a chair or on a special stretch mat. A program per exercise depended on a patient’s condition ranging from 4 to 10 sessions. Exercises and active ball games were involved. A session ended with a short relaxation between the physical activities. The following is a common complex of therapeutic gymnastics in bronchial asthma for school-age children.

1. Starting position (SP) – standing, feet together, arms down by sides. Toe of foot touching the floor behind simultaneously raising hands forward and up with palms inward, backbend – inhale, arm down by the sides slowly – exhale. To pronounce a drawl sound M-M-M during expiration with a closed mouth. To repeat 4–5 times.

2. SP – the same, legs apart, arms down by sides, raising arms fore-inward – inhale, toe touch bending slowly, swinging in a flexed position (body with hips flexed, legs straight, knees locked!), several toe touches – exhale. To pronounce a sound Z-Z-Z during expiration. To repeat 3-4 times.

3. SP – the same, legs astride, lifting up arms with a gymnastic stick. Inhale – trunk, arms and stick lean left – exhale. To take the SR – inhale, the same lean right – exhale. To pronounce a drawl sound U-H-H-H during expiration. To repeat 3–4 times on either side.

4. SP – lying flat on back (on the mat), stretched legs, arms by sides. Inhale – to bend knees, wrap straight arms around knees and press to chest – exhale. To pronounce a drawl and loud sound P-F-F-F during expiration. To repeat 3–4 times

5. SP – the same, joined legs, arms overhead (lying on the mat). Inhale – straight-arm swing and a sitting position moving, to stretch forward trying to touch toes – drawling exhale with a simultaneous loud sound B-A-A-H-H-H-H-H pronunciation. To repeat 3–4 times.

6. SP – standing, feet together, arms down by sides. Rising on toes, shoulders backward, palms outward, backbend – inhale. To take the SR – exhale with a drawl sound Sh-Sh-Sh pronunciation. To repeat 4–5 times.

7. SP – the same, feet together, arms down by sides, then arms to side-up, backbend – inhale, slow squat, wrap arms around knees and press to chest, neck bend – exhale pronouncing loudly a sound O-H-H-H. To repeat 8–10 times.

8. Walking quietly around the room, nasal freely breathing – 2–3 minutes.

9. SP – sitting back on a chair, arms down by sides, muscles relaxed. Arms to the sides, backbend – inhale, arms folded across the chest slowly pressing, to tuck stomach in, neck bend – exhale. Drawling exhale, purse lips, up to full exhalation with a sound F-F-F pronunciation. To repeat 4–5 times.

Vibration therapeutic massage or total body massage was also used. A neck-collar or spine massage was performed in concomitant sympathicotonia, while a lower extremity and abdominal massage – in vagotonia. The course of treatment consisted of 15–20 sessions. Chest massage included percussion, vibration and postural drainage. During a bronchial asthma attack, the massage involved the chest wall muscles and intercostal spaces as well as abdominal muscles. In addition, the treatment and rehabilitation complex included the influence of decimeter-range electromagnetic waves and high-frequency therapy on the areas of pulmonary hilum projection [10].

The most effective respiratory exercise that reflexively contributed to the expansion of bronchi was slow inhalation of air through the nose and its slow exhalation through the mouth with pronouncing sizzling or buzzing sounds “SH”, “F”. The most effective breathing exercises contributing to reflex bronchodilation were slow nasal inhalation slow exhalation through the mouth pronouncing fricative or buzzing sounds “Sh”, “Zh”. The standard “sound gymnastics” consisted of special exercises involving sound pronunciation. A “closed groan” – “mmm” and purifying exhalation – “pff” were performed at the beginning of the sound gymnastics. The vocal cord vibration is transmitted to the trachea, bronchi, lungs, chest resulting in constricted bronchi and bronchioles relaxation during the “sound gymnastics”. The “sound gymnastics” as aimed at developing the inhalation-to-exhalation ratio of 1 : 2. The “sound gymnastics” consists of nasal inhale (1–2 seconds), pause (1 second), active exhale through the mouth (2–4 seconds), pause (4–6 seconds). In addition to “sound gymnastics”, children were asked to breathe into a vessel filled with water through a thin tube, to inflate balloons or bubbles in order to improve ventilation as well as to encourage and enhance the breathing exercises performance [10].

Physiotherapy included physical exercises for flexion, extension, torsion adduction and abduction, limbs, and tilting forward and sideways, especially for strengthening the chest and abdominal muscles. Exercises were carried out both in an upright position, and sitting on a chair or on a special carpet. The number of repetitions of the exercises depended on the patient’s condition, but on average ranged from 4 to 10. The exercises with balls and active ball games were involved. Between the exercise loads there was a relaxing short rest. The “vibrational” therapeutic massage or a general massage was also carried out. With the underlying sympathicotonia, a massage was done on the cervico-collar area or spine, with vagotonia the massage of the lower extremities and abdomen was carried out. The course of treatment consisted of 15–20 procedures.

Hydrotherapeutic procedures were also performed for BA children rehabilitation depending on the baseline autonomic nervous system tone [11].

Domiciliary we used dousing with water, rubdown, contrasting shower and subsequent rubbing with a rough towel and developing resistance to cold.

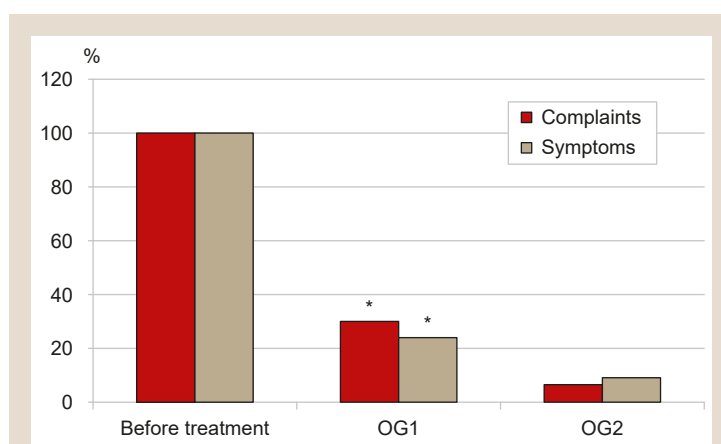


Fig. 4. Dynamics of complaints and bronchial asthma symptoms frequency in children before and after medical and physical therapy measures.

*: $P < 0.05$ – in comparison with the corresponding observation group.

The main principle of developing resistance to cold was cold water treatment, as the most effective form of increasing the overall resistance of the organism. The irritating effect of water on skin receptors and blood vessels has a strengthening effect, increasing the general resistance of the body to cold. Hydrotherapeutic procedures stimulate metabolism, toning up the cardiovascular and nervous systems. By the intensity of health effect on the body, hydrotherapeutic procedures can be arranged in the following order: washing, rubbing, dousing with water, shower, bathing.

Washing of face, hands, neck and chest is with water at temperature from $+28^{\circ}\text{C}$ to $+24 \dots +20^{\circ}\text{C}$.

Wet rubbing has been carried out after dry rubbing for 5–7 days. Wet wiping is considered as the best to be done in the morning hours with a general hygienic purpose. Hands, chest, abdomen, back, buttocks, legs are rubbed to reddening with a wet flannel or a soft woolen glove (the limbs should be rubbed from the periphery to the center), followed by rubbing with a dry towel. The recommended temperature for children of 2–4 years is within fluctuations from $+32 \dots +33^{\circ}\text{C}$ to $+24 \dots +25^{\circ}\text{C}$, for children of 5–7 years it is from $+30 \dots +32^{\circ}\text{C}$ to $+20 \dots +21^{\circ}\text{C}$, for schoolchildren – from $+30$ to $+17 \dots +18^{\circ}\text{C}$. The duration of the procedure is 2–5 minutes with the course length of 1.5–2.0 months.

Dousing with water. After a hygienic bath the child should be poured over with 2–3 liters of water at a lower temperature. By lowering the water temperature by 1°C every 4–5 days, it should be reduced from $+35 \dots +36^{\circ}\text{C}$ to $+25^{\circ}\text{C}$. With the time it is possible to recommend conducting independent water dousing with gradual decrease of water temperature to $+19 \dots +20^{\circ}\text{C}$. Afterwards the child should be rubbed with a dry towel.

Shower is carried out to children after a course of wet rubbing. The water temperature should be pleasant for a child. Duration of the procedure should be from 1.0–1.5 minutes for babies of the first two years of life to 3–5 minutes for older children. Initial water temperature is $+36^{\circ}\text{C}$ with a decrease of 1°C every 5–7 days to $+28^{\circ}\text{C}$.

Swimming activities should be carried out in 1.0 to 1.5 hours after eating. Swimming should be preceded by a light

massage and exercises for the limbs simulating the swimmer's movements (10 to 15 movements in 20–30 seconds). The swimming procedure gradually increases from 10–15 minutes to 40–50 minutes with the simultaneous decrease in water temperature from +36 ... +37 °C to +22 ... +23 °C (decrease by 1 °C every 4–5 days). When swimming, you must follow the principle of graduality.

In addition during the remission period of the disease, except for swimming, the following was recommended: skiing, skating, riding bicycles, dosed walking and, if possible, health resort (mountain-climatic) treatment with speleotherapy.

The effectiveness of the treatment and physical therapy measures was evaluated according to the dynamics of complaints and symptoms of the clinical course of asthma in children (Fig. 4).

According to the observation data, after the treatment and physical therapy measures in children with allergic diseases, complaints and clinical manifestations of the disease were reliably regressed in the dynamics.

It was noted that in children of the OG1 group remission lasted from 6 to 12 months with 66 % of the therapy effectiveness and in children of the OG2 group up to 24 months with 89.6 % of the therapy effectiveness, whereby the high efficiency of treatment and physical therapy measures in the OG2 group was due to both the long absence of clinical manifestations of allergic diseases, and the normalization of indicators of spirographic research, indicators of physical development, initial vegetative tonus and vegetative provision in children with bronchial asthma.

Thus, the use of physical therapy in the treatment of children with bronchial asthma, which allowed to increase the efficiency of conventional basic therapy with a decrease in complaints and symptoms, increase in the length of the remission period and a reduction in the risk of transformation of the disease in more severe forms, gave grounds to recommend it for use in pediatric practice.

Discussion

The conducted analysis of the scientific articles review on the issue of using physical therapy in the treatment of patients with asthma showed that physical therapy, which included gymnastic exercises, breathing exercises, manual therapy and other physiotherapeutic methods in postural position, along with pharmacotherapy decreased the frequency daytime BA symptoms from 94.0 % to 28.0 %; at night from 54.7 % to 7.1 %; leading to a frequency decrease in the use of bronchodilators, improvement of spirometry, peak flow measurements, and advance in life quality and disease control [12,13].

As well as in our study, V. Polkovnyk-Markova, L. Dugina have noted that 31.9 % of children with asthma had disharmonious physical development, mainly with a decrease in adaptive reserves of respiratory and cardiovascular systems, which required inclusion in therapy of physical therapy methods using breathing exercises, special physical exercises and games [14].

The organization of physical therapy of children with bronchial asthma, carried out on the basis of the integrated use of natural therapeutic factors, medication and non-medication therapy and other methods, includ-

ing physical therapy, is widely covered in the works of B. V. Dykyi, M. V. Rostock-Reznikov and N. A. Lian, M. A. Khan, and the effectiveness of physiotherapy treatment methods in patients with asthma is considered in the article of Marjolein L. J. Bruurs, Lianne J. van der Giessen, Heleen Moed [8, 15, 16].

Pieshkova O. V., Avramenko O. M., Mitko O. V., Tretyak L. O. also proved the positive influence of physical therapy in the examined girls, which included medical gymnastics and respiratory exercises with elements of general and local muscle relaxation, nasal breathing, therapeutic massage, physiotherapy, autogenous training and procedures developing resistance to the cold, on indicators of breast circle and excursions, respiratory rate, heart rate, arterial systolic and pulse pressure parameters, vital lung capacity, inspiratory rate, indicators of Stange's and Genci's test samples [17].

Statiyev S.I. also analyzed the effects of physical therapy on the respiratory system of children with bronchial asthma and proved the effectiveness of this therapy, but warned that gymnastics classes would only produce effect if they were systematic and regular [18].

Conclusions

1. Bronchial asthma in children, irrespective of place of residence, clinical course and severity, was characterized by a mild and moderate persistent course in 50.57% and 40.23 % of urban and 47.50 % and 45.00 % of regional patients with obstructive type of violation of bronchial conduction.

2. Physical development of children with bronchial asthma, grown up in the conditions of district centers, had more often harmonious physical development (85.00 %) than patients from the city (56.32 %) ($P < 0.05$), and, on the contrary, disharmonious prevailed in urban patients (43.68 %) and was less common in regional (15.00 %) patients, mainly in boys (59.65 % vs. 16.67 %, $P < 0.05$).

3. In all patients with bronchial asthma, unlike healthy children from control group, eutonia (34.48 % and 42.50 %) was rarely recorded but more often sympathicotonia (33.33 % and 32.50 %) and vagotonia (32.18 % and 25.00 %) with a significant difference with the control group of the regional children with asthma for the hypersympathicotonic version of vegetative provision and in urban areas for sympathoasthenic, asthenosympathetic and hyperdiastolic variants.

4. The use of physical therapy in the treatment of children with bronchial asthma has significantly reduced complaints, disease symptoms, accelerated remission and increased its duration to 24 months and reduce the risk of transformation of the disease into more severe forms.

Prospects for further researches. In the future, we plan to investigate the impact of the combined physical therapy on the indicators of cellular and humoral immunity of children both with bronchial asthma and other allergic diseases.

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References

- [1] (2017). Hlobalna stratehiia likuvannia ta profilaktyky bronkhialnoi astmy (Global Initiative for Asthma, GINA), perehliad 2017 r. Rozdil 4. Likuvannia pohirshennia perebihu ta zahostrennia bronkhialnoi astmy (u doroslykh, pidlitkiv i ditei starshykh za 6 rokov) [Global Strategy for Asthma Management and Prevention (Global Initiative for Asthma, GINA), updated 2017. Chapter 4. Magement of Worsening Asthma and Exacerbations (Adults, Teens, and Children older than 6 Years)]. *Astma ta alerhiia*, (3), 72-83. [in Ukrainian].
- [2] Papadopoulos, N. G., Čustović, A., Cabana, M. D., Dell, S. D., Deschildre, A., Hedlin, G., Hossny, E., Le Souëf, P., Matricardi, P. M., Nieto, A., Phipatanakul, W., Pitrez, P. M., Pohunek, P., Gavornikova, M., Jaumont, X., & Price, D. B. (2019). Pediatric asthma: An unmet need for more effective, focused treatments. *Pediatric Allergy and Immunology*, 30(1), 7-16. <https://doi.org/10.1111/pai.12990>
- [3] Just, J., Deschildre, A., Lejeune, S., & Amat, F. (2019). New perspectives of childhood asthma treatment with biologics. *Pediatric Allergy and Immunology*, 30(2), 159-171. <https://doi.org/10.1111/pai.13007>
- [4] (2017). Kyshenkove kerivnytstvo z likuvannia i profilaktyky bronkhialnoi astmy (u doroslykh i ditei starshe 5 rokov) Global Initiative for Asthma – GINA, perehliad 2017 r. [Pocket Guide for Asthma Magement and Prevention (for Adults and Children older than 5 Years) Global Initiative for Asthma – GINA, updated 2017]. *Astma ta alerhiia*, (2), 43-56. [in Ukrainian].
- [5] Yastrebov, A. P. (Ed.). (2018). *Patofiziologiya neuroendokrinnoi sistemy- [Pathophysiology of the Neuroendocrine System]*. UGMU. [in Russian].
- [6] Culver, B. H., Graham, B. L., Coates, A. L., Wanger, J., Berry, C. E., Clarke, P. K., Hallstrand, T. S., Hankinson, J. L., Kaminsky, D. A., MacIntyre, N. R., McCormack, M. C., Rosenfeld, M., Stanojevic, S., & Weiner, D. J. (2017). Recommendations for a Standardized Pulmonary Function Report. An Official American Thoracic Society Technical Statement. *American Journal of Respiratory and Critical Care Medicine*, 196(11), 1463-1472. <https://doi.org/10.1164/rccm.201710-1981st>
- [7] Jat, K. R. (2013). Spirometry in children. *Primary Care Respiratory Journal*, 22(2), 221-229. <https://doi.org/10.4104/pcrj.2013.00042>
- [8] Dykyi, B. V., & Rostoka-Reznikova, B. V. (2013). *Nemedykamentozni metody v reabilitatsii khvorykh na bronkhialnu astmu [Non-drug methods in rehabilitation of patients with bronchial asthma]*. Uzhhorod. [in Ukrainian].
- [9] Golubev, V. L. (Ed.). (2010). *Vegetativnye rasstroistva: klinika, diagnostika, lechenie [Vegetative disorders: clinic, diagnosis, treatment]*. Meditsinskoe informatsionnoe agentstvo. [in Russian].
- [10] Mykhaliuk, Ye. L., & Reznichenko, Yu. H. *Osoblyvosti fizychnoi reabilitatsii v pediatrii [Characteristics of pediatric physical rehabilitation]*. ZSMU. [in Ukrainian].
- [11] Borysova, T. P., & Abaturov, A. E. (2018). Klinicheskie proyavleniya i korrektsiya vegetativnoi disfunktsii u detei i podrostkov [Clinical

- manifestations and correction of autonomic dysfunction in children and adolescents]. *Zdorov'e rebenka*, 13(6), 588-594. <https://doi.org/10.22141/2224-0551.13.6.2018.143165> [in Russian].
- [12] Astafieva, N., Kobzev, D., Gamova, I., Perfilova, I., & Udovichenko, E. (2011). Physical rehabilitation in asthma management. *European Respiratory Journal*, 38(Suppl. 55), Article 4803.
- [13] Laurino, R., Barnabe, V., Saraiva-Romanholo, B., Stelmach, R., Cukier, A., & Nunes, M. (2012). Respiratory rehabilitation: a physiotherapy approach to the control of asthma symptoms and anxiety. *Clinics*, 67(11), 1291-1297. [https://doi.org/10.6061/clinics/2012\(11\)12](https://doi.org/10.6061/clinics/2012(11)12)
- [14] Polkovnyk-Markova, V., & Dugina, L. (2016). Use motion games in exercise with children with bronchial asthma. *Slobozans'kij nauko-vo-sportivnij visnik*, (1), 54-58.
- [15] Lyan, N. A., & Khan, M. A. (2016). Meditsinskaya reabilitatsiya detei s bronkhial'noi astmoi [Medical rehabilitation of children with bronchial asthma]. *Allergologiya i immunologiya v pediatrii*, (2), 7-20. [in Russian].
- [16] Bruurs, M. L. J., van der Giessen, L. J., & Moed, H. (2013). The effectiveness of physiotherapy in patients with asthma: A systematic review of the literature. *Respiratory Medicine*, 107(4), 483-494. <https://doi.org/10.1016/j.rmed.2012.12.017>
- [17] Peshkova, O., Avramenko, O., Mitko, H., & Tretyak, L. (2013). Kompleksna fizychna reabilitatsiia ditei pry bronkhialnii astmi ii stupenia tiazhkosti na statsionarnomu etapi [Complex physical rehabilitation of children at bronchial asthma of II of the stage of weight on the stationary stage]. *Slobozhanskyi naukovo-sportyvnyi visnyk*, (2), 134-144. [in Ukrainian].
- [18] Statiev, S. I. (2010). Fizychna reabilitatsiia ditei molodshoho shkilnoho viku z bronkhialnoiu astmoiu v umovakh dennoho statsionaru [Physical rehabilitation of primary school children with asthma in day hospital]. *Problemy fizychnoho vykhovannia i sportu*, (6), 125-127. [in Ukrainian].