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Original Article

Effectiveness of physical therapy for schoolchildren with chronic heart failure

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Abstract.
The purpose of the research is to substantiate the structure and content of physical therapy of school children with chronic heart failure of the I–IIA stages of cardiological etiology. The research methods are analysis and generalization of library resources, documentary method, method of questioning, testing, pedagogical and clinical methods of research, methods mathematical statistics. Results. It is found that heart failure remains one of the most urgent problems of modern children's cardiology. It was carried out a therapy examination. It made it possible to determine the functional state of the cardiovascular and respiratory systems, the state of the autonomic system, musculoskeletal system, physical development, exercise tolerance, psychological and emotional status and quality of life of schoolchildren with chronic heart failure. This is the complex approach that has made it possible to detect various violations by different body systems and take into account the individual peculiarities of the child while sectioning means of physical therapy. This approach made it possible to develop and individualize a program of physical therapy for such children that lasted 28 weeks. After the completion of the physical rehabilitation program, the supporting phase continues on a permanent basis. Conclusion. The obtained results pedagogically proved the effectiveness of the developed program of physical therapy at home for schoolchildren with chronic heart failure for changes in functional, psychological, emotional conditions, and life quality. Program of physical therapy may be recommended for application in the practice of treatment and prevention institutions according to established results of the growth of functional capabilities of the cardiovascular and respiratory systems.
Key words: complex examination, program of physical therapy, functional condition, quality of life.

Introduction

The heart failure remains one of the most urgent problems of modern children's cardiology (Domka-Jopek E. *et al.* 2018; Emory Healthcare, 2019; Galan et al., 2019; Grygus et al., 2019a; Kashuba et al., 2021b; Lui G., McGarry C. *et al.* 2019; Pavlova Y., 2015; Savliuk et al., 2020).

It was found out that there are some works devoted to the physical therapy of the adult population suffer from the cardiovascular diseases (CVD) but the lack of studies devoted to physical therapy at children. However, the need to resolve the present medical and social, and scientific and practical problem was identified due to the lack of a scientifically grounded and experimentally proven program of physical therapy for school children with chronic heart failure (CHF) of I–IIA stages (Dido et al., 2021; Kashuba et al., 2021a; Lazko et al., 2021; Nesterchuk et al., 2020; Shestopal et al., 2021; Szczegielniak J. *et al.*, 2015; Chekhovska M. *et al.*, 2017).

The analysis, synthesis and systematization of scientific, methodological and professional literature allowed us to identify that such scholars as Ann Knocke (2012) and Vitomsky V. (2016) emphasize on the necessity of physical activity to prevent the progression of CHF, stabilize the current condition and even to improve the functionality of the body of such children, and hence their quality of life (Grygus et al., 2019b).

Current normative documents of Ukraine do not cover the process of physical therapy of persons with chronic heart failure, in particular their physical activity (Bogdanovska N., 2017).

Thus, in Ukraine there is not enough paid attention to the study of physical therapy of school-age children with chronic heart failure.

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Purpose

The purpose of the research is to substantiate the content of physical therapy of school children with chronic heart failure of the I–IIA stages of cardiological etiology.

Materials and methods of research

To achieve this, we used the following research methods: analysis and generalization of specialized literature on the problem of research; documentary method; method of questioning helped to get information on the regime of the day and leisure time for school-age children with chronic heart failure of I-IIA stages; testing was used to determine the psycho-emotional state of children by hospital scale of anxiety and depression (HADS) (Hospital Anxiety and Depression Scale, A. Zigmond, R. Snaith, 1983) and the methodology "Feeling, activity and mood" (FAM), and the quality of life (in the opinion of children and their parents) by using the questionnaire PedsQL 4.0 (Varni J.W. *et al.* , 2001,2003, 2007; pedagogical methods of research (pedagogical observation, pedagogical experiment); clinical: anthropometry, REEDCO scale (REEDCO Posture Score Sheet), Ketle index, index of stinginess were used to examine the functional state of the children musculoskeletal system and its physical development; breath rate, vital index were used to determine the state of the respiratory system; heart rate, blood saturation (SpO2), left ventricular capacity, Robinson index, blood flow coefficient, adaptive potential were used to determine the functional state of the cardiovascular system; vegetative index of Kerdo, coefficient of Hildebrand were used to determine the state of the autonomic nervous system; laboratory and instrumental methods: general blood test, tonometry, electrocardiography, echocardiography were used to determine the current state of the cardiovascular system of the patient and to establish the diagnosis; pyclometrium, spirometry, pulseoximetry were used to determine the functional state of the respiratory system; methods of functional diagnostics: 6-minute walk test, Borg scale, Robertson scale were used to determine exercise tolerance and methods of mathematical statistics.

The study was conducted on the basis of the Western Ukrainian Specialized Children's Medical Center (Lviv, Ukraine). The research was conducted in three stages. 34 school aged children (aged 6–17) with CHF I–IIA stages were engaged to the research. The distribution of children to the main group (MG, 16 persons) and the comparison group (CG, 18 persons) was performed by random sampling as the children were admitted to the hospital, and the statistically the same performance of these groups was determined at the beginning of the study ($p > 0.05$).

Statistical processing of the results was performed using the nonparametric Mann-Whitney test to estimate the difference between two unrelated samples and the nonparametric Wilcoxon test to estimate the difference between two related samples The main statistical characteristics given in the description of the results of the study include: arithmetic mean, error of the mean, relative values, median, level of statistical significance. The critical value of the significance level (p) was taken as ≤5% ($p \leq 0.05$) and ≤1% ($p \leq 0.01$).

Formation and editing of the primary database of the researched data was carried out in Windows10 Home Prem OA (584037-001), Microsoft Office Profi Plus 2019 (N9J9Q-Q7MMP-XDDM6-63KKP-76FPM). All types of statistical processing were performed using the licensed software product "Statistica for Windows 6.1" (StatSoft, Inc., Serial N:AGAR909E415822FA) and Excel-2019 (collection 13328. 20292, "Office can", Open License 67528927).

Results

To conduct a pedagogical experiment and obtain data processing, we have developed a card for examination of a child with chronic heart failure to establish physical, functional, psycho-emotional disorders and the quality of her or his life (Liberman R. *et al.*, 2014;). This is the complex approach that has made it possible to detect various violations by different body systems and take into account the individual peculiarities of the child while sectioning means of physical therapy.

The CVD examination in children with CHF I–IIA stages revealed, despite medical therapy (constant / episodic), that in 47.06% of children have accelerated HR, that is, the heart uses the reserve capacity, which is a characteristic feature of this syndrome. In 32.35% of children of BPs and in 44.12% of children of BPd were above average values. 70.6% of children were found to have high energy expenditures for blood flow through the body, and the aerobic capacity of the body in 47.06% and 32.35% of children was assessed as low and below average respectively. This negatively characterizes the functioning of the blood circulation system. In 32.35% of the children surveyed, adaptation was ensured through the mobilization of functional reserves (fig. 1).

Surveys of the respiratory system have been found to be resting in 11.76% of children with pathologically increased respiratory rate. Only in 14.7% of children the ratio of lung capacity (LC) to proper size (PLC) was within normal limits.

The study of the autonomic nervous system revealed the predominance of excitatory effects in the regulation of blood circulation in 50% of the patients (50%).

The data of the examination of the musculoskeletal system indicated a tendency to stinginess in 35.29% of school-aged children with CHF of I–IIA stages, and 17.65% schoolchildren suffer from it. The average score for posture examination in sagittal and frontal planes was 65.88 ± 1.89 out of 100 possible. Based on

anthropometric measurements, disharmonic physical development is defined in 23.53% of children, and highly disharmonious physical development in 17.65%. That is, 41% of children have deviations in physical development.

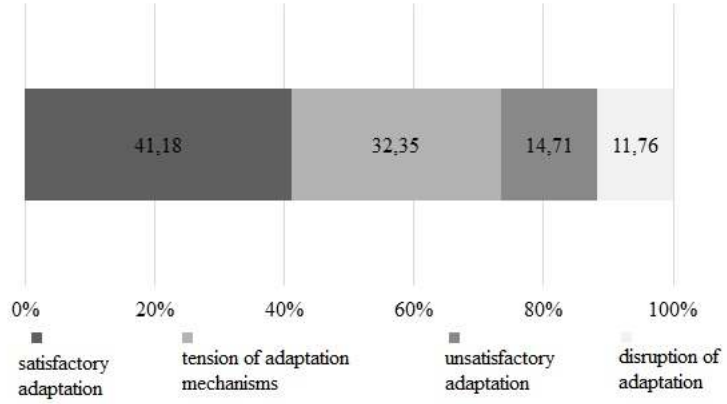


Fig. 1. Adaptive possibilities of the cardiovascular system of school-age children with chronic heart failure I-IIA stages (%)

The load of the 6-minute walk test is estimated by the children as moderate (26.47%), moderate - moderate to difficult (17.65%), moderately difficult (11.76%) and difficult (8.82%). At that, the examined children showed the following range of walking dyspnea: form the lowest 29.41% to the gradually increased 8.82%, 8.82%, and 2.94% as the highest. Restoration of pulse after walking, as a daily load, in children lasted quite slowly, since in 10 minutes of rest only 8.82% of all examined children this indicator reached the original value. In 32.35% of children, bronchial responses to physical activity were detected, and in 47.06% of children, negative results of dynamic spirometry, indicating the presence of respiratory failure at this physical activity in children with chronic heart failure.

The examination of the psychological and emotional state of CHF students revealed subclinical anxiety in 41.18% of them, and 17.65% - expressed anxiety clinically. In a half of the examined children (50%) there is subclinical depression (fig. 2).

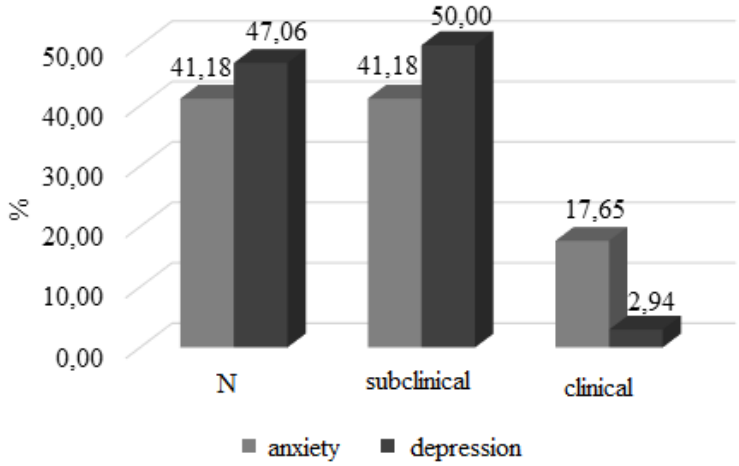


Fig. 2. Condition of anxiety and depression in school aged children with chronic heart failure of I-IIA stages

Their life quality (LQ) was estimated at 70.17 ± 1.63 points, and their parents - 64 ± 2.08 points (out of 100 possible).

The results of the examination after the implementation of the author's program of physical therapy found out that, more than 18.75% of children with average heart rate at rest, and 5.55% in the CG, there were found out fewer children with the same average heart rate. The coefficient of blood circulation efficiency after the pedagogical experiment normalized in 43.75% ($p \leq 0.05$) of MG children and worsened in 16.67% ($p \leq 0.05$) of the CG children. High values of the Robinson index were found in 18.75% of MG children (12.5% more), and with average aerobic capacity, after a re-examination, the number of children increased by 7 times. In CG children, this indicator was low and tended to deteriorate, reaching 50% of children ($p > 0.05$) after a re-examination. The functional possibilities of adaptation and left ventricular capacity have been statistically

significantly improved, and in children of CG this indicator had only a positive tendency in CG children. The blood pressure of the MG children of the increased by 3.56 ± 0.84% ($p \leq 0.01$) and was 97.19 ± 0.65%, which is within the normal range. Blood saturation had a positive tendency in CG children ($p > 0.05$), but the obtained value (93.83 ± 0.54%) remained below the norm.

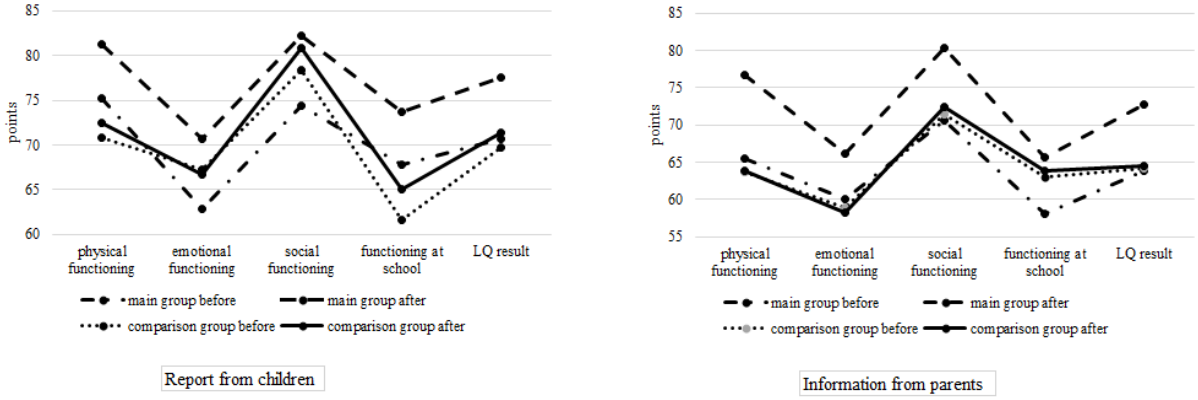
A re-examination has established that there are more than 18.75% of MG children with average breathing rate. In CH children, the number of children with respiratory values within the above average values increased by 22.22%. The number of children of MG after classes according to the proposed program with the normal ratio of LC to PLC has increased to 37.5% ($p \leq 0.05$). And the number of children with the ratio of CG in the normal range remained unchanged at 11.11% ($p > 0.05$). The proposed program contributed to a statistically significant increase in the number of children with normative values of the living index of 12.5% of children in MG ($p \leq 0.01$).

The dynamics of vegetative changes in children with CHF under the influence of occupations has somewhat improved, but without statistically significant changes in children of both groups ($p > 0.05$).

The improvement of posture in children with MG was 7.19 ± 1.02 ($p \leq 0.01$) points according to a 100-point scale, while in children, CG was 3.89 ± 1.03 ($p \leq 0.05$). Positive changes in the index of stinginess in children with MG were proved by 3.7 ± 1.35% ($p \leq 0.05$) and in children with HF - by 1.47 ± 0.46% ($p \leq 0.05$).

The assessment of the distance travelled by the 6-minute walk after the completion of the pedagogical experiment remained good, however, in children with MG, it increased by 0.63 ± 0.15 points ($p \leq 0.05$) according to a 6-point scale, and in children with CG it had a tendency to decrease (by 0.1 ± 0.13 points, $p > 0.05$). Blood saturation after the 6xx test in children of MG after the study termination increased by 4.63 ± 0.58% ($p \leq 0.01$), and in children with CG this figure decreased by 1.22 ± 0.53% ($p \leq 0.05$).

The results of schoolchildren's LQ are presented in fig. 3.



Note: ** - $p \leq 0.01$

Fig. 3. Changing the quality of life of school aged children with chronic heart failure of I-IIA stages under the influence of program

The growth ($p \leq 0.01$) of number of children having a good health condition (31.25), high activity (18.75%), good mood (by 56.25%), with the normative value of anxiety (by 37.5%), and with the standard depression rate (56.25%) was improved. In control group there was a statistically significant increase ($p \leq 0.05$) in the number of children with good mood (by 16.67%), with a standard depression rate (by 16.67%) and a positive trend ($p > 0.05$) to increasing the children number with good health and regulatory significance of anxiety.

Discussion

In the process of drawing up the physical therapy program for sick pupils we have taken into account the principles of physical therapy and physical education. The paper presents the algorithm process of the physical therapy, on which we worked and the selection scheme of physical therapy facilities for problems that arise in CHF patients. Since the program is foreseen for children with CHF stage I-IIA, this was preceded by a cardiological examination, which determined the affiliation of children to this group. On the basis of the therapy survey there was a set of relevant tools. The program consisted of a practical and theoretical part and was designed for 28 weeks. Practical part included morning and evening hygienic gymnastics, a complex of therapeutic exercises, gymnastics, dosed walking and walking stairs. Practical part is supplemented with elements of hardening, adherence to the principles of healthy nutrition and favorable psychological microclimate in the family. The practical part of the program was divided into three stages. After the completion of the physical therapy program, the supporting phase continues on a permanent basis. At all stages of the developed program of physical therapy (28 weeks) was carried out operational, current and stage control, the results of

which were corrected further therapy process. The theoretical part in the form of interactive classes was aimed at obtaining some new information by parents, mastering vagal samples, etc. Theoretical lessons on problematic issues with CHF were aimed at the formation of facilities for self-control, modification of motor regimen of the day, lifestyle, etc., among patients and their parents (Boukovala M. *et al.*, 2019; Critical Congenital Heart Defects Screening, 2016).

Taking into account the poor prognosis of long-term survival of CHF patients and the results of the examination, maintaining an acceptable level of their life quality is an important clinical task. That is why we have developed a program of physical therapy at home for schoolchildren with CHF I–IIA stages (Boukovala M. *et al.*, 2019).

Assessing the MG schoolchildren's life quality at the I-IIA stages showed a significant improvement in four blocks. The physical functioning of children has improved from 75.2 ± 2.76 to 81.25 ± 2.92 points ($p \leq 0.05$), and according to their parents - from 65.43 ± 5.55 to 76.76 ± 3.87 points ($p \leq 0.01$). Exactly the physical functioning of parents' information was the biggest improvement. Social functioning also had a positive change from 74.38 ± 4.78 to 82.19 ± 3.62 points ($p \leq 0.05$) according to the report of children of MG and from 70.63 ± 4.23 to 80.31 ± 3.97 points ($p \leq 0.01$) according to information from parents. This indicates an improvement in the social adaptation of children in society, in particular, among their peers. According to the final result, their LQ improved from 70.72 ± 2.98 to 77.51 ± 2.64 points ($p \leq 0.01$) according to the children themselves and from 63.79 ± 3.64 to 72.83 ± 2.98 ($p \leq 0,01$) according to their parents. In children with hypertension, the improvement of LQ has a positive trend, since the increase in the indicator is considered by the children from 69.69 ± 1.66 to 71.38 ± 1.93 points ($p > 0.05$), and according to their parents - from 64. 19 ± 2.34 to 64.55 ± 2.06 points ($p > 0.05$) (Chekhovska M., 2016; Congenital Heart Defects (CHD) - Data & Statistics, 2019; Varni, J.W. *et al.*, 2019).

Thus, there is a clear contradiction, which is that in recent years there has been an increase in the number of children with cardiovascular disease, and accordingly with HF, which confirms the relevance of the study (Costello J.M. et al., 2016; Amedro P. et al., 2016, 2018; Abassi H. et al., 2020), and the use of physical therapy for children with cardiovascular pathology and the creation of scientifically sound and experimentally tested physical therapy programs remains poorly developed (Bogdanovska N., 2017), despite the need and importance of motor activity for such children (Amedro P. et al., 2016, 2018). This demonstrates the need to solve an important medical, social and scientific task.

Conclusions

The obtained results pedagogically proved the effectiveness of the developed program of physical therapy at home for schoolchildren with CHF I–IIA stages for changes in functional and psychological and emotional conditions, and life quality.

1. In Ukraine, despite the existing positive world practice, the physical therapy of people with chronic heart failure remains an urgent problem. In this regard, there is a need to develop and implement a program of physical therapy for school-age children with chronic heart failure of the I-IIA stages of cardiological etiology to improve their functional and psycho-emotional states, quality of life.

2. The examination of the cardiovascular system in children with chronic heart failure of I-IIA stages found out ineffective functioning of it in 79,41% of children.

3. Results of testing the psycho-emotional condition of schoolchildren indicated that 41.18% of children had subclinically expressed anxiety, and in 17.65% of children with chronic heart failure anxiety was expressed clinically. Half of the examined children (50%) have subclinically expressed depression. The quality of life of children was estimated at 70,17 ± 1,63 points be themselves, and at 64 ± 2,08 points by their parents. The results of the survey revealed that parents of 85.29% of children and, as a result, 79.41% of the surveyed children do not engage in motor activity at leisure. It is important that 28.57% of children do not engage in motor activity because of the prohibition of parents.

4. In the developed program of physical therapy for children of school age with chronic heart failure I-IIA stages of cardiology etiology it is provided the observation using the developed card, the algorithm of the therapy process, the individual orientation and availability of means, the practical and theoretical part (a combination of practical skills and theoretical knowledge). At all stages of the proposed program of physical rehabilitation, current and step-by-step monitoring was conducted to monitor the status of children and to make adjustments.

5. After implementation of the developed program, there was established normalization of the indicator of efficiency of blood circulation in 43.75% of the children of the main group ($p \leq 0.05$) and its deterioration in 16.67% of the children of the comparison group ($p \leq 0.05$). The number of children in the main group with average aerobic capacity increased in 7 times. The percentage of children in the main group with satisfactory adaptive potential has doubled (87.5%, $p \leq 0.05$). Improvements were also observed in the blood saturation in resting state on 3.56 ± 0.84% in children of the main group ($p \leq 0,01$). In children of the comparison group, this indicator had only a positive trend. The number of children in the main group with a normal ratio of lung capacity to its proper value increased by 12.5% ($p \leq 0.05$), in the comparison group there was no change ($p >$

0.05). In children of the main group, the posture was improved by 7.19 ± 1.02 points (p≤0.01) and by 3.89 ± 1.03 points - in the comparison group (p≤0.05).

6. In all children of the main group, the testing of quality of life in the four areas of the child's functioning was characterized by significant and statistically significant improvement from 70.72 ± 2.98 to 77.51 ± 2.64 points (p≤0.01) according to the children answers and from 63.79 ± 3.64 to 72.83 ± 2.98 points (p≤0.01) according to their parents opinion. The improvement in quality of life in children of the comparison group is less significant, since there is tendency to increasing the indicator in the opinion of children from 69,69 ± 1,66 to 71,38 ± 1,93 points (p> 0,05), and according to their parents opinion - from 64.19 ± 2.34 to 64.55 ± 2.06 points (p> 0.05).

7. The results obtained in the research testify to the effectiveness of the proposed program of physical therapy for school-age children with chronic heart failure of I-IIA stages of cardiology etiology. It is possible to recommend the developed program of physical therapy for application in the practice of treatment and prevention institutions according to established results of the growth of functional capabilities of the cardiovascular and respiratory systems, improvement of indicators of the musculoskeletal system, physical development and exercise tolerance in the process of research.

Conflict of interest. The authors declare that there is no conflict of interests.

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