

Assessment of influence of the program of physical rehabilitation on results of the six-minute test of walking at children with recurrent bronchitis

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Purpose: to estimate efficiency of the carried out program of physical rehabilitation of children with recurrent bronchitis in the conditions of sanatorium.

Material & Methods: 109 children of the younger school age are examined. The six-minute test of walking was carried out for the research of functional and adaptation opportunities, and the degree of loading is also estimated on the Borg scale. The obtained data were processed by the adequate methods of mathematical statistics.

Results: the improvement of level of the studied indicators at children of the main and control groups is noted after the termination of the course of physical rehabilitation. However, statistically the best dynamics of indicators of length of distance, index of adaptation, index of adaptation of restoration of rhythm and points on the Borg scale are revealed among children of the main groups.

Conclusions: the developed and introduced program of physical rehabilitation was more effective in comparison with the standard one.

Keywords: recurrent bronchitis, six-minute test of walking, the Borg scale, functional state, cardiorespiratory system.

Introduction

It is specified by results of the last statistical researches of the structure of incidence of children that the first place is won by diseases of the respiratory system among which respiratory diseases prevail [6]. Nonspecific inflammations of respiratory tracts, which are followed by frequent repeated episodes, are widespread among children and practically are not prevented, and episodes of diseases are badly treated, as predetermines the relevance of problem [3]. Besides, the role of treatment consists not only in diagnostics and therapy, but also in prevention of these diseases [7].

Communication of the research with scientific programs, plans, subjects

The work is performed according to the scientific subject "The latest technologies in physical rehabilitation, assessment of quality of life of different groups of the population at diseases of internals and systems of organism and musculoskeletal system". Number of the state registration is 0111U001870.

The purpose of the research:

to estimate efficiency of the program of physical rehabilitation of children this is carried out in the conditions of sanatorium with recurrent bronchitis.

Material and Methods of the research

Materials of the work were received during the research on the basis of the sanatorium "Malyatko" (Uzhhorod). The contingent of investigated – 109 children of younger school

age, who are ill with recurrent bronchitis, from them 53 (48,6%) are boys and 56 (51,4%) are girls, aged from 7 up to 9 years, which arrived for performing sanatorium treatment. The middle age made $8,6 \pm 0,62$ ($\bar{x} \pm S$) years.

At implementation of the six-minute test of walking (6-MTW) which is rather widely used also among children [5, 9, 10], distance length indicators in the first and second attempt (D_1, D_2) were registered for calculation of index of adaptation ($IAd = D_2/D_1$); heart rate (HR), systolic and diastolic arterial pressure (SAP and DAP); time of renewal of HR to initial heart rate in the first and second attempt (t_1, t_2) for calculation of index of adaptation of renewal of rhythm ($IAt = t_2/t_1$). Besides, the Borg scale in the modified look was applied to the assessment of feeling of physical efforts and fatigue [4, 8].

Children were distributed on two groups for definition of reliable differences in the state of health according to indicator of index Tiffeneau (IT), namely by the absence (norm, conditional norm of 61 children) or the existence of moderate changes (48 children). In turn each of these groups at passing of the sanatorium therapy were divided into the main and control for the research of features of dynamics of indicators throughout the sanatorium therapy with use of the developed program of rehabilitation. So, children with the moderate decrease in IT got to MG1 (n=23) and CG1 (n=25), and without the essential changes to MG2 (n=32) and CG2 (n=29). The MG1 and CG1 groups did not differ among themselves ($p > 0,05$), MG2 and CG2 also satisfied this condition.

Let's note that children without changes of IT had the best results on indicators of D_2 , IAd and point by the Borg scale at the time of arrival.

Results of the research and their discussion

The sanatorium stage of rehabilitation is important for the maximum renewal of health and use of rehabilitation potential among children [2]. The developed program of physical rehabilitation was introduced in the process of the sanatorium therapy of children of the main groups and went to the main tasks in pediatrics, namely on the improvement of somatic health and quality of life [1], and also included at itself the sparing and sparing-training motive modes and consisted of basic and variable components; was based on the complex of the indicators, which were received in the course of the stating experiment and, in particular, differed from standard in methodical creation and content of remedial gymnastics classes and hydro-kinesiotherapy.

The carried-out analysis of dynamics of indicators which were defined when carrying out 6-MTW, found the existence of changes of number of indicators throughout the sanatorium therapy, which was defined by the comparison of values before and after between the main and control groups, and reliable differences, between results of certain indicators of the main and control groups that was not observed at the time of arrival to the sanatorium.

The reliable differences are established ($p < 0,001$) when comparing lengths of the passable distance in six minutes in the first attempt (D_1) before and after as children ($n=109$) took part in rehabilitation programs which passed in conditions of sanatorium, confirm the statistical growth of this indicator and positive influence of the carried-out therapies on functional condition of the cardiorespiratory system and physical fitness of patients. The indicator D_1 grew more significantly at the same time in the main groups (tab. 1).

So, indicator D_1 of MG1 at children authentically differed from CG1 ($p < 0,01$), and in MG2 from CG2 ($p < 0,01$). The value of indicator D_1 in MG1 after passing of rehabilitation course grew by 47,4 m (12,1%) to 438,70±12,36 m; the gain was a little smaller in CG1 and made 32,4 m (8,3%) to 422,20±15,21. The similar tendency was observed % in groups of children who had no considerable changes of IT at the time of arrival. So, the increase is noted in D_1 in the MG2 group by 47,5 m (12,1%) to 438,75±14,14 m, and in the CG2 group on 32,42 m (8,2%) to 424,66±14,07 m. The reliable differences between the MG1 group (with the available moderate changes of IT) and the group of children of MG2 (without considerable changes in values of index Tiffeneau) are not revealed at the time of extract ($p > 0,05$). Such dynamics of indicator of D_1 indicates big efficiency of the developed program concerning the improvement of condition of the cardiorespiratory system and the general endurance.

The point by the Borg scale that displays the assessment of effort and fatigue from the executed 6-MTW, authentically didn't change at the time of extract ($p > 0,05$) in the general selection of children ($n=109$). However the reliable reduction of the point by the Borg scale is revealed in MG1 ($p < 0,05$). So, the initial result was recorded at the level of 11,52±0,79 points, and 10,96±0,77 points at the repeated inspection. The reliable changes are not established ($p > 0,05$) among children of other groups. So, the following changes before and after the course of recovery treatment respectively were found in CG1, MG2 and CG2: from 11,52±0,92 to 11,44±0,96 points; from 10,91±0,73 to 10,88±0,71 points; from 10,86±0,69 to

11,14±0,64 points.

Considering the lack of reliable differences at inspections both at the time of receipt, and after the passable rehabilitation course, between MG1 and CG2 ($p > 0,05$), CG1 and CG2 ($p > 0,05$) by the results of D_1 , the fact that the received points by the Borg scale when comparing the main groups among themselves and control do not differ attracts attention after passing of physical rehabilitation ($p > 0,05$). Thus, the carried-out treatment promoted the improvement of subjective tolerance of loading at children with the available decrease in IT, as the best point but the Borg scale at children without the essential changes of IT was established authentically ($p < 0,01$) at the time of the first inspection. And it is possible to tell that the developed program in this aspect was more effective considering the reliable decrease in the point of the mentioned above in MG1 and the difference between MG1 and CG1 ($p < 0,01$) by the values D_1 .

Also statistical differences were established ($p < 0,001$) when comparing lengths of the passable distance in the second attempt 6-MTW (D_2) before and after the rehabilitants ($n=109$) executed rehabilitation programs in the conditions of the sanatorium which confirms the statistical general growth of this indicator and the positive influence of both programs on possibilities of the cardiorespiratory system. The indicator D_2 grew more significantly at the same time among children of the main groups that is noted in the table.

In particular, D_2 indicator at children of MG1 authentically differed from CG1 ($p < 0,01$), and in MG2 from CG2 ($p < 0,01$). The value of indicator of D_2 after passing of the rehabilitation course grew by 58,26 m (14,5%) to 459,35±14,48 m among children of MG1; the gain was a little smaller and made 33 m (8,4%) to 428,20±16,00% CG1. The similar dynamics was observed among groups of children who had no considerable changes of IT at the time of receipt. So, the increase in D_2 is noted by 64,53 m (15,8%) to 473,44±9,87 m in the MG2 group, and in the CG2 group on 33,8 m (8,2%) to 444,66±17,62 m. The given dynamics of indicator D_2 indicates the smaller efficiency of the standard program concerning the improvement of condition of the cardiorespiratory system and the general endurance. Besides, found existence of the reliable difference between the MG1 group (with the available moderate changes of IT) and the group of children of MG2 (without considerable changes in values of index Tiffeneau) at the time of extract ($p < 0,01$), and also similar differences in between control groups that indicates the lack of equalizing of groups of children (for IT) by the results of D_2 and after the sanatorium therapy.

The presented results demonstrate that the gradual increase in physical activity of children with recurrent bronchitis can and promote in the future improvement of results of length of distance as children after passing of the course of recovery treatment didn't reach the standard values, which are given in literature for healthy children, though they got closer to them.

Dynamics of changes of IAd developed as follows: reliable differences in comparison with initial results are found only among children of the main groups. So, the growth of IAd from 1,03±0,03 s.u. is recorded in MG1 to 1,05±0,04 s.u. ($p < 0,001$), and in MG2 from 1,05±0,05 s.u. to 1,08±0,03 s.u. ($p < 0,001$) that confirms the big efficiency of the developed

program of rehabilitation. Also the reliable differences were found during the statistical analysis when comparing results of MG1 from CG1 ($p < 0,01$), MG2 from CG2 ($p < 0,01$) at the time of the repeated inspection. These differences also in addition prove advantages of the developed program of physical rehabilitation.

Children with the available moderate changes of IT didn't achieve results of children without considerable changes of index Tiffeneau and at the time of extract from the sanatorium to what the existence of statistical differences between MG1 and MG2 ($p < 0,01$), CG1 and CG2 testifies ($p < 0,05$).

The reliable changes of values of indicator of HR before 6-MTW are not revealed after passing of the sanatorium therapy with application of means of physical rehabilitation both in the general selection, and among groups of children ($p > 0,05$). So, the average value of indicator of HR before 6-MTW made $86,90 \pm 3,73$ bpm⁻¹ at the time of extract at the examined children ($n=109$).

The analysis of heart rate after 6-MTW found the reliable difference between values before and after passing of the sanatorium therapy with application of means of physical rehabilitation in the general selection of children ($p < 0,05$),

though the reduction made $1,2$ bpm⁻¹ to $114,13 \pm 7,12$ bpm⁻¹ that demonstrates the presence of this small reduction of heart rate at the vast majority of children.

When carrying out the analysis of indicators of HR after 6-MTW in groups of children, the reliable differences between results of MG1 and CG1 were not revealed where the indicator respectively made $116,04 \pm 6,23$ bpm⁻¹ and $114,60 \pm 6,60$ bpm⁻¹ ($p > 0,05$), and also MG2 and CG2 where average values made $112,28 \pm 6,71$ bpm⁻¹ and $114,24 \pm 8,42$ bpm⁻¹ ($p > 0,05$).

The value of indicator of HR_Δ, what displays the change of heart rate at the time of the termination 6-MTW in comparison with condition of rest, authentically changed on the termination of the rehabilitation course only in MG2 on $2,5$ bpm⁻¹ also made $25,69 \pm 5,35$ bpm⁻¹ ($p < 0,01$). In other groups indicator HR_Δ didn't experience the reliable changes in comparison with results at the time of receipt ($p > 0,05$). Let's note also that the values received at the time of extract had no statistical differences between MG1 and CG1, MG2 and CG2 ($p > 0,05$).

Indicators of systolic arterial pressure before 6-XTX changed in the general selection ($p < 0,01$) and in all groups of children ($p < 0,05$). The result lowered from $107,34$ $6,46$ mm Hg to $106,44$ $6,54$ mm Hg in the general selection of children,

Average indicators of the six-minute test of walking at children with recurrent bronchitis after the sanatorium therapy

| Indicators of the test of the forced vital capacity of lungs | Number of group | MG | | CG | | p |
|--|-----------------|-----------|-------|-----------|--------|-------|
| | | \bar{X} | S | \bar{X} | S | |
| Distance ₁ , m | 1 | 438,70 | 12,36 | 422,20 | 15,21 | <0,01 |
| | 2 | 438,75 | 14,14 | 424,66 | 14,07 | <0,01 |
| Point by the Borg scale, балів | 1 | 10,96 | 0,77 | 11,44 | 0,96 | >0,05 |
| | 2 | 10,88 | 0,71 | 11,14 | 0,64 | >0,05 |
| HR before 6-MTW, bpm ⁻¹ | 1 | 87,52 | 3,68 | 87,48 | 3,16 | >0,05 |
| | 2 | 86,59 | 4,43 | 86,24 | 3,42 | >0,05 |
| HR after 6-MTW, bpm ⁻¹ | 1 | 116,04 | 6,23 | 114,60 | 6,60 | >0,05 |
| | 2 | 112,28 | 6,71 | 114,24 | 8,42 | >0,05 |
| HR _Δ , bpm ⁻¹ | 1 | 28,52 | 5,16 | 27,12 | 6,37 | >0,05 |
| | 2 | 25,69 | 5,35 | 28,00 | 6,93 | >0,05 |
| SAP before 6-MTW, mm Hg | 1 | 105,87 | 7,52 | 108,08 | 5,93 | >0,05 |
| | 2 | 106,34 | 6,71 | 105,59 | 6,08 | >0,05 |
| SAP after 6-MTW, mm Hg | 1 | 112,74 | 7,55 | 114,40 | 4,72 | >0,05 |
| | 2 | 112,97 | 7,36 | 111,41 | 7,76 | >0,05 |
| SAP _Δ , mm Hg | 1 | 6,87 | 7,41 | 6,32 | 4,83 | >0,05 |
| | 2 | 6,63 | 6,14 | 5,83 | 6,74 | >0,05 |
| DAP before 6-MTW, mm Hg | 1 | 67,22 | 6,77 | 66,84 | 5,42 | >0,05 |
| | 2 | 66,81 | 6,17 | 67,59 | 6,04 | >0,05 |
| DAP after 6-MTW, mm Hg | 1 | 69,52 | 6,91 | 67,320 | 5,59 | >0,05 |
| | 2 | 67,44 | 6,52 | 67,414 | 7,34 | >0,05 |
| DAP _Δ , mm Hg | 1 | 2,30 | 4,17 | 0,48 | 3,4951 | >0,05 |
| | 2 | 0,63 | 3,99 | -0,17 | 4,43 | >0,05 |
| Distance ₂ , m | 1 | 459,35 | 14,48 | 428,20 | 16,00 | <0,01 |
| | 2 | 473,44 | 9,87 | 444,66 | 17,62 | <0,01 |
| IAd, s.u. | 1 | 1,05 | 0,04 | 1,02 | 0,04 | <0,01 |
| | 2 | 1,08 | 0,03 | 1,05 | 0,05 | <0,01 |
| t ₁ , s | 1 | 34,96 | 3,02 | 35,68 | 3,21 | >0,05 |
| | 2 | 34,50 | 2,85 | 35,86 | 3,02 | >0,05 |
| t ₂ , s | 1 | 32,61 | 2,52 | 35,00 | 3,85 | <0,05 |
| | 2 | 32,25 | 2,26 | 35,48 | 3,79 | <0,01 |
| IAt, s.u. | 1 | 0,94 | 0,06 | 0,98 | 0,06 | <0,05 |
| | 2 | 0,94 | 0,06 | 0,99 | 0,06 | <0,01 |

the change also had insignificant quantitative character in groups that it is impossible to connect fully by the carried-out programs of rehabilitation. Besides we will note what the reliable differences between MG1 and CG1, MG2 and CG2 groups are not established also at the time of extract from the sanatorium ($p > 0,05$).

The reliable changes which took place throughout stay in the sanatorium only among children of the MG2 group, indicator of SAP after 6-MTW are noted ($p < 0,05$): the average result lowered from $114,13 \pm 6,50$ mm Hg to $112,97 \pm 7,36$ mm Hg. The change had not reliable character in other groups ($p > 0,05$). However, the statistical changes in comparison with results of the first inspection ($p < 0,01$) are also noted in the general selection of children though, as well as changes of SAP before 6-MTW, they had small quantitative character. It is not established the reliable differences when comparing results of MG1 from CG1, MG2 from CG2 at the same time at extract from the sanatorium ($p > 0,05$).

The increase in systolic pressure upon exercise stress was reliable ($p < 0,001$) and for the end of stay in the sanatorium what is displayed in indicator of SAP_{Δ} . However values of SAP_{Δ} didn't experience the reliable changes during the course of physical rehabilitation both basically and in control groups ($p > 0,05$).

The part of indicators of diastolic arterial pressure authentically changed throughout the made experiment, however changes were insufficient for their objective treatment and interpretation. In particular, we will note that the indicator of DAP before 6-MTW authentically grew in the general selection by $1,24$ mm Hg ($p < 0,001$), in MG1 on $1,05$ mm Hg ($p < 0,05$), in MG2 on $1,87$ mm Hg ($p < 0,01$), in CG2 on $0,93$ mm Hg ($p < 0,05$).

Dynamics of average indicators of time of renewal of heart rate after exercise stresses (6-MTW) also had reliable changes before initial throughout the sanatorium therapy. So, the reliable differences of t_1 are registered in MG1 where the duration of indicator decreased on $4,04$ s to $34,96 \pm 3,02$ s ($p < 0,01$), and in CG1 changes had no reliable character – the indicator grew on $1,2$ s to $35,68 \pm 3,21$ s ($p < 0,05$). Among children without the initially registered considerable changes, IT is noted the following: in MG2 reliable reduction of t_1 on $2,75$ s to $34,50 \pm 2,85$ s ($p > 0,01$) is noted, and in CG2 doubtful on $1,9$ s to $35,86 \pm 3,02$ s ($p > 0,05$). Thus, the main groups by the indicator of t_1 had the reliable improvement of results in comparison with previous, but statistically did not differ from control groups ($p > 0,05$).

Dynamics of indicator t_2 during the stay in the sanatorium and passing of programs of rehabilitation was more noticeable. The reliable changes are noted among children of all

groups. The duration of time of t_2 decreased on $10,39$ s to $32,61 \pm 2,52$ s ($p < 0,01$) among MG1 group, and among children of CG1 on $5,64$ s to $35,00 \pm 3,85$ s ($p < 0,01$). Between children without the initially registered considerable changes of IT the following changes are established: the reliable reduction of t_2 on $8,72$ s to $32,25 \pm 2,26$ s ($p < 0,01$) in MG2, and in CG2 on $5,76$ s to $35,48 \pm 3,79$ s is noted ($p < 0,01$). Proceeding from it, it is possible to draw conclusion that, despite of reliability of positive changes in control groups, improvements of adaptation opportunities among children of the main groups were more essential what is confirmed by the available statistical differences between MG1 and CG1 groups ($p < 0,05$), MG2 and CG2 ($p < 0,01$).

Also we will note that t_1 is authentically bigger for t_2 in the main groups, and the reliable difference is absent in the control groups that at the accounting of the established values of these indicators at receipt and dynamics of indicators of D_1 and D_2 indicates the best influence of the developed program on adaptation opportunities and regulation of rhythm of warm reductions.

Changes of indicators of t_1 and t_2 affected also dynamics of the IAt index in groups. Among MG1 group IAt The value decreased from $1,11 \pm 0,04$ s.u. to $0,94 \pm 0,06$ s.u. ($p < 0,01$), and among children of CG1 from $1,10 \pm 0,05$ s.u. to $0,98 \pm 0,06$ s.u. ($p < 0,01$). The following changes are established between children without the initially registered considerable changes of IT: the reliable reduction of IAt from $1,10 \pm 0,05$ s.u. to $0,94 \pm 0,06$ s.u. ($p < 0,01$) is noted in MG2, and in CG2 from $1,09 \pm 0,04$ s.u. to $0,99 \pm 0,06$ s.u. ($p < 0,01$). Considering the reliable differences, which are established between MG1 and CG1 ($p < 0,05$), MG2 and CG2 ($p < 0,01$), it should be noted that the improvement of values of IAt was more essential in the main groups.

Conclusions

Considering the stated, it is possible to draw conclusion that the main studied indicators of the test 6-MTW experienced positive changes in the main and control groups of children with recurrent bronchitis at extract from the sanatorium, however more positive dynamics was noted among children who passed the sanatorium therapy with inclusion of the developed program of physical rehabilitation. In particular, authentically the best changes took place in indicators of the passable distance in both attempts, index of adaptation, index of adaptation of renewal of rhythm which testifies to efficiency of the introduced program of physical rehabilitation.

Prospects of the subsequent researches consist in the research of influence of the conducted course of physical rehabilitation on the respiratory system, posture and quality of life of children.

Conflict of interests. *The author declares that there is no conflict of interests.*

Financing sources. *This article didn't get the financial support from the state, public or commercial organization.*

References

1. Vitomskiy, V. & Lazareva, O. (2016), "Indices of Biogeometric Profile of Posture and Life Quality of Children with a Functional Single Ventricle of a Heart", *Physical Education, Sport and Health in Modern Society*, No 4 (32), pp. 156–160. (in Ukr.)

2. Vitomskiy, V. (2014), "Characteristics of means of physical rehabilitation at the sanatorium and dispensary stages of restoring the health of children undergoing surgery with congenital heart defects", *Theory and Methods of Physical Education and Sport*, No 4, pp. 41-46. (in Ukr.)
3. Pikuza, O. I. & Samorodnova E. A. (2002), "The etiology and pathogenesis of recurrent bronchitis in children", *Kazanskiy meditsinskiy zhurnal*, Vol. 83 No 2, pp. 128-130. (in Russ.)
4. Vitomskiy, V. V. (2016), *Fizychna reabilitatsiya ditey iz skladnymy vrodzhenymy vadamy sertsya z funktsional'no yedynym shlunochkom pislya hemodynamichnoyi korektsiyi: avtoref. dys. ... kand. nauk z fiz. vykhovannya ta sportu* [Physical rehabilitation of children with complex congenital heart disease with functional single ventricle after correction of hemodynamic: PhD thesis abstract]. The National University of Ukraine for Physical Education and Sport, Kiev, 20 p. (in Ukr.)
5. Kuz'minskiy, V. A. & Klochkova, E. V. & Mal'tsev, S. B. & Grachev, A. P. (2012), "Physical therapy: an electronic a training manual", available at : http://manual-pt.sdc-eu.info/4_6_3.html (accessed 1 August 2016). (in Russ.)
6. Khristova, T. E. (2012), "Current approaches to physical rehabilitation of children who often suffer from acute respiratory infections", *Pedagogika, psikhologiya ta mediko-biologichni problemi fizichnogo vikhovannya i sportu*, No 5, pp. 119-123. (in Ukr.)
7. Yurochko, F. (2013), "Recurrent respiratory infections in children", *Sovremennaja pediatrija*, No 5(53), pp. 91-96. (in Ukr.)
8. Borg, G. A. V. (1982), "Psycho-physical bases of perceived exertion", *Med. Sci Sports Exerc.*, Vol. 14, pp. 377-381.
9. Kleppe, S. E. & Muir, N. (2011), "Reference values on the 6-minute walk test for children living in the united states", *Pediatric Physical Therapy*, Vol. 23 Is. 1, pp. 32-40.
10. Ulrich, S. & Hildenbrand, F. F. & Treder, U. (2013), "Reference values for the 6-minute walk test in healthy children and adolescents in Switzerland", *BMC Pulmonary Medicine*, No 13 (49), available at: <http://www.biomedcentral.com/1471-2466/13/49> (accessed 1 August 2016).

Received: 05.09.2016.

Published: 31.10.2016.

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