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### RESEARCH ARTICLE

#### KINESITHERAPY AND ULTRASOUND IN CHILDREN WITH BRONCHIAL ASTHMA

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#### Abstract

**Introduction:-** There are no studies in the literature on the combination of kinesitherapy and ultrasound in children with bronchial asthma.

**Objective:-** To compare the effect of the combination of kinesitherapy and ultrasound in children with bronchial asthma compared to a control group without rehabilitation.

**Material and methods:-** 24 children (age  $9.63 \pm 3.56$  years) with bronchial asthma were followed for 10 days (5 days as inpatients and 5 days as outpatients). They were randomized into two identical groups - "physiotherapeutic" and "control". Both groups were treated with standard pharmacotherapy. The "physiotherapy" group was further treated with kinesitherapy and ultrasound. Spirometric and anthropometric parameters were recorded at the beginning and end of the therapeutic course. The ratios between actual and expected spirometric parameters, adjusted for all anthropometric parameters, were included in the statistical analysis.

**Results:-** In both groups, the ratios between the actual and the expected spirometric parameters improved significantly after 10 days of treatment compared to before ( $P < 0.05$ ). The improvement after treatment was significantly greater in the "physiotherapeutic" compared to the "control" group ( $P < 0.05$ ).

**Conclusion:-** In the 10-day treatment of children with bronchial asthma, the combination of kinesitherapy and ultrasound has a significant therapeutic effect, building on that of pharmacotherapy.

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#### Introduction:-

Asthma is the most common chronic disease in childhood, affecting over 7% of children (1-5). In Bulgaria, about 500,000 people suffer from asthma, 15,000 of whom are children (1,3-5). The disease most often begins in childhood - about 80% of asthmatics are diagnosed before the age of 6, and boys get sick more often than girls in a ratio of 1:4 (4,5).

One of the many considerations for kinesitherapy in children with bronchial asthma is its capacity to counteract the effects on the musculoskeletal system, adversely affecting the respiratory system: respiratory muscle imbalance (inspiratory muscles /mm.intercostales externi, mm.scaleni, m.levator scapulae, and m.trapezius descendens/ are

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shortened with increased tone and spasm, while the expiratory muscles (/mm.intercostales interni, m.obliquus externus abdominis and m.rectus abdominis/ are elongated with reduced tone and strength), descended lower ribs, increased frontal to sagittal chest ratio, increased thoracic kyphosis, "barrel-shaped" chest, enlarged cervical lordosis, "shortened" neck, "Gothic shoulders", raised and extended shoulder girdle, reduced chest mobility, reduced diaphragmatic breathing, reduced lung volumes and capacities (6-12). With adequate kinesitherapy, these changes are preventable (6,9,11). A consideration against kinesitherapy in children with bronchial asthma is that excessive exercise can provoke an attack (13,14). Avoiding exercise, however, can lead to detraining, reduced tolerance to daily loads, easier fatigue, lethargy, obesity, and increased stress (6,7,9,11,13,14). In addition, exaggerations can be controlled by warm-up exercises (6,9,11,13,14). Moreover, exercise training reduces the frequency and severity of exaggerations caused by excessive exercise (6,7,9,11,13,14). In addition, exercise has a bronchodilator effect due to increased and frequent muscle contractions and co-contractions (6-14).

There are no studies in the literature on asthma in children regarding the combination of ultrasound and exercise. Ultrasound therapy has local and general anti-allergic (desensitizing), anti-inflammatory, resorbable, vasodilating, relaxing (antispastic), and analgesic effects (16). In addition, general immunological reactivity of the body, blood and lymph circulation is activated (16). The functions of the endocrine organs and the sympathetic function of the nervous system are stimulated (16). The tone of the respiratory muscles and the bronchial drainage function is improved (16).

The aim of the study was to compare the effect of the combination of kinesitherapy and ultrasound in children with bronchial asthma compared to a control group without rehabilitation.

### **Material And Methods:-**

24 children with bronchial asthma (age  $9.63 \pm 3.56$  years) were followed for 10 days (5 days as inpatients and 5 days as outpatients) at the Children's Clinic of a University Hospital. They were randomized into two identical groups - "physiotherapeutic" and "control". Both groups were treated with identical standard pharmacotherapy (7). The "physiotherapy" group was additionally treated with ultrasound and kinesitherapy.

Ultrasound was performed over two zones with direct contact, constant mode, labile method (with longitudinal movements) (17). The dose by intensity was  $0.2 \text{ W/cm}^2$  (17). The first zone was paravertebral two centimeters from processi spinosi of T1 to T12 (17). It affects the sympathetic ganglia of the chest corresponding to the innervations of the bronchi (17). The second zone was over VI-th and VII-th intercostals spaces bilaterally (from paravertebral to axial line). It relaxes the spastic respiratory muscles (17). On the first day, the first zone was treated for 2 minutes bilaterally with a total duration of 4 minutes (17). On the second day, both zones were treated with a total duration of 8 minutes (17). The course of treatment consisted of 10 procedures (17).

Kinesitherapy was performed twice a day with 3 sets of 10 repetitions with a break of 2 minutes between each series. It included breathing retraining (exercises manipulating the breathing pattern); respiratory muscle training (exercises increasing the strength and endurance of the respiratory muscles); musculoskeletal flexibility and posture/balance training (exercises increasing the flexibility of the thoracic cage and improving posture by correcting the muscle imbalance) (2,6-10,12,13). The 'Breathing retraining' was aiming to correct the abnormal breathing patterns by adopting a slower respiratory rate with longer expiration, reducing hyperventilation, using a diaphragmatic type of resting breathing (rather than abdominal or upper-chest one), and using nasal breathing (rather than oral one) (2,6-10,12,13). It was performing 2 times daily with 3 sets of 10 repetitions with a pause of 2 minutes between each set (2,6-10,12,13). The diaphragmatic inspiration was performing from functional residual capacity to maximum inspiratory lung volume with 2 consecutive breaks while maintaining a ratio of 2 to 1 breath (2,6-10,12,13). The 'respiratory muscle training' was performing 2 times daily with 3 sets of 10 repetitions with a pause of 2 minutes between each set (2,6-10,12,13). Each repetition included a maximal inspiration from residual volume to total lung capacity in sitting position (2,6-10,12,13). The expiration was performing at the functional residual capacity in order to avoid hyperventilation (2,6-10,12,13). There were intervals of 60 s between these respiratory maneuvers (2,6-10,12,13). The 'musculoskeletal flexibility training' included chest expansions, alt back expansions, sidearm rises, arm circles, torso flexion, extension, lateral flexion, and rotation (2,6-10,12,13). It was performing 2 times daily with 3 sets of 10 repetitions with a pause of 2 minutes between each set (2,6-10,12,13). The musculoskeletal posture/balance training was performing 2 times daily with 3 sets of 10 repetitions with a pause of 2 minutes between each set (2,6-10,12,13). It included correction of the posture and muscle imbalance by

relaxation/stretching of the shortened static muscles (pectoral, scapular elevator, upper trapezoidal) and strengthening of the elongated/flabby muscles (lower trapezoidal, rhomboid, serratus anterior) (2,6-10,12,13).

Spirometric (15) and anthropometric (2,6-8,10,13) parameters were recorded at the beginning and end of the therapeutic course. Spirometry was performed in each test three times with a computer spirometer (15). The best of three consecutive trials was recorded (15). Anthropometric parameters were:- age (d), height (cm), weight (kg), chest circumference at pause, at maximum inspiration and expiration, Brugsh index (mean chest circumference divided by height in cm), Erisman index (chest pause circumference - 1/2 of the height in cm.), Tomayer test (toe-floor distance in cm.), Ott test (mobility of the spine in cm.), sagittal and frontal diameter of the chest and their ratio (2,8,10,12).

Correlation analyzes with post-hoc multiple linear regression tests were used to calculate the significance of the interaction between spirometric and anthropometric parameters, obtaining significant real multiple regression formulas. Based on them, we calculated the expected spirometric parameters, adjusted for all anthropometric parameters. They had higher statistical flexibility than the expected spirometric parameters, calculated automatically by the computer spirometer based on only 3 anthropometric parameters (age, height, and weight), which did not change for 10 days. In the statistical analysis, we additionally included the ratios in percentages between the real spirometric results and the expected spirometric parameters according to the obtained real regression formulas. For statistical analysis, a balanced design of MANOVA with 2x2 levels of interaction was used - "before" versus "after" treatment and "physiotherapeutic" versus "control" group. Post-hoc multiple Bonferroni comparative tests were used to isolate which statistical clusters differed significantly from the others.

### Results:-

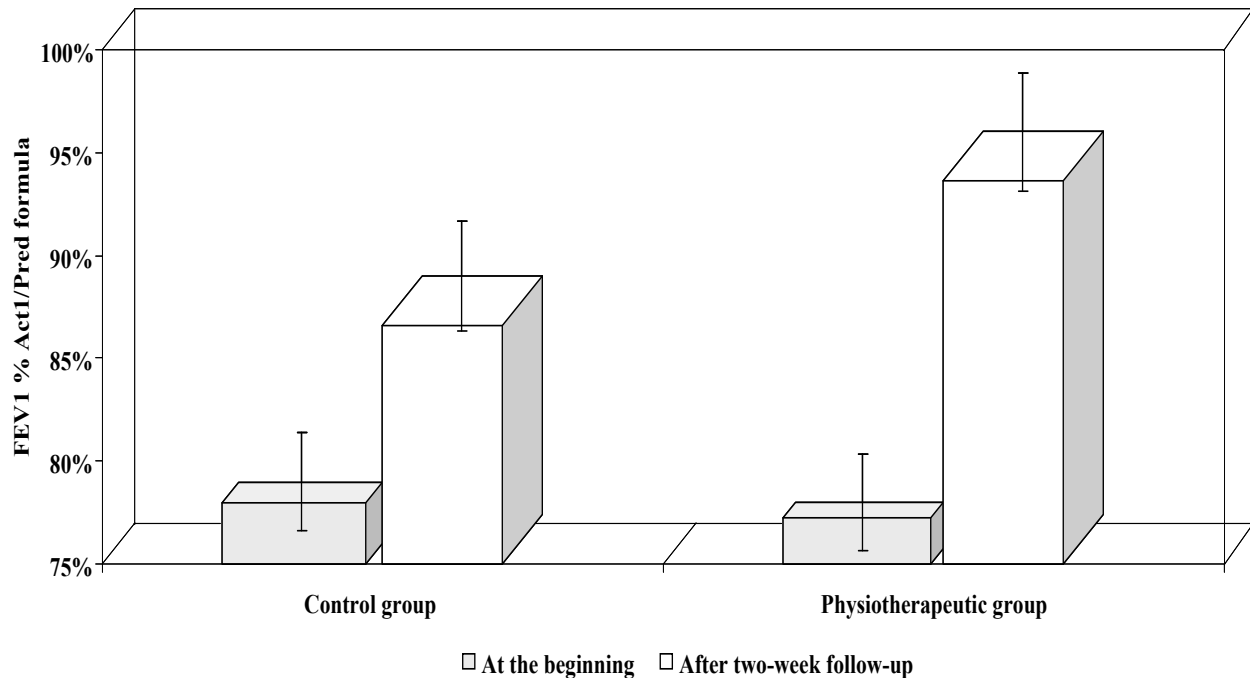
There were no statistically significant MANOVA interactions ( $P > 0.05$ ) with respect to the individual real spirometric parameters and with respect to the ratios between the actual and the parameters predicted by the computer spirometer, adjusted for age, height, and weight.

Statistically significant multiple correlations ( $P < 0.05$ ) between the actual forced expiratory volume for 1 second ("FEV1 Act1") and all anthropometric parameters, allowed us to calculate based on these real results, the following statistically significant multiple regression formula:

$$\text{„FEV1 Act1”} = 4,14 + (0,0156 * \text{Age}) + (0,0189 * \text{Height}) + (0,0260 * \text{Weight}) + (0,0790 * \text{chest circumference in maximum inspiration}) - (0,0796 * \text{chest circumference in maximal expiration}) + (0,00435 * \text{chest circumference in pause}) - (0,329 * \text{Brugsh index}) - (0,000605 * \text{Erisman index}) - (0,0233 * \text{Tomayer test}) - (0,0682 * \text{Ott test}) + (0,198 * \text{sagittal chest diameter}) - (0,188 * \text{frontal chest diameter}) - (4,37 * \text{the ratio sagittal/frontal diameter}).$$

This real formula was applied to calculate the expected "FEV1 Pred1 formula", adjusted for all anthropometric parameters. The ratio between the actual and the expected forced expiratory volume for 1 second, according to this formula ("FEV1% Act1/Pred formula"), was subjected to statistical MANOVA analysis with post-hoc multiple comparative tests of Bonferroni.

After the 10-day course, there was a significant increase in "FEV1% Act1/Pred formula" in the "physiotherapy" group ( $P < 0.05$ ) and the "control" group ( $P < 0.05$ ), but the "physiotherapy" group showed a statistically significantly higher value of this parameter compared to the "control" group after the two-week follow-up ( $P < 0.05$ ) (**Figure 1**).



**Figure 1:-** The ratio between the actual and the expected forced expiratory volume for 1 second, according to the formula (“FEV1% Act1/Pred formula”), in the “physiotherapy” group and the “control” group at the beginning and after the two-week follow-up.

The results from the other ratios between actual and expected spirometric parameters, adjusted for all anthropometric parameters, were similar to “FEV1% Act1/Pred formula”. They are not presented due to a limitation in the scope of this article.

### Discussion:-

At a 10-day follow-up, the actual spirometric parameters and the ratios between the actual and the predicted parameters by the computer spirometer were not sensitive enough to reach statistically significant differences. The expected spirometric parameters calculated by the computer spirometer cannot verify improvement after a 10-day period, as they are based only on inert anthropometric measurements (age, height, and weight). The remaining anthropometric parameters showed sufficient flexibility and sensitivity within a two-week follow-up. That is why the ratios between actual and expected spirometric parameters, adjusted for all anthropometric parameters, showed statistically significant dynamics within a two-week follow-up.

In both groups, an improvement was found after the 10-day therapeutic course in terms of the percentage ratios between the actual and the expected spirometric parameters, adjusted for all anthropometric parameters. This confirms the therapeutic effect of pharmacotherapy and rehabilitation with a combination of kinesitherapy and ultrasound in children with asthma.

A constructive effect of the combination of kinesitherapy and ultrasound on that of pharmacotherapy in children with asthma was found, as the improvement after treatment was significantly greater in the “physiotherapeutic” group compared to the “control” group.

### Conclusion:-

The combination of kinesitherapy and ultrasound has a significant therapeutic effect in 10-day inpatient and outpatient treatment of children with bronchial asthma, building on that of pharmacotherapy.

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