"BABEȘ-BOLYAI" UNIVERSITY CLUJ-NAPOCA

FACULTY OF PHYSICAL EDUCATION AND SPORT

DOCTORAL SCHOOL

THESIS SUMMARY

IMPROVING POSTURE, POSTURAL CONTROL AND QUALITY OF LIFE IN VISUALLY IMPAIRED STUDENTS THROUGH AN AQUATIC INTERVENTION PROGRAMME

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Summary

Berthold Lowenfeld, psychologist, researcher and advocate for the visually impaired hypothesized that blindness imposes 3 basic limitations on a person (often referred to as Lowenfeld losses):

1. Loss of range and variety of experiences

2. Loss of the ability to move

3. Loss of control over the environment and the self in relation to it.

Because of these restrictions, the individual relates to and learns about the world through the remaining senses, especially hearing, touch, kinaesthesia. Lowenfeld stated that "many experiences that are taken for granted with regard to children are either impossible or much more difficult for blind children". Lowenfeld found that visually impaired students need special experiences to help them understand what they are learning (Lowenfeld, 1965).

Studies show that consistent and sustained physical activity corrects posture, improves postural control and body balance, and relaxes the whole body, which relieves musculoskeletal pain (Ko & Kim, 2003; Kim & Lee, 2004; Jung & Chae, 2002; Tse et al., 2005; Kim et al. Al., 2015).

Higher levels of physical exercise have been linked to improved performance of postural control, balance, postural stability, improved dynamic gait stability, and superior orientation and movement performance in blind and visually impaired children and adolescents (Rogge et al. 2021).

A persistent visual impairment alters how postural control subsystems communicate with each other. The vestibular and somatosensory systems appear to play a more significant role in maintaining postural balance in visually impaired subjects, partially compensating for absent or poor visual input (Schwesig, 2011).

In the experimental study we aimed to follow the effects of a specially designed and tailored intervention program for visually impaired individuals on posture and postural control. We also proposed a multidimensional approach to this population, including not only factors such as physical functioning (posture, postural control and lung values), but also quality of life with respect to life satisfaction, social and emotional well-being.

The underlying hypothesis of the paper is that a specially designed and tailored aquatic intervention program for students with visual impairments will improve posture and postural control, spirometry values and quality of life, and orientation skills in the water.

The main objectives of the paper:

- To develop a theoretical framework on the influences of a swimming program on posture and postural control for visually impaired students.

- To identify postural parameters altered due to visual impairment.

- To develop a complex assessment model according to the proposed objectives.

- To develop a specially designed and adapted aquatic intervention programme for visually impaired students to improve posture, acquire orientation skills in water and eventually swimming.

- To apply the aquatic intervention programme to a sample of 30 visually impaired students.

- Record results and compare with a control sample on: posture parameters, postural control, water orientation skills, spirometry values and quality of life.

- The established research topic was studied in the context of an interventional, prospective study by defining a study sample following the cohort design.

PRELIMINARY INVESTIGATION

THE INFLUENCE OF AN AQUATIC PROGRAM, ROCK CLIMBING AND TRAMPOLINE JUMPING ON POSTURE AND POSTURAL CONTROL IN VISUALLY IMPAIRED STUDENTS

The aim of this research was to investigate the effects of three intervention programs on posture, postural control, quality of life and spirometry values in students with visual impairment.

The three intervention programs are: an aquatic program designed and adapted to visually impaired students, a climbing program designed and adapted to visually impaired students, trampoline jumping

At the end of the preliminary research, comparative studies were carried out to determine the most effective intervention programme to improve posture and postural control, quality of life and spirometry values in visually impaired students.

Preliminary research hypotheses

1. The application of the three intervention programs will contribute to the improvement of the participants' posture.

2. The application of the three intervention programmes will contribute to the improvement of postural control in visually impaired students.

3. The application of the three intervention programmes will contribute to the improvement of the health-related quality of life of students with visual impairment.

4. The implementation of the three intervention programmes will contribute to the improvement of spirometry values in visually impaired pupils.

The three experimental groups were:

- Experimental group 1: aquatic programme

- Experimental group 2: climbing programme

- Experimental group 3: trampoline jumping

Preliminary investigation research methods

Bibliographic study method

The bibliographical study method consisted of browsing 401 studies and scholarly articles.

The search for articles took place in the following databases: PUBMED, MEDLINE, PEDRO, CINAHL, EBSCO, with the following keywords: posture, postural control, postural balance, vision impairment, quality of life, spirometry, aquatic program, swimming.

Questionnaire survey method

A quality of life assessment questionnaire, continuous scale questionnaire. Kindlr (Ravens-Sieberer & Bullinger, 1998) is a generic instrument for assessing health-related quality of life in children and adolescents aged 3 years and older.

Test method

Complex postural analysis unit, global postural system, represents the newest and most complex postural assessment unit. It is an advanced, non-invasive, global postural analysis system for functional diagnosis and monitoring the effects of rehabilitation programmes.

Students participated in the testing in their bathing suits and were positioned on the testing apparatus by the research assistant. For posture analysis, images were captured from the sagittal plane for the right and left sides.

Measurements taken were as follows: plumb line - tragus distance, plumb line - acromion distance, plumb line - greater trochanter distance and plumb line - lateral tibial tuberosity distance. Values are expressed in centimetres.

For the analysis of postural control the following data were recorded: centre of gravity distance on the x and y axis for the lateral-lateral and antero-posterior tilts, expressed in millimetres.

The weight distribution on the lower limbs, the length of the curve expressed in millimetres and the confidence area of the ellipse expressed in square millimetres for the centre of gravity oscillations were recorded. A computer calculates the information and provides the answers as a weight graph (expressed in kilograms and percentages, on each leg support point) and stability graph (centre of leg pressure, assumed to be the barycentre of the body and its sway/oscillation over time).

Spirometry

For the evaluation of spirometric values we used the MIR spirometer, portable spirobank IIS/N 000912 from the interdisciplinary research center in the field of physical education and sport, UBB, Cluj-Napoca.

Measurements were performed by the research assistant of the above mentioned center in the kinesiology room of the special institution. The children had 5 minutes to get used to the spirometer. They had the possibility of 3 attempts and the best result was considered.

The spirometry measurements evaluated were as follows: Forced expiratory volume in 1 s (FEV1); Forced vital capacity (FVC), the maximum amount of air that can be exhaled when blowing as fast as possible; Vital capacity (VC), the maximum amount of air that can be exhaled when blowing as fast as possible; FEV1 / FVC ratio; Peak Expiratory Flow (PEF), the maximum flow that can be exhaled when blowing at a constant rate; Forced Expiratory Flow, also known as Middle Expiratory Flow; rates are given at 25%, 50% and 75% FVC.

Performing spirometry

Before testing: before spirometry was performed, the identity of the students was verified, their height without shoes or boots and weight measured (with mechanical scales), age, gender and race and the data were recorded.

Positioning of students: the correct measuring posture was as follows: sitting upright, feet flat on the floor with legs uncrossed so as not to use abdominal muscles for standing.

Experimental method

In this preliminary research there is an independent variable, determined by the means of intervention, which is manipulated within the three experimental groups: experimental group 1: aquatic program, experimental group 2: climbing program, experimental group 3: trampoline jumping

By manipulating the independent variable within the three groups of participants, the effects that emerged from investigating the dependent variables were followed: posture (plumb line - tragus distance, plumb line - acromion distance, plumb line - greater trochanter distance and plumb line - lateral tibial tuberosity distance), postural control (ideal barycentre distance on x and y axis, length of curve and area of ellipse, weight distribution on lower limbs), quality of life (physical well-being, emotional well-being, self-esteem, family, social relationships, school), spirometry (forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), vital capacity (VC), FEV1/FVC ratio, peak expiratory flow (PEF), forced expiratory flow, also known as middle expiratory flow).

Statistical-mathematical method

Statistical analysis was performed using medcalc statistical software version 19.1 (medcalc software bv, ostend, belgium; https://www.Medcalc.Org; 2019). Continuous data were tested for normality of distribution using the Shapiro-Wilk test and characterized by mean and standard deviation, or median and 25th and 75th percentiles. Qualitative data were expressed as absolute and relative frequency. Comparisons between repeated measurements were performed with paired t-test. Differences between measurements were tested with ANOVA for repeated measures testing or two-way ANOVA for repeated measures whenever appropriate. A value of $p<0.05$ was considered statistically significant.

To determine whether there were changes between paired variables we used the Wilcoxon test or the marginal homogeneity test as appropriate. To test the influence of a parameter on the variation of values of a pairwise variable we used the GLM test for repeated measurements. Statistical significance was set at a threshold value of 0.05.

In order to show the correlation between two normally distributed continuous variables we used Pearson correlation. To show the correlation between 2 non-normally distributed variables we used Spearman's correlation.

Preliminary research sample

The research was conducted at the Special High School for the Visually Impaired, Cluj-Napoca, Cluj County, with the consent of the management of the educational institution and the participants' parents. The swimming sessions took place at the Universitas Swimming Complex, Cluj-Napoca. Climbing and trampoline jumping sessions took place in the sports hall of the Special High School for the Visually Impaired, Cluj-Napoca, respectively in different climbing halls and in Cheile Turzii, county of Cluj-Napoca. Cluj.

The study included 30 visually impaired students, randomly selected from secondary school, aged between 12 and 15 years.

The experimental group 1: aquatic program included 6 girls and 4 boys diagnosed with amblyopia and blindness,

Experimental group 2: climbing programme included 5 girls and 5 boys diagnosed with amblyopia and blindness,

Experimental group 3: trampoline jumping included 4 girls and 6 boys diagnosed with amblyopia and blindness.

The group distribution of blindness and amblyopia was similar.

Inclusion criteria for the study: dignostic of amblyopia and blindness, age 12-15 years, ability to follow instructions, physical ability to perform moderate physical effort, no child had ever participated in swimming, climbing and trampoline jumping sessions.

Exclusion criteria from the study: presence of associated impairments, age under 12 years or over 15 years, inability to follow instructions, physical inability to perform moderate physical exertion, participation in swimming, climbing and trampoline jumping prior to the study.

Organisation of preliminary research

Experimental group 1- aquatic intervention program: students participated in 2 swimming sessions of 60 minutes each for 2 months. Outside the swimming sessions, students participated in school physical education classes, 2 hours per week.

Experimental group 2 - climbing programme: pupils participated in 2 climbing sessions of 60 minutes each for 2 months. Outside the climbing sessions, pupils participated in physical education classes in the school, 2 hours per week.

Experimental group 3 - Trampoline jumping: students participated in 2 trampoline jumping sessions of 40 minutes each for 2 months. Outside of the trampoline jumping sessions, pupils participated in school physical education classes, 2 hours per week.

Preliminary research assessments and measurements

For the preliminary research, each group had two values measured and recorded: initial values - at the beginning of the study and final values - after two months

These measurements were recorded for all proposed tests and questionnaires:

- Quality of life assessment questionnaire, continuous scale questionnaire : Kindl-R

- Complex Postural Analysis Unit, Global Postural System: tragus plumb line distance, acromion plumb line distance, greater trochanter plumb line distance and lateral tibial tuberosity plumb line distance; stabilometric values: x- and y-axis centre of gravity distance for anteroposterior and laterolateral tilts, lower limb weight distribution, curve length and ellipse confidence area for centre of gravity oscillations.

- Spirometry (Forced expiratory volume in 1 s (FEV1), Forced vital capacity (FVC), Vital capacity (VC), FEV1/FVC ratio, Peak expiratory flow (PEF), Forced expiratory flow, also known as middle expiratory flow)

Measurements

Climbing group measurements

Posturograph

For the climbing group the lead-tragus distance changes statistically significantly: from 6.40 decreases to 3.50 cm, lead-acromion distance changes significantly from 3.00 decreases to 1.60 cm, lead-trochanter major distance changes significantly from 4.40 decreases to 2.30 cm, lead-tibial tuberosity distance changes significantly from 2.10 decreases to 1.00 cm (Table 3).

Comparing the mean initial values with the mean final values we observe statistically significant changes $p<0.05$ for all measured items

Spirometry

For the climbing group, statistically significant changes can be observed for the spirometry values. The mean forced vital capacity values increase from 2.10 litres to 2.40 litres.

The mean maximum expiratory volume per second increases from 2.20 to 2.30 litres, the Tiffeneau index shows significant changes from 93.90 to 96.10 litres, the maximum peak flow changes significantly from a value of 3.40 litres increases to 3.70 litres.

The mean value of the maximum voluntary ventilation increases from 54.80 to 59.80 litres.

Quality of life - KINDL-R questionnaire

For the climbing group, statistically significant changes occurred for all domains of the questionnaire (Table 7). The total score showed significant changes from 51.16 to 80.40.

The largest change in scores was for the SOCIAL RELATIONSHIPS domain where the score increased from 44.75 to 85.10, followed by the EMOTIONAL WELLNESS domains from 54.48 to 86.30 and SELF-ESTEEM from 53.76 to 85.70.

The SCHOOL domain also showed significant changes from a score of 50.50 increased to 74.00.

The PHYSICAL WELLNESS domain showed significant increases from an average of 56.90 to 76.30.

FAMILY showed increases from 45.80 to 76.90.

Comparing the mean of the initial values with the mean of the final values, there are statistically significant changes $p<0.05$ for all items measured.

Stabilometer

For the distance to the ideal barycentre calculated on the X-axis (right/left direction), statistically significant changes were observed, from 18.00 it decreased to 7.00 mm, on the Y-axis (posterior/anterior direction) it decreased from 32.60 to 15.40 mm.

For the length of the curve there was a decrease from 852.20 to 610.60 mm. The value of the ellipse area decreased from 488.60 to 300.30 mm2.

Regarding the weight distribution on the lower limbs initially, 42.40% left lower limb and 57.60% right lower limb was observed. At the final assessment the distribution changed, for the left lower limb to 46.90 and 53.10 for the right lower limb, approaching the normal 50% weight distribution for each lower limb.

Comparing the mean of the initial values with the mean of the final values, statistically significant changes ($p<0.05$) are found for all measured items.

Measurements of the trampoline jumping group

Posturograph

For the trampoline jumping group the distance lead-tragus changed statistically significantly from 6.60 decreased to 3.80 cm, the distance lead-acromion changed significantly from 5.20 decreased to 3.20 cm, the distance lead-trochanter major changed significantly from 4.40 decreased to 2.90 cm, the distance lead- tibial tuberosity changed significantly from 2.30 decreased to 1.00 cm .

Comparing the mean of the initial values with the mean of the final values, statistically significant changes ($p<0.05$) are found for all measured items.

Spirometry

For the trampoline jumping group, statistically significant changes were found for spirometry values. The mean forced vital capacity values increased from 2.60 litres to 3.20 litres. The mean peak expiratory volume per second increased from 2.60 litres to 2.90 litres, the Tiffeneau index showed significant changes from 95.00 to 98.30 litres, peak peak flow changed significantly from a value of 4.50 litres increased to 5.20 litres. The mean values of the maximum voluntary ventilation increased from 86.50 litres to 91.10 litres.

If the spirometric values were expressed as a percentage, values well below the baseline values could be observed at the initial assessment. Following participation in the swimming programme at the final assessment, statistically significant changes occurred, which were close to the reference values for some respiratory volumes such as CVC, FEV1.

For forced vital capacity, an initial 79.50% was recorded, which increased to 97.80% of baseline. Peak expiratory volume reached a percentage close to the reference value, from 84.80% increased to 99.70%.

The Tiffneau index increased from 102.40 to 105.20; peak peak flow increased from 64.30 to 71.90 and maximum voluntary ventilation changed significantly from 78.30% to 82.60% .

Comparing the mean initial values with the mean final values we observed statistically significant changes ($p<0.05$) for all measured items.

Quality of life - KINDL-R questionnaire

For the trampoline jumping group, statistically significant changes were observed for all areas of the questionnaire.

The total score showed significant changes from 51.23 to 79.30.

The largest change in scores occurred for the SOCIAL RELATIONSHIPS domain, where the score increased from 42.25 to 85.40, followed by the EMOTIONAL WELLNESS domains from 53.98 to 84.00 and SELF-ESTEEM from 54.56 to 84.20.

The SCHOOL domain also showed significant changes from a score of 51.50 increased to 76.40.

The PHYSICAL WELLNESS domain showed significant increases from an average of 55.30 to 75.40.

FAMILY showed increases from 46.40 to 76.60.

Comparing the mean initial values with the mean final values, statistically significant changes ($p<0.05$) were observed for all items measured.

Stabilometer

For the distance to the ideal barycentre calculated on the X-axis (right/left direction), statistically significant changes were observed, from 15.10 decreased to 13.10 mm, on the Y-axis (back/back direction) decreased from 28.90 to 25.00 mm.

For the length of the curve, there was a decrease from 757.20 to 735.20 mm. The value of the area of the ellipse decreased from 290.00 to 240.00 mm2 .

For the weight distribution on the lower limbs initially, values of 43.40% on the left lower limb and 55.60% on the right lower limb were recorded.

At the final assessment the distribution changed, for the left lower limb to 44.90% and 53.10% for the right lower limb, approaching the normal weight distribution of 50% for each lower limb.

Comparing the mean of the initial values with the mean of the final values, statistically significant changes ($p<0.05$) are found for all measured items.

Evolution of parameters by batch comparison

Evolution of parameters by batch comparison for posturograph

Comparing groups with each other for posturographic values there were no statistically significant differences. For all measured values differences between groups were observed. The largest change occurred in the swimming group.

For climbing, the mean difference for the lead - drag distance was 2,900 cm, for swimming the mean difference for the lead - drag distance was 3,600 cm, for trampolining the mean difference was 2,800 cm.

For the plumb line - acromion distance the average differences were 1,400 cm for climbing, 2,200 cm for swimming and 2,000 cm for trampoline.

For the lead wire - trochanter distance the average differences were 2,100 cm for climbing, 2,400 cm for swimming, 1,500 cm for trampolining.

For the distance plumb line - tibial tuberosity the average differences were 1,100 cm for climbing, 1,600 cm for swimming, 1,300 cm for trampolining.

Evolution of parameters by comparison between groups for spirometry

Comparing groups with each other for spirometry values, a statistically significant difference was determined for the difference between groups for FVC AND FEV1 (Tables 29, 30).

Differences between groups were recorded for all measured values.

The largest change was found in the swimming group for all measured variables

Evolution of parameters by comparison between groups for quality of life - KINDL-R questionnaire

We determined a statistically significant difference for the difference between groups for the total score of the KINDL-R questionnaire. The largest change was found in the swimming group.

Evolution of parameters by comparison between groups for the stabilometer

Comparing the groups with each other for the posturographic values, no statistically significant differences were found.

For all measured values differences between groups were observed. The largest change was found in the swimming group.

For the distance from the ideal barycentre on the x-axis for the climbing group the mean difference was,100 mm, for the swimming group 11.6 mm, for the trampoline group it was 2.00 mm.

For the distance from the ideal barycentre on the y-axis for the climbing group the average difference was -.200 mm, for the swimming group 17.2 mm, for the trampoline group 3.9 mm.

For the curve length in the climbing group the mean difference was 4.3 mm, for the swimming group 41.6 mm, for the trampoline group 2.0 mm.

For the area of the ellipse for the climbing group the average difference was -4.2 mm2, for the swimming group 88.3 mm2, for the trampoline group 0.0 mm2.

Preliminary research findings

The preliminary study aimed to investigate the effectiveness of three intervention programs (aquatic program, rock climbing, trampoline jumping) on posture, postural control, spirometric values and quality of life of visually impaired students.

1. All the programmes applied had a statistically significant influence on posture, postural control, quality of life and spirometric values.

2. The application of the intervention programmes significantly influences the respiratory volumes of children and adolescents with visual impairment.

3. Health-related quality of life questionnaire values show statistically significant changes for children and adolescents with visual impairment following participation in intervention programmes.

4. Following the implementation of the intervention programs posture, sagittal plane deviations showed significant changes for children and adolescents with visual impairment.

5. Postural control, the distribution of the projection of the center of gravity within the support surface were significantly influenced following the application of the intervention program for children and adolescents with visual impairment.

6. Health-related quality of life improved for all domains studied as a result of going through the programs.

7. Vital capacity and maximum expiratory volume scores were closest to baseline following the intervention programmes.

Following the results of the preliminary study, in which the effects of the aquatic activities exceeded the effects of the other two programmes (climbing and trampoline jumping) on posture, postural control, quality of life and spirometry values, we proposed to refine the aquatic programme and follow up its effects on posture, postural control, spirometry values, quality of life. We also aimed to assess the level of water orientation acquisition that visually impaired students can achieve following a 6-month swimming programme.

PART III

EXPERIMENTAL RESEARCH

IMPROVEMENT OF POSTURE, POSTURAL CONTROL, WATER ORIENTATION SKILLS, SPIROMETRIC VALUES AND QUALITY OF LIFE IN VISUALLY IMPAIRED STUDENTS BY SWIMMING

Research objectives

To develop a theoretical framework on the influences of an aquatic program on posture and postural control for visually impaired students.

To identify postural parameters altered due to visual impairment.

To develop a comprehensive assessment model according to the proposed objectives.

To design an aquatic programme, specifically designed and adapted to visually impaired students, to improve posture, postural control, acquisition of water orientation skills and eventually learning to swim.

Application of the aquatic programme to a sample of 30 visually impaired pupils.

Recording of results and comparison with a control sample, with reference to posture parameters, postural control, water orientation skills, spirometric values and health-related quality of life.

Subjects and venue

The research was conducted at the Special High School for the Visually Impaired, Cluj-Napoca - for the experimental group and the Special High School Moldova, Targu Frumos for the control group.

The swimming sessions were held at the Universitas Swimming Complex, Cluj-Napoca.

The study included 60 visually impaired students randomly selected from the two institutions mentioned above, from secondary school, aged between 12 and 15 years.

The control group included 14 girls and 16 boys diagnosed with amblyopia and blindness. The experimental group also included 16 girls and 14 boys diagnosed with amblyopia and caeconia. The batch distribution of blindness and amblyopia is similar.

Application of the swimming programme

- The experimental group participated in 2 swimming sessions/week of 60 min/session for 24 weeks (total 48 sessions). In addition to the swimming sessions, students participated in school physical education classes, 2 hours per week.

- The control group participated in school physical education classes, 2 hours per week.

- During the course of the study the pupils did not participate in any other extracurricular physical activities.

Research methods

- Identical to the preliminary study with the addition of the modified Water Orientation and Swimming Skills Inventory (WOS)

The original swimming programme for visually impaired students

The adapted program consists of motor learning that focuses on postural control to teach people with visual impairments to swim.

Successive steps teach participants to experience and master, through various movement patterns, a movement in the water through "swimming", "rowing" movements. The steps of the programme are an effective method for teaching swimming to both disabled and healthy people.

The programme includes the following steps: mental adaptation (adjustment), balance control and movement.

Presentation, analysis and interpretation of data

Postural parameters identified in the group

In the studied groups we identified the following postural parameters:

- Head tilted forward: in the control group 73.3% of subjects, in the experimental group 86.7% of subjects;

- Kyphosis: in the control group 96.7% of subjects, in the experimental group 90.0% of subjects;

- Lordoza: in the control group 73.3% of subjects, in the experimental group 86.7% of subjects;

- Hip flexion: in the control group 60.0% of subjects, in the experimental group 70% of subjects;

- Hip extension: in the control group 13.3% of subjects, in the experimental group 16.7% of subjects;

- Pelvic anteversion: in the control group 53.3% of subjects, in the experimental group 63.3% of subjects;

- Knee flexion: in the control group 33.3% of subjects, in the experimental group 30.0% of subjects;

- Knee extension: in the control group 13.3% of subjects, in the experimental group 16.7% of subjects.

Following data analysis we identified 2 postural profiles for the studied group:

1. Head tilted forward, dorsal area tucked, lumbar lordosis, hip flexed, pelvis anteverted, knees flexed/extended .

2. Head tilted forward, back tucked, lumbar lordosis, hip extension, knees bent/extended.

Analysis and interpretation of results

POSTUROGRAPH

I. Analysis and interpretation of the results of the experimental group (initial - final test)

For the experimental group the distance of the lead-thrax thread changed statistically significantly from 6.23 cm decreased to 3.55 cm, the distance of the lead-thrax thread - acromion changed significantly from 4.10 cm decreased to 2.43 cm, the distance of the lead-thrax thread - greater trochanter changed significantly from 4.44 cm decreased to 2.62 cm, the distance of the lead-thrax thread - tibial tuberosity changed significantly from 2.12 cm decreased to 1.06 cm.

The mean of the differences between the two assessments showed significant changes for the experimental group, $p<0.05$

II. Analysis and interpretation of the results of the control group (initial - final test);

It can be seen that for the control group the recorded data showed no statistically significant changes. The mean differences did not change significantly for the control group, $p>0.05$

III. Analysis and interpretation of comparative results between groups (final test)

The analysis of the data showed a significant difference between the results of the groups, $p<0.05$ (Table 44, Figure 39).

In comparing the results obtained by the two groups, statistically significant changes were observed for the experimental group.

If at the beginning of the study the difference between the groups in terms of posturographic values was not significant, statistically significant differences were observed at the final evaluation for the values of all measured landmarks.

At the final evaluation the lead-thread - tragus distance for the control group was 6.05 cm while for the experimental group the distance decreased to 3.55 cm, the lead-thread - acromion distance for the control group was 4 cm while for the experimental group the distance decreased to 2.43 cm, the distance of the lead wire - greater trochanter for the control group was 5.01 cm, while for the experimental group the distance decreased to 2.62 cm, the distance of the lead wire - tibial tuberosity for the control group was 2.02 cm, while for the experimental group the distance decreased to 1.06 cm

SPIROMETRY

I. Analysis and interpretation of experimental group results (initial - final test)

For the experimental group following participation in the swimming sessions there were statistically significant changes in spirometry values.

The mean forced vital capacity values increased from 2.42 litres to 2.89 litres. The mean peak expiratory volume per second increased from 2.36 litres to 2.75 litres, the Tiffeneau index showed significant changes from 93.907 litres to 96.49 litres, peak peak flow changed significantly from a value of 3.93 litres increased to 4.48 litres.

The mean values of the maximum voluntary ventilation increased from 72.62 litres to 77.91 litres.

If spirometry values are expressed as percentages, values well below baseline were observed at baseline. Following participation in the swimming programme, statistically significant changes occurred at the final assessment, which were close to the reference values for some respiratory volumes such as CVC, FEV1.

For forced vital capacity we initially observed 77.07%, which increased to 91.33% of baseline. Peak expiratory volume reached a percentage close to the reference value, from 80.67% it increased to 92.80%.

The Tiffeneau index increased from 102.06 to 103.47, peak peak flow increased from 60.83 to 69.89%, and maximum voluntary ventilation changed significantly from 72.83% to 77.00%.

The mean of the differences between the two assessments showed significant changes for the experimental group for all respiratory volumes assessed, $p<0.05$.

II. Analysis and interpretation of control group results (initial - final test)

For the control group, which did not participate in the swimming sessions, no statistically significant changes were observed for spirometric values.

The mean forced vital capacity values increased from 2.23 litres to 2.38 litres.

The mean peak expiratory volume per second increased from 2.29 to 2.33 litres, the Tiffeneau index did not change from 94.21 litres to 94.21 litres, peak peak flow changed insignificantly from a value of 3.72 litres increased to 3.73 litres.

The mean value of the maximum voluntary ventilation increased from 67.89 litres to 68.29 litres.

If spirometric values were expressed as percentages, values well below the reference values were observed at the initial assessment. As the control group did not participate in any swimming activity, no statistically significant changes occurred at the final assessment.

For forced vital capacity we initially observed 77.53%, which increased to 77.67% of the reference value. Maximum expiratory volume reached a percentage close to the reference value, from 79.73% it increased to 80.20%.

The Tiffeneau index remained at 102.46, peak peak flow increased from 60.80% to 61.17%, and maximum voluntary ventilation changed insignificantly from 72.67% to 72.97%.

III. Analysis and interpretation of comparative results between groups (final test)

There were no significant differences between the groups for any of the respiratory volumes assessed in the initial evaluation.

In the final evaluation there were significant differences between groups for all breathing volumes assessed.

For FVC the control group showed an average of 2.23 litres, while the experimental group showed an average of 2.42 litres.

For FEV1 the control group showed an average of 2.33 litres, while the experimental group showed an average of 2.75 litres.

The Tiffeneau index showed a mean of 94.21 litres for the control group, while the experimental group showed a mean of 96.49 litres.

FMV showed an average of 3.73 litres for the control group and 4.48 litres for the experimental group. Average VMV volumes averaged 68.29 litres for the control group, while the control group averaged 77.91 litres.

When expressed as a percentage of the reference values, we observed that the values of the experimental batch were close to the reference values. The FVC values from 77.67% reached 91.33%, FEV1 values from 80.20% reached 92.80%.

QUALITY OF LIFE - KINDL-R QUESTIONNAIRE

I. Analysis and interpretation of the results of the experimental group (initial - final test)

For the experimental group statistically significant changes were observed for all domains of the questionnaire.

The greatest change in scores occurred for the SOCIAL RELATIONSHIPS domain where the score increased from 44.90 to 85.44, followed by the EMOTIONAL WELL-BEING domains from 54.60 to 84.59 and SELF-ESTEEM from 54.26 to 84.23.

The SCHOOL domain also showed significant changes, from a score of 51.93 increased to 74.15.

The PHYSICAL WELLNESS domain showed significant increases, from an average of 56.36 increased to 75.93.

FAMILY showed an increase from 54.25 to 65.45.

Mean differences between the two assessments showed significant changes for the experimental group for all dimensions assessed, $p<0.05$.

II. Analysis and interpretation of the results of the control group (initial - final test);

No statistically significant changes were observed for the control group for any of the domains of the KINDL-R questionnaire.

III. Analysis and interpretation of comparative results between groups (final testing)

For the total score of the KINDL-R questionnaire we observed significant changes in the comparison between the groups at the final assessment.

The experimental group obtained an average value of 79.79 points, and the control group an average of 52.12 points.

At baseline, no significant differences were observed between groups in any of the questionnaire domains.

At the final assessment there were significant differences between the groups for all domains of the questionnaire (Table no. 58, Figure 45).

For the PHYSICAL WELL-BEING domain, the control group scored 56.70 points, while the experimental group scored 75.93 points; for the domain EMOTIONAL WELL-BEING we observed in the case of the control group a score of 54.75, while the experimental group obtained a score of 84.23 points.

For the SELF-ESTEEM domain, in the case of the control group, a score of 54.63 points was recorded, while the experimental group obtained 84.23 points.

For the FAMILY domain, a score of 57.76 points was observed for the control group, and a score of 65.45 points for the experimental group.

For the SOCIAL RELATIONS domain, the control group obtained an average of 45.38 points, while the experimental group obtained 85.44 points.

For the SCHOOL domain, an average of 51.46 points was obtained for the control group, and the experimental group obtained an average of 74.15 points.

STABILOMETER

I. Analysis and interpretation of the results of the experimental group (initial - final testing)

For the distance to the ideal center of gravity calculated on the X axis (right/left direction) we observed statistically significant changes, from 15.70 mm it decreased to 6.70 mm, and on the Y axis (back/front direction) decreased from 28.30 mm to 14.87 mm.

For the length of the curve we observed a decrease in the value from 771.40 mm to 565.77 mm. The ellipse area value decreased from 355.10 mm2 to 218.30 mm2.

Regarding weight distribution on the lower limbs, values of 45.17% for the left lower limb and 54.83% for the right lower limb were initially observed.

At the final assessment the distribution changed, for the left lower limb to 48.63% and 52.03% for the right lower limb, approaching the normal weight distribution of 50% for each lower limb.

Comparing the average of the initial values with the average of the final values, statistically significant changes were recorded, $p<0.05$ for all measured items

II. Analysis and interpretation of control group results (initial - final testing)

The mean of the differences did not show significant changes for the control group, $p>0.05$, for any of the dimensions evaluated in the case of stabilimeter.

III. Analysis and interpretation of comparative results between groups (final testing)

Comparing the results of the experimental group with those of the control group, statistically significant differences were observed for all measured items, $p<0.05$.

For the distance to the ideal barycenter calculated on the X-axis (right/left direction) there were statistically significant changes, from 15.70 it decreased to 6.70 for the experimental group, while for the control group the values have decreased from 15.87 to 14.93; on the Y axis (posterior/anterior direction) for the experimental group the mean decreased from 28.30 to 14.87, while for the control group the change was a decrease from 28.27 to 27.83.

For curve length there was a decrease in value from 771.40 to 565.77 for the experimental group, while for the control group the mean change was a decrease from 770.07 to 758.87.

The ellipse area value decreased from 355.10 to 218.30 for the experimental group; for the control group the change was a minimal increase, from 353.10 to 353.83.

Regarding weight distribution on the lower limbs, initially values of 45.17% were observed in the left lower limb and 54.83% in the right lower limb for the experimental group, and for the control group values of 45, 03% in the left lower limb and 49.57% in the right lower limb.

At the final evaluation, for the experimental group, the distribution changed, the values were 48.63% for the left lower limb and 52.03% for the right lower limb, approaching the normal weight distribution of 50% for each lower limb .

For the control group, the final evaluation showed the following values: for the left lower limb 46.83%, and for the right lower limb 51.43%.

WATER ORIENTATION SKILLS ASSESSMENT SCALE (WOS – water orientation skills)

At the end of the 6 months of intervention, major changes were registered regarding the acquisition of orientation skills in water and swimming.

We calculated a validation coefficient or internal consistency for the modified WOS. A value greater than 0.7 of the Cronbach's Alpha coefficient shows a scale with good internal consistency.

In our case, the value of the Cronbach's Alpha coefficient = 0.828 showed a scale with good internal consistency.

The mean of the initial score was 6.92±5.397, the mean of the final score was 102.96±36.643.

A significant change was observed between the initial and final assessment, from a value of 4.77% to 71.00% of the maximum value of 100%.

30% of the students learned all 3 types of swimming mentioned in the questionnaire.

30% of students learned at least one swimming style.

The remaining 40% of the students managed to fulfil all the items of the scale, of which the last 6 with aids.

CONCLUSIONS OF EXPERIMENTAL RESEARCH

1. 2 postural profiles were identified in visually impaired students, as follows:

a) Head tilted forward, kyphosis dorsal area, lordosis lumbar area, flexed hip, anteverted pelvis, flexed/extended knees;

In this postural profile, the following were observed: (1) increased thoracic kyphosis, (2) protraction of the head, (3) flattened or inverted lower cervical lordosis, (4) increased upper cervical lordosis (5) protraction of the shoulders and scapulae (6) lumbar lordosis increased and (7) increased pelvic anteversion (anterior tilt). Increased anterior tilt of the pelvis leads to increased flexion of the hip joints.

The head line is displaced anterior to the thoracic spine, the lumbar vertebral bodies, and the axis of the hip and knee joint.

b) Head tilted forward, dorsal area kyphosis, lumbar lordosis, hip in extension, trunk translated backward, knees flexed/extended.

In this postural profile observed: (1) anterior pelvic displacement, (2) thoracic kyphosis extended to upper lumbar spine (longer thoracic kyphosis is noted), (3) apparently shorter lumbar lordosis (4) anterior pelvic tilt normal or slightly decreased.

The pelvis is in front of the head line, while the upper part of the trunk is displaced posteriorly relative to this axis. The head is in a protraction, the chest is inclined in relation to the support surface and the line of the head. The line of the head passes posteriorly to the lumbar vertebral bodies (resulting in overloading their extension) and posteriorly to the axis of the hip joints (resulting in overloading the hip joints).

2. The application of an adapted aquatic program significantly influences the posture and deviations in the sagittal plane, in children and adolescents with visual impairments.

A spine that exhibits deficient positions in various planes denotes a lack of movement in the opposite directions of the deficiency. The aquatic program provides and facilitates this movement experience, causing spinal movements in all planes around the three axes, thereby providing posture relief.

The adapted aquatic program contains many elements and techniques that stimulate labyrinthine righting reflexes, neck righting reflexes, head-to-head righting reflexes and body-to-body righting reflexes in an unstable environment, which will also trigger the body's rebalancing reactions , thus explaining the improvement of postural control.

3. The application of an adapted aquatic program significantly influences postural control and the distribution of the projection of the center of gravity inside the support surface, in children and adolescents with visual impairments.

4. Applying an adapted aquatic program significantly influences respiratory volumes in children and adolescents with visual impairments.

The results of the study suggest that visual sensory deficits that are present during childhood and adolescence affect the functional capabilities of the respiratory system.

After completing the adapted aquatic program, vital capacity and maximum expiratory volume scored the closest to the reference values, FVC 91.33% and FEV1 92.80%.

5. Applying an adapted aquatic program significantly influences health-related quality of life questionnaire values in visually impaired children and adolescents.

6. Health-related quality of life improved for all domains studied following the adapted swimming program.

Swimming is a form of activity that significantly influences the quality of life, especially in the areas of SOCIAL RELATIONSHIPS, EMOTIONAL WELL-BEING and SELF-ESTEEM, but also in other areas, such as FAMILY and SCHOOL.

Personal contributions to research

Swimming has always been considered a means of promoting physical health in general. Water activities are promoted as an intervention for the general population.

The novelty of the presented research consists in studying for the first time in Romania the effects of a swimming program specially designed and adapted to students with visual impairments. Previous studies have investigated posture in this population, but no studies have presented specific means of intervention.

The period and frequency of application of the program (6 months, 2x per week) is higher than in most studies for the general population.

Another novelty is the adapted aquatic intervention program itself, which consists of exercises specially designed to improve posture and postural control in blind students.

The adapted aquatic program contains many elements and techniques that stimulate labyrinthine righting reflexes, neck righting reflexes, body to head righting reflexes and body to body righting reflexes in an unstable environment that will also trigger the rebalancing reactions of body, thus explaining the significant results for this batch.

Performing movements in an environment where gravity acts differently on the structures of the locomotor apparatus provides participants with facilitation of mobilization in all planes of the spine.

Since water is a medium in which forces such as the Archimedean force, the gravitational force and the metacenter act, twisting movements around the axes of the body become much easier to achieve. In the development of human motor skills, the first movements of the spine are those of flexion and extension, followed by movements of lateral tilt. Rotations are the last movements of the spine as they appear in ontogenesis and are the first to disappear in the case of various conditions, being compensated with flexions, extensions or lateral tilts. Facilitating these rotational movements combined with flexion, extension and lateral bending will increase stability and keep the body in the midline.

The program does not work on movement components that the children will then apply functionally; children work on functional tasks to learn new skills such as back float, back float lift, back float stand up, etc.

The aquatic environment is an environment that forces a change in respiratory function. The pressure of the water on the rib cage forces inspiration. Activities in the water involve forced inhalation, forced exhalation, apnea, activities that stimulate changes in respiratory parameters, which will increase the mobility of the ribcage and thus influence the mobility and posture of the spine.

The study included measurements from all dimensions of the International Classification of Functioning and Disability (ICF): (a) body structure and functions, (b) activity, (c) participation. The ICF suggests that a person must be viewed in a multidimensional context so that the goals of assessments and treatment can be determined not only from a medical perspective, but also from a socio-emotional perspective. Also, the specially designed and adapted program brings improvements in all these areas, facilitating the social inclusion of these students.

Limitations of the research

One of the limitations of the research is represented by the fact that the long-term maintenance of the effects of the aquatic program on posture, postural control, quality of life and spirometric values was not evaluated. A reassessment is recommended at least 6 months after the end of the intervention.

Another limitation may be the small size of the study sub-groups for the visually impaired subtypes: totally blind and amblyopic, so we could not compare the results between totally blind and amblyopic students.

As future research directions, we propose expanding the study to a larger number of participants and tracking the maintenance of the long-term effects of the aquatic program beyond 6 months after the end of the study. We also propose applying the program to other sensory impairment groups such as hearing impairment groups.

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