STUDIA UBB EDUCATIO ARTIS GYMN., LVIII, 3, 2013, pp. 101 - 115
(RECOMMENDED CITATION)

# INFLUENCING THE GROSS MOTOR FUNCTION, SPASTICITY AND RANGE OF MOTION IN CHILDREN WITH CEREBRAL PALSY BY AN AQUATIC THERAPY INTERVENTION PROGRAM

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**ABSTRACT.** The aim of this paper is to track the aspects and results of applying an aquatic therapy intervention program adapted and integrated in the treatment of neuromotor reeducation of children with cerebral palsy on gross motor function, spasticity and range of motion. The aquatic therapy program had duration of 6 months, 2 weekly sessions. The average duration of a session was 45 minutes. The water temperature was 36° C. Besides the aquatic therapy sessions the children participate in 2 physical therapy sessions which were included in the rehabilitation program of the institutions they belonged to. 24 children diagnosed with cerebral palsy have participated in this study. The average age was 12,5 ± 2,7 years. The assessment methods used are: Gross Motor Function Measure - GMFM-88 for the assessment of the evolution of the gross motor function, goniometer assess range of motion and the Modified Ashwort Scale for the assessment of the spasticity level. The gained results for the evaluation of the gross motor functions have shown significant statistical differences: patients with higher level of GMFCS will achieve significantly higher score of the subsection A (lying and rolling) (p=0,002), B (sitting) (p=0,002), C (crawling and kneeling), (p=0,001). Patients with a lower GMFCS level will achieve significantly higher score for the subsection E (walking, running, jumping) (p=0,001). We observed statistically significant differences between the initial and final evaluation for the achieved scores on spasticity of the left triceps sural muscle (p=0,003); for the right triceps sural muscle (p=0,001); for the adductor muscles of the hip (p=0,001). With regards to active and passive range of motion we noticed a significant statistical difference between the initial and final evaluation for the coxofemoral abduction movement and scapulohumeral flexion (p < 0,001). The results of the study have shown significant statistic differences with regards to the increase of passive and active range of motion, decrease of spasticity and improvement of gross motor functions in all studied dimensions. The aquatic therapy program is a factor which influences these parameters together with the classic rehabilitation program.

**Key Words:** aquatic therapy program, gross motor function, spasticity, range of motion, cerebral palsy

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**REZUMAT.** ***Influenţarea funcţiei motorii grosiere, a spasticităţii și mobilităţii articulare la copii cu paralizie.*** Lucrarea de faţă își propune să urmărească aspecte și rezultate în urma aplicării unui program de intervenţie terapeutică acvatică adaptat și integrat în tratamentul de reeducare neuromotorie a copiilor cu paralizie cerebrală asupra funcţiei motorii grosiere, a spasticităţii și mobilităţii articulare. Programul terapeutic acvatic a avut o durată de 6 luni, 2 ședinţe săptămânale. Durata medie a ședinţelor a fost de 45 de minute. Temperatura apei a fost de 36 C. Au participat un număr de 24 de copii cu diagnosticul de paralizie cerebrală. Media de vârsta a fost de 12,5 ± 2,7 ani. Metodele de evaluare au fost: Scala de Evaluare a Funcţiei Motorii Grosiere - GMFM-88 pentru aprecierea evoluţiei motricităţii grosiere, goniometrul pentru aprecierea gradelor de mobilitate articulară și Scala Ashwort modificată pentru aprecierea nivelului spasticităţii. Rezultatele obţinute au arătat diferenţe semnificative din punct de vedere statistic: pacienţii încadraţi într-un nivel mai mare GMFCS vor obţine creșteri semnificativ mai mari ale scorului subsecţiei A (decubit și rostogolire) (p=0,002), B (așezat) (p=0,002), C (târâtul și pe genunchi, (p=0,001). Pacienţii încadraţi într-un nivel mai mic GMFCS vor obţine creșteri semnificativ mai mari ale scorului subsecţiei E (mersul, alergatul, săritul) (p=0,001). Am observat diferenţe semnificative statistic între evaluarea iniţială și finală pentru scorurile spasticităţii tricepsului sural stâng (p=0,003); pentru scorurile spasticităţii tricepsului sural drept (p=0,001); pentru adductorii coapsei (p=0,001). În ceea ce privește mobilitatea articulară activă și pasivă am observat o diferenţă semnificativă din punct de vedere statistic între evaluarea iniţială și finală pentru mișcarea de abducţie coxofemurală, flexia scapulohumerală (p<0,001). Rezultatele studiului au arătat diferenţe semnificative statistic asupra creșterii mobilităţii articulare atât pasive cât și active, în ceea ce privește scăderea spasticităţii și îmbunătăţirea motricităţii grosiere în toate dimensiunile studiate. Programul terapeutic acvatic este un factor în influenţarea acestor parametrii alături de programul de recuperare clasic.

**Cuvinte cheie:** program acvatic terapeutic, funcţie motorie grosieră, spasticitate, mobilitate articulară, paralizia cerebrală

## Introduction

Aquatic exercise programs can be a beneficial therapy form for children and adolescents with cerebral palsy, especially for those with significant motor/ movement constrains for which physical activities on land are difficult.

For children and adolescents who suffer from cerebral palsy throughout the severity spectrum it is more likely to have a lower physical activity level than their peers, thus they risk to suffer more negative consequence with regards to their health. (Morris 2008) A published systematic review (2006) on the topic of aquatic intervention on children suffering from cerebral palsy has come to the conclusion: proofs that this therapy is efficient exists but they are insufficient.

(Getz et al. 2006) Swimming is one of the most frequent encountered physical activity for children and adolescents with cerebral palsy. That is why information on how safe and beneficial this therapy is, are necessary, especially for those who suffer from a more severe form of cerebral palsy.

It is possible that programs of aquatic exercise to be of significant benefit for this population (Kelly et al. 2005, Fragala-Pinkam 2008). The unique attributes of water offer a favorable environment for children and adolescents with cerebral palsy. (Ondrak-Thorpe 2007) For example, requirements of weight bearing, amount of trunk control, joint load and the effects of gravity are reduced in water. (Ondrak-Thorpe 2007) As a result the aquatic physical activity is more protective for the integrity of the joints compared to physical activity on land. (Thorpe 2005) The warm aquatic environment of 32-33°C reduces the muscular tonus which enables a more efficient movement in children with a higher muscular tonus. Studies have reported that the execution of movements in water can increase the self confidence level and can decrease reluctance in trying more difficult tasks in comparison with exercise on land. (Fragala-Pinkam 2009) Moreover, activities in water can be more fun and innovative for children, with potential to increase motivation and interest. (Retarekar 2009)

## Purpose of the Study

The aim of this paper is to observe the effects of an aquatic therapy intervention program on gross motor function, spasticity and range of motion in children with cerebral palsy.

## Material and Method

**Table 1.** Main characteristics of the participants

| | | | | |
|---|---|---|---|---|
| Number of participants | 24 | | | |
| Age of participants | average | | | 12,5 ± 2.7 years |
| Gender of participants | boys | | | 18 |
| | girls | | | 6 |
| Clinical forms | Spastic cerebral palsy | | | |
| | | Paraparesis | | 5 |
| | | Tetraparesis | | 10 |
| | | Hemiparesis | right | 2 |
| | | | left | 2 |
| | Dyskinetic cerebral palsy | | | 4 |
| | Ataxic cerebral palsy | | | 1 |
| **GMFCS Level** | | | | |
| **Level I** | | | | |
| Independent walk, restrictions of the advanced ability of movement | | | | 0 |

| | |
|---|---|
| **Level II**<br>Walking without aid, restrictions of the walk in the outdoor environment or on accidental ground | 10 |
| **Level III**<br>Walking with assistive mobile devices, restrictions of the movement outdoor or in the community | 8 |
| **Level IV**<br>Diminished mobility, the child is transported or needs other means of transport outdoors or in the community | 2 |
| **Level V**<br>Independent mobility is severely restricted even with technical support | 4 |

This study involved 24 children suffering from different clinical forms of cerebral palsy from the Cluj County, enrolled in different rehabilitation centers.

The age of the participants in this study was between 8 and 16 years. The criteria of inclusion in this program were: diagnostic, capacity to follow simple verbal instructions. None of the children have ever participated in aquatic therapy intervention programs.

## Methods

**Gross Motor Function Classification System.** The level of mobility of children and adolescents at home, in school and in the community can be best described with the system of classification of the extended and revised gross motor function (GMFCS E&R). GMFCS covers an ample range from the level I, at which the individual functions at an advanced level being capable or having potential to walk without limitations up to level V for individuals with own very restricted mobility which required a high level of assistance.

**Gross Motor Evaluation.** The gross motor evaluation was done by using the Gross Motor Function Measure Scale (GMFM - 88) in all 5 dimensions: A: lying and rolling B: sitting C: crawling and kneeling D: standing E: walking, running and jumping. The scores were calculated for each dimension in turn and then a total score was calculated for all dimensions. The Gross Motor Function Measure Scale (GMFM) is a standardized observational instrument designed to measure the gross motor functions in time for children with cerebral palsy, a test which is well documented in the specialized literature. (Nordmark et al. 1997, Russel et al. 1998)

**Modified Aschworth Scale.** For the evaluation of the level of pyramidal spasticity we used the Modified Aschworth Scale, which is a common measuring tool in the evaluation of resistance to passive movement for children with cerebral palsy. (Ahloborg et al. 2006,Bohannon 1987). This system ensures a gradual supervision of the resistance level experienced by the examiner. It includes 5 levels of rigidity of the muscular tonus graded from 0 to 4. Bohannon modifies the scale introducing the level 1+. The evaluation of spasticity was done at the level of the spastic muscles of the upper member – for the extension of the elbow – brachial biceps and of the lower member – for the hip abduction – adductor muscles of the hip, for the knee extension – knee flexors (hamstrings muscles), for the plantar dorsiflexion – plantar flexors (sural triceps).

**Range of Motion.** We evaluated the active and passive movement amplitude for the scapulohumerale abduction, scapulohumerale flexion, scapulohumerale internal and external rotation, scapulohumerale abduction, coxofemoral abduction, with plastic goniometer of 30 cm, 360 g. (2 rulers in cm, rotation of 360 degrees, gradation in 360 degrees with pace of 1 degree) (McDowell et al. 2000) by standard positions and methodology. (Norkin-White 1985)

The **Aquatic Therapy Program** is a strategy to teach persons with neuromotor disabilities swimming. The concept uses principles from the mechanics of fluids to enable the subjects to gain stability and controlled movement in water.

The aquatic therapy program which lasted over a period of 6 months comprised 2 weekly sessions. The duration on the sessions was 45 minutes. The water temperature was 36 º C.

The purpose of this method is independence which is demonstrated by coordinated movements. Keeping the balance in water required accommodation to the mechanical changes of the environment. The accommodation is the result of a psycho sensory motor learning process, which offers to the individual the possibility to learn how to keep balance in an instable environment. Once balance is gained (stability) movement can be initiated and controlled (Lambeck 1996).

For the **statistical analysis** the program SPSS version 20 was used. The data was classified as nominal or quantitative. For the description of the nominal variable the frequency and percentage was used and for the quantitative variable we used the average and standard deviation or median and percentile 25 and 75, depending on the situation. For the verification of the normality of the quantitative data the Kolmogorov-Smirnov test was used. In order to determine if there are changes between pair variables we used the Wilcoxon test or marginal homogeneity test, depending on the situation. In order to check the influence of a parameter upon the value variation of a pair variable we used the GLM test for repeated measures. The statistical signification was set at a threshold value of 0.05.

## Results

### Gross Motor Function Measure – GMFM

Table 2 presents the difference between the initial and final evaluation of each dimension of the GMFM individual and total test.

**Table 2.** Score GMFM – dimensions: A, B, C, D, E (%)

| | | A initial | A final | B initial | B final | C initial | C final | D initial | D final | E initial | E final |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Median** | | 100,00 | 100,00 | 97.00 | 100.00 | 66.66 | 86.90 | 55.12 | 79.48 | 46.52 | 65.27 |
| | **25** | 77,45 | 86,27 | 69.75 | 77.75 | 48.20 | 64.28 | 19.22 | 61.53 | 11.10 | 16.31 |
| **Percentile** | **75** | 100,00 | 100,00 | 100.00 | 100.00 | 91.06 | 97.01 | 69.23 | 84.61 | 60.76 | 76.38 |
| **P** | | **A: p=0,008** | | **B: p=0,001** | | **C: p<0,001** | | **D: p<0,001** | | **E: p<0,001** | |

The results indicate significant increase from statistical point of view for all the dimensions. For dimension A (lying and rolling) at percentile 25% we notice an increase between the initial and final evaluation of: 8.82%; from 77,45% to 86,27%. For dimension B (sitting) at percentile 50 we observe an improvement of 3%; from 97,00% to 100,00%. For dimension C (crawling and kneeling) we notice a significant increase from 91.06 to 97.01% at the percentile 75%. The highest increases we notice at dimension D (standing) and E (walking, running and jumping) p< 0,001(D: from 69.23% to 84.61%, E: from 60.76% to 76.38%).

Table 3 presents the differences between the initial and final evaluation for the total scores GMFM. We noticed significant statistical differences p < 0,001. The value of the median increases from 73,03% to 85,24%, at the percentile 25 it increases from 45,74% to 54,92%, at the percentile 75 the increase is from 80,48% to 89,90 %.

**Table 3.** GMFM Score –Total (%)

| | | Total initial | Total final | |
|---|---|---|---|---|
| **Median** | | 73.03 | 85.24 | |
| **Percentile** | **25** | 45.73 | 54.92 | |
| | **75** | 80.48 | 89.90 | |
| **P** | | | | **Total: p<0,001** |

We showed that patients from a lower GMFCS level will gain significantly higher scores at the subsection E (walking, running, jumping) p < 0,001;

We showed that patients from a higher GMFCS level will gain significantly higher increase of the total score p = 0,05;

In order to determine if there are also other factors which influence the evolution of the total scores, besides therapy, we applied the GLM test (general linear model). We transformed logarithmically the initial and final scores. We didn't determine a significant statistical change due to change of parameters: age, body mass index, diagnostic subtype (p>0,05).

### Evaluation of Spasticity

We excluded from this assessment the 4 children with the diagnostic of diskinetic cerebral palsy, and 1 child with ataxic cerebral palsy.

Significant results were registered for the hip adduction (ADD) p < 0,001 for both the lower right and lower left member, left knee flexors(F) p = 0010, right p = 0,001, right sural triceps(TRIC. S) p< 0,001, left p = 0,001, right brachial biceps(BB) p = 0,010 left p = 0.005. (Table 4)

We noticed significant results from statistical point of view with regards to correlation between spasticity and clinical diagnostic. Children diagnosed with spastic tetra paresis have recorded the results with the highest statistical significance p < 0,001 by comparison to the other forms of cerebral palsy.

**Table 4.** Modified Aschworth Scale

| | | INIŢIAL | FINAL | P |
|---|---|---|---|---|
| **B. B. left** | MEAN | 1,26 | 0,89 | =0,05 |
| | ST DEVIATION | 1,19 | 0,80 | |
| **B.B.right** | MEAN | 1,26 | 0,95 | =0,010 |
| | ST DEVIATION | 1,19 | 0,91 | |
| **Hip ADD.** | MEAN | 2,11 | 1,53 | <0,001 |
| **left** | ST DEVIATION | 1,10 | 0,90 | |
| **Hip ADD** | MEAN | 2,16 | 1,58 | <0,001 |
| **right** | ST DEVIATION | 1,16 | 0,90 | |
| **Knee. F.** | MEAN | 1,74 | 1,42 | =0,010 |
| **left** | ST DEVIATION | 0,99 | 0,83 | |
| **Knee F.** | MEAN | 1,89 | 1,42 | =0,001 |
| **right** | ST DEVIATION | 1,04 | 0,83 | |
| **Tric. S.left** | MEAN | 1,95 | 1,47 | = 0,001 |
| | ST DEVIATION | 0,97 | 0,84 | |
| **Tric. S. right** | MEAN | 2,05 | 1,47 | <0,001 |
| | ST DEVIATION | 1,07 | 0,84 | |

### Range of Motion

### Passive mobility

Following the analysis of the initial and final data of the passive mobility we noticed a highly significant statistical change p<0,001.

The distribution of the study group is non normal which is the reason why we used the median and percentile 25% and 75% for expressing the results.

The values of the passive mobility for the initial and final evaluation can be found in Table 5, 6, 7, 8, 9.

**Table 5.** Passive mobility – scapulohumerale abduction

| | | initial DR | final DR | initial STG | final STG | P |
|---|---|---|---|---|---|---|
| **Median** | | 163,50 | 178,50 | 164,50 | 178,00 | |
| **Percentile** | **25** | 127,50 | 146,75 | 133,50 | 151,25 | |
| | **75** | 173,00 | 180,00 | 173,50 | 180.00 | |
| P | | | | | | p<0,001 |

**Table 6.** Passive mobility – scapulohumerale flexion

| | | initial DR | final DR | initial STG | final STG | |
|---|---|---|---|---|---|---|
| **Median** | | 161,50 | 175,50 | 157,50 | 175,00 | |
| **Percentile** | **25** | 118,00 | 136,75 | 122,50 | 141,25 | |
| | **75** | 173,00 | 180,00 | 175,00 | 180,00 | |
| P | | | | | | p<0,001 |

**Table 7.** Passive mobility – scapulohumerale internal rotation

| | | initial DR | final DR | initial STG | final STG | |
|---|---|---|---|---|---|---|
| **Median** | | 75,00 | 88,00 | 78,00 | 89,00 | |
| **Percentile** | **25** | 48,50 | 60,00 | 47,75 | 60,00 | |
| | **75** | 85,00 | 90,00 | 87,00 | 90,00 | |
| P | | | | | | p<0,001 |

**Table 8.** Passive mobility – scapulohumerale external rotation

| | | initial DR | final DR | initial STG | final STG | |
|---|---|---|---|---|---|---|
| **Median** | | 73,50 | 85,50 | 78,00 | 89,00 | |
| **Percentile** | **25** | 46,25 | 58,50 | 45,00 | 61,75 | |
| | **75** | 83,00 | 90,00 | 87,75 | 90,00 | |
| P | | | | | | p<0,001 |

**Table 9.** Passive mobility – coxofemoral abduction

| | | initial DR | final DR | initial STG | final STG | |
|---|---|---|---|---|---|---|
| **Median** | | 30,00 | 40,00 | 27,00 | 36,50 | |
| **Percentile** | **25** | 23,25 | 31,50 | 23,00 | 30,00 | |
| | **75** | 87,75 | 90,00 | 35,00 | 42,00 | |
| P | | | | | | p<0,001 |

## Active mobility

Following the analysis of the initial and final data of the active mobility we noticed a highly significant statistical change p<0,001.

The distribution of the study group is non normal which is the reason why we used the median and percentile 25% and 75% for expressing the results.

The values of the active mobility for the initial and final evaluation can be found in Table 10, 11, 12, 13, 14.

**Table 10.** Active mobility – scapulohumerale abduction

| | | initial DR | final DR | initial STG | final STG | P |
|---|---|---|---|---|---|---|
| **Median** | | 147,00 | 165,00 | 145,00 | 164,50 | |
| **Percentile** | **25** | 112,50 | 134,00 | 116,25 | 135,50 | |
| | **75** | 167,00 | 176,00 | 160,00 | 175,00 | |
| P | | | | | | p<0,001 |

**Table 11.** Active mobility – scapulohumerale flexion

| | | initial DR | final DR | initial ST | final ST | |
|---|---|---|---|---|---|---|
| **Median** | | 134,50 | 155,50 | 133,50 | 160,00 | |
| **Percentile** | **25** | 104,50 | 123,00 | 105,00 | 125,00 | |
| | **75** | 170,00 | 180,00 | 173,75 | 180,00 | |
| P | | | | | | p<0,001 |

**Table 12.** Active mobility – scapulohumerale internal rotation

| | | initial DR | final DR | initial ST | final ST | |
|---|---|---|---|---|---|---|
| **Median** | | 63,50 | 75,00 | 65,00 | 77,00 | |
| **Percentile** | **25** | 38,50 | 51,00 | 40,00 | 50,50 | |
| | **75** | 81,75 | 90,00 | 86,50 | 90,00 | |
| P | | | | | | p<0,001 |

**Table 13.** Active mobility – scapulohumerale external rotation

| | | initial DR | final DR | initial ST | final ST | |
|---|---|---|---|---|---|---|
| **Median** | | 61,50 | 75,00 | 63,00 | 75,00 | |
| **Percentile** | **25** | 35,50 | 47,75 | 36,25 | 50,50 | |
| | **75** | 79,75 | 90,00 | 87,00 | 90,00 | |
| P | | | | | | p<0,001 |

**Table 14.** Active mobility – coxofemoral abduction

| | | initial DR | final DR | initial ST | final ST | |
|---|---|---|---|---|---|---|
| **Median** | | 23,50 | 32,00 | 23,00 | 32,00 | |
| **Percentile** | **25** | 17,75 | 26,25 | 17,25 | 25,00 | |
| | **75** | 27,00 | 37,00 | 28,00 | 36,75 | |
| P | | | | | | p<0,001 |

## Discussions

The present study wished to follow the aspects and results in the development of the gross motor function, influencing range of motion and spasticity in children with cerebral palsy during an aquatic therapy intervention program.

The results indicate changes with positive statistical significance on the gross motor function. For the dimensions A (lying and rolling), B (sitting), D (standing) we observe a significantly higher increase between the initial and final evaluation in children with higher GMFCS level (IV, V). For the dimension E (walking, running and jumping) significantly higher results were gained by children with a lower GMFCS level (II, III).

Gorter-Currie (2011) in a review of the articles written between 2005 - 2011 about aquatic programs for children and adolescents with cerebral palsy claims that most studies involve children with the GMFCS level I, II, III and one single participant with level IV. None of these studies involved participants of GMFCS level V. For these reasons the results of the studies could not be generalized for children suffering from severe neuromotor disabilities. As a result of the discussions Gorter-Currie claims that information is missing regarding the population who could potentially benefit most from the effects of a therapeutically aquatic intervention. (11) The water is a gentle environment by comparison with the land and could allow children especially with level GMFCS IV, V to move in the water more freely than on land. (Fragala-Pinkam 2009)

Our study involved 6 participants with level GMFCS IV (2 participants) and V (4 participants).

We have shown that patients with a higher GMFCS level will gain significantly higher score in the subsection A ($p = 0{,}002$), subsection B ($p = 0{,}002$), subsection D ($p<0{,}001$).

The gained results for the GMFM test are in conformity with Mackinon (1997), Thorpe et al. (2005), Fragala-Pinkham et al. (2009).

Makinnon (1997) observes an increase of the total GMFM score from 91% to 96% in a case study of a patient suffering from spastic diplegia following an aquatic program of 6 weeks with one weekly session. Thorpe et al. (2005) have established an increase of the E dimension of 7% ($p=0{,}01$) after applying an aquatic program of 10 weeks with a frequency of 3x per week of 45 minutes.

Chrysagis et al. (2009) determines an improvement of the E dimension of 6,02% after a program of 10 weeks with a number of 6 participants in an experimental group.

In our study in the case of the E dimension at the 25% percentile we observed an increase of 5,21%, at the 75% percentile an increase of 15,62% and at the median an increase of 18,75%.

The distribution of the study group is non normal which is the reason why we used the median and percentile 25% and 75% for expressing the results.

Fragala-Pinkham et al. (2009) determined a significant statistical improvement for the total score GMFM of 7,53% following a program of 12 sessions which took place over 6 weeks, 60 minutes a session: 8 sessions of aquatic therapy, 4 sessions of physical therapy.

In our study for the total score GMFM we observed the following improvement: at the 25% percentile an increase by 9.19%, at the percentile 50% an increase of 12,21% and the 75% percentile an increase of 9,41%.

Our higher scores can be attributed to the extended intervention program duration of 6 months which is 3 or 4 times longer than the duration of the aquatic programs mentioned in the previous studies.

The results achieved in this exploratory study and the analysis of the former studies indicate the fact that aquatic programs with a frequency of 2-3x per week and a duration of 45-60 minutes have a positive influence on the development of the gross motor function.

The program application duration, in the case of our study of 6 months compared to the duration of maximum 14 weeks in the case of the former studies can suggest the fact that the extended application of an aquatic program contributes to the significant increase of the GMFM scores.

The fact that we included 6 participants with a GMFCS level IV and V and the fact that they showcased significant statistical results in the dimensions A, B, D confirms Gorter-Currie (2011) theory that these children could potentially benefit most from the effects of an aquatic therapeutic intervention.

Range of motion has increased both for the active and passive mobility in the case of scapulohumerale abduction, scapulohumerale flexion, internal and external scapulohumerale rotation and coxofemoral abduction which is in agreement with the findings of Pegannof's study (1984) who achieved improvement at the level of the scapulohumerale flexion of 15 degrees both for the passive and active movement and 10 degrees for the scapulohumerale abduction both for the passive and active movement.

In the case of our study for the active scapulohumerale abduction we observed at the 50% percentile an increase of 18 degrees (right), 19 degrees (left), at the 75% percentile an increase of 9 degrees (right), 15 degrees (left), at the 25% percentile an increase of 22 degrees (right) and 19 degrees (left).

For the passive scapulohumerale abduction we observed at the percentile 50% an increase of 15 degrees (right), 13.50 degrees (left), at the percentile 75% an increase of 7 degrees (right), 7 degrees (left), at the 25% percentile an increase from 19,25 degrees (right) and 17 degrees (left).

For the active scapulohumerale flexion we observed at the 50 % percentile an increase of 21 degrees (right), 26 degrees (left), at the 75% percentile an increase of 10 degrees (right), 6,25 degrees (left), at the 25% percentile an increase of 18,50 degrees (right) and 20 degrees (left).

For the passive scapulohumerale flexion we observed at the 50 % percentile an increase of 14 degrees (right), 18 degrees (left), at the 75% percentile an increase of 7 degrees (right), 5 degrees (left), at the 25% percentile an increase of 18,75 degrees (right) and 18,75 degrees (left).

These changes can occur as a result of the reciprocal movement of the arms during backstroke which activates the flexors and abductors of the shoulder. (Peganoff1984, Kelly-Darrah 2005) The floatability of water confer people with cerebral palsy the opportunity to feel their body freed from the limitations which they experience in the movements against gravity. (McMillan 1977) The warm aquatic environment with the temperature of 32-33 °C reduces the muscular tonus and allows more efficient moves in the case of children with high muscular tonus. (Adams et al. 1991)

Getz-Hutzler (2005) in a review of the articles written from 1966 to 2005 about the effects of aquatic interventions for children with neuromotor disabilities claims that an important factor in the aquatic environment is water temperature. The reactions of the body immersed in warm water of different temperatures has been well documented. (Routi et al. 1997) Four articles out of the review have mentioned an average of the water temperature of 33° C.

The results for spasticity in our study could be owned to the water temperature of 36 ° C; the influence of this temperature on the muscular tonus for children with cerebral palsy has not been studied in other articles.

Warm water and alternative movements of the lower members without the scissoring movement could contribute to the reduction of spasticity in hip adductors. (Lepore et al. 1998, Bromley 1998)

Nash et al. (1989) affirms that the degree of spasticity can vary from one day to the other in the case of cerebral palsy.

Dimirijevic et al. (2012) achieved significant changes with regards to decrease of spasticity $p>0,001$, after applying an aquatic program with a duration of 12 weeks.

Chrysagis et al. (2009) achieved significant statistical results for the spasticity of the hip abductors ($p=0,002$) by applying an aquatic program of 10 weeks.

Within our study significant results were registered for the hip adduction muscles spastisity decrease $p=0,001$for both the lower right member and the lower right member; for the flexors of the left knee $p=0,014$, right $p=0,003$; right sural triceps $p=0,001$, left $p=0,003$; right brachial biceps $p=0,014$ left $p=0.008$.

## Conclusions

The present paper has aimed to track the effects of an aquatic therapy intervention program on the gross motor function, spasticity and range of motion in children with cerebral palsy. The results of the study have shown significant statistical differences with regards to the increase of both active and passive range of motion, decrease of spasticity and improvement of gross motor function in all the studied dimensions.

The aquatic program beside land base exercise improve the gross motor function. For the dimensions A (lying and rolling), B (sitting), D (standing) a significantly higher increase between the initial and final evaluation was gained by children with higher GMFCS level (IV, V). For the dimension E (walking, running and jumping) significantly higher results were gained by children with a lower GMFCS level (II, III). Patients with a higher GMFCS level gained significantly higher score in the subsection A ($p = 0{,}002$), subsection B ($p = 0{,}002$), subsection D ($p<0{,}001$).

Also children with higher GMFCS level (IV, V) could benefit from the effects of an aquatic therapeutic intervention.

Range of motion increase both for the active and passive mobility in the case of scapulohumerale abduction, scapulohumerale flexion, internal and external scapulohumerale rotation and coxofemoral abduction after the aquatic therapeutic intervention.

The floatability of water confers people with cerebral palsy the opportunity to feel their body freed from the limitations which they experience in the movements against gravity. (McMillan 1977)

The warm aquatic environment with the temperature of 36 °C could reduces the muscular tonus and allows more efficient moves in the case of children with high muscular tonus.

Warm water and alternative movements of the upper and lower members could contribute to the reduction of spasticity.

Aquatic exercise programs can be a beneficial therapy form, a pleasant alternative for children and adolescents with cerebral palsy including those with significant motor / movement limitations for whom physical activities on land are difficult.

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