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The Effect of a Functional Progressive Strength Training Program on Mobility of Ambulatory Adolescents and Young Adults with Cerebral Palsy

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Abstract

The present single blind randomized control trial examined the effect of a school-based functional strength training program of the lower limbs, during the Adapted Physical Education (APE) class, upon the mobility of ambulatory adolescents and young adults with Cerebral Palsy (CP) (GMFCS I-III). The participants, 35 individuals with diplegia and tetraplegia, aging 12 to 19 years old, were allocated in the Experimental and Control Conditions (EC&CC). The EC received their treatment with functional weight bearing exercises, 3 times per week for 10 weeks. Both groups followed their conventional treatment at school. Mobility was assessed with GMFM (D&E), GMFM D, GMFM E, Sit to Stand (STS), Lateral Step up (LSU) and Time Up and Go (TUG). Secondary outcome variables were isometric strength, passive range of motion and spasticity. The results were significant for GMFM (D&E), GMFM D, GMFM E, STS, LSU, TUG and isometric strength. No adverse effects were found for ROM and spasticity. The findings are discussed in accordance to the conflicting literature, the repetitive tasks throughout the intervention, specificity of functional strength training and the enjoyment experienced during the intervention of the CP adolescents and young adults in the EC.

Keywords: Cerebral palsy; Strength training; Functional activities; Mobility; Physical therapy; Adapted physical activity

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Introduction

Strength training has been reported in the literature as an effective intervention for individuals with Cerebral Palsy-CP [1,2]. The effect of strength training programs has been essentially based upon the ICF model [3] and its respective limitations within the 'Body Functions and Structures' and 'Activities and Participation' components [4]. Further, strength has been traditionally used by PT practitioners and related specialists (e.g. adapted physical activity specialists) in order to restore and maintain the physical, psychological and social potential of individuals with CP [5].

During the last 15 years, a number of systematic reviews have questioned the effectiveness of strength training programs upon the mobility [2], functional activities of daily living [5-7], motor abilities [8], activity capacity [9], etc of CP individuals. The above studies reached to contradicting results. These results were previously supported by Taylor et al. [4] who evaluated 18 systematic reviews and stated that whether 'the progressive resistance exercises used is appropriate' remains unclear (p. 1209). The researchers concluded that despite the term used (e.g. progressive resistance training or strengthening exercises) more research is required to clarify whether strengthening programs may substantially improve daily activities and participation of the individuals involved [4]. The above conflicting findings and the need to provide evidence based data for practitioners in the field led us to follow the previous research suggestions [1,8,9,], claiming that more RCTs are required to evaluate the effectiveness of strengthening interventions upon the mobility of individuals with CP.

The published RCTs examining the effect of strength training programs on mobility and walking ability of individuals with CP have reached to conflicting results. Scholtes et al. [10] for example reported a significant increase in isometric strength of the knee extensors and abductors but this improvement was not accompanied with an increment in mobility measures (GMFM 66, STS and LSU tests). Later, Scholtes et al. [11] failed to support a significant effect on the walking ability measured with 10 MWT, 1 MIN FAST WALK TEST, TIMED STAIR TEST and CAPE. Taylor et al. [12] did not report a significant effect on 6 MIN WALK TEST, self-selected walking speed, TUDS and GMFM 66 (D&E). Cheng et al. [13] found a positive effect on muscle strength but no effect on gross motor function measured with BOTMP. Finally, Unger et al. [14] reported no significant effect on the walking parameters examined. On the other hand, other RCTs reported significant positive effect of strength training programs on mobility. Liao et al. [15] for example found improvement in GMFM 88 scores after a six week strength training program. Verschuren et al. [16] found a significant effect on muscle strength and agility and Bryant et al. [17] reported significant differences in GMFM 88 scores (D) for the intervention bicycle group and trends for improvement for cycling and treadmill intervention groups in GMFM 66 and GMFM 88 (E) scores. Dodd et al. [18] did not report significance but stated that there was a trend only for the experimental group to improve in GMFM 88 (E) scores following a strength training program. Finally, although Fowler et al. [19] reported no significant between group differences, they reported a significant pre-post improvement in the 600 yards test and GMFM 66 following a strength training program for the experimental group.

The above conflicting findings provided the rational for conducting the present study. Our literature review suggested that the reported ambiguities may be due to the various interventions employed [7,19], protocols [6,10], the guidelines used [9], variability of the participants [1,12,16,17,19], duration [7,10,13], setting [12,18], severity [7,13,19], etc. Following the above ambiguities therefore and the recommendations for conducting RCT studies to guide future clinical practice, the present study was designed to examine the effect of a school-based functional strength training program of the lower limbs upon the mobility of ambulatory adolescents and young adults with CP tetraplegia and diplegia, aging 12 to 19 years old. It was anticipated that the strength training program would enhance the strength which, in turn, would enhance the mobility of the participants. For the purposes of the present study mobility was defined, according to ICF [3], as the 'ability to change body position or location or by transferring from one place to another' (p. 179).

Materials and Methods

Power analysis

A power analysis was initially conducted, using the effect size from a strengthening program assessed with the GMFM score (D&E) [15]. The G* Power 3 program was employed [20] for that reason, with an effect size of 1.20, alpha level of 0.05, power of 0.80, two independent groups and two assessments across time. The results revealed that a minimum of 6 participants was deemed necessary (3 per group) to detect significant findings.

Participants

Initially a pool of 42 adolescents and young adults (12 to 19 years old) from 4 special schools in the wider area of Athens was identified for recruitment in the present study (convenience sampling). The inclusion criteria were as follows:

a) Diagnosis of spastic cerebral palsy

b) Ability to follow simple commands

c) GMFCS I-III.

Further, they did not participate in an organized strengthening program for the last 3 months, and were not exposed to any

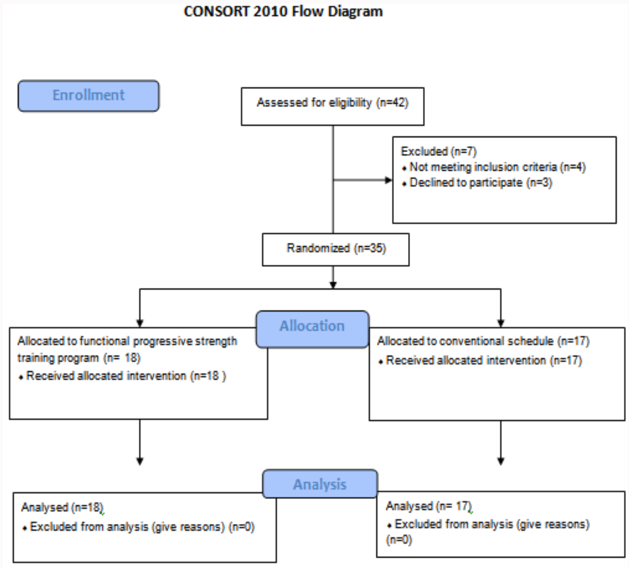

Figure 1: CONSORT 2010 Flow Diagram.

therapeutic intervention procedure such as surgery, Botox injection, spasmolytic medication, etc during the last six months [18,21]. The participants did not exhibit unstable seizures or other medical conditions (e.g. diabetes, cardiac disease) or behavioral impairments. Accordingly, 7 participants were excluded due to upcoming surgery (n=1), unwillingness to participate (n=3) and Botox injection (n=3). The total sample therefore was limited to 35 participants. The flow diagram may be seen in (Figure 1).

The study was approved as a requirement for the PhD thesis of the primary researcher, by the ethics committee of the National and Kapodistrian University of Athens and the Ministry of Education, and performed according to the declaration of Helsinki. The adolescents and young adults with CP who met the inclusion criteria and provided the informed concern form were eligible for participation. Their demographics were published by Chrysagis et al. [21]. The participants were informed from the primary researcher for the purpose of the study. A single blind randomized control trial was designed. Blindness was feasible by the assessors who were not aware of the participants enrolled in the experimental or control groups and the purposes of the study. The team of assessors was constituted by two physiotherapists experienced with CP individuals.

Measures/tools

The primary outcome measures were GMFM (D&E), GMFM D, GMFM E, Sit to Stand (STS), Lateral Step up (LSU) and Time Up and Go (TUG) [21]. GMFM is an observational tool that measures gross motor function and consists from 5 parameters with 88 items. In the present study, the dimensions D (standing) and E (walking, running, jumping) were used in percentage, combined (D&E) and separate for D (standing) and E (walking/running/jumping). The STS assesses the repetitions an individual performs in 30 sec, from rise in a chair and sit back. In the LSU the individual places one leg on a step beside and the assessor records (in 30 sec) the number of repetitions placed by the other leg on to the step and back to the initial position (onto the floor). The TUG assesses the time needed for the individual to rise from a chair, walk a distance of three meters, come back and sit again in the chair.

Secondary outcome measures were range of motion, strength and

Table 1: Baseline repeated sample t-tests (between right and left side) with respect to the secondary outcome variables.

Variable	Mean Differences	S.E Differences	t	p
Passive ROM				
Knee extension	0.17	1.06	0.162	0.872
Hip abduction	0.34	0.85	0.404	0.689
Isometric strength				
Knee flexion	0.48	0.32	1.484	0.198
Knee extension	-0.06	0.44	-0.131	0.896
Hip abduction	-0.3	0.3	-0.987	0.33
Spasticity				
Hip adduction	-0.11	0.13	-0.892	0.379
Knee flexion	-0.17	0.1	-1.785	0.083
Knee extension	-0.03	0.11	-0.255	0.8

spasticity. A plastic goniometer was used to evaluate the passive range of motion of the knee extension and hip abduction. The isometric strength of the knee flexors/extensors and hip abductors was examined with a hand held dynamometer (Nikolas Manual Muscle tester). The individuals actively applied effort after the examiners command in order to evaluate isometric strength. Finally, the modified Ashworth scale [22] was used to evaluate the spasticity of the hip adductors and knee flexors/extensors. The Ashworth scale takes into account the muscle resistance to passive motion in a 5 graded scale.

Statistical analysis

The SPSS 13.0 was used for data analysis. Repeated sample t-tests examined the pre-test differences between right and left side with respect to the secondary outcome variables. The secondary outcome variables were spasticity, Range of Motion (ROM), and strength (knee extensors, knee flexors, hip abductors and hip extensors). No differences were found and the results were averaged for further statistical analyses (Table 1).

Baseline comparisons were examined then with respect to the primary outcome variables, with independent sample t-tests. The independent variable was experimental condition (Experimental Group -EG *vs.* Control Group-CG), and the primary outcome variables for mobility were the GMFM (D&E) total score, GMFM D, GMFM E, Lateral Step Up (LSU), Sit To Stand (STS) and Time Up and Go (TUG) scores. No significant differences were found in the above baseline comparisons for GMFM (D&E) total score (t=0.398, p=0.693), GMFM D (t=0.356, p=0.724), GMFM E (t=0.397, p=0.694), LSU (t=0.044, p=0.965), STS (t= -0.379, p=0.707) and TUG (T= -0.707, p=0.939) scores.

Separate ANCOVAs were then used for data analysis. The goal was to examine the post test differences between the EG and CG, with the adjustment of their pre testing scores. Intraclass Correlation Coefficients (ICC) was used to report reliability. The 0.05 was the pre determined significance level.

Procedure

A sealed allocation procedure was followed to assign the 35 participants in the experimental and control groups. The randomization was stratified according to the GMFCS scores (I: n=9, II n=15, and III: n=11). The research team provided the sealed envelopes, after the baseline assessment, and the whole sample was assigned to 18 participants in the experimental (I: n=5, II: n = 8, III: n=5) and 17 participants in the control (I: n=4, II: n=7, III: n=6) groups.

Table 2: Pre-post test data in the primary and secondary outcome variables.

Variable	Baseline (pre)	Post
Primary Outcome Variables		
GMFM (D & E)		
EG	63.61 ± 17.10	66.70 ± 16.53
CG	62.21 ± 18.57	61.80 ± 16.98
GMFM-D		
Experimental Group	70.22 ± 16.20	73.22±15.59
Control Group	68.17 ±17.93	68.63±14.74
GMFM-E		
Experimental Group	57.00 ± 19.84	60.18 ± 19.88
Control Group	54.25 ± 21.16	54.98 ± 21.45
TUG		
Experimental Group	18.21 ± 9.25	17.50 ± 8.64
Control Group	18.47 ± 10.35	18.67 ± 9.55
STS		
Experimental Group	9.94 ± 2.07	10.83 ± 1.75
Control Group	10.23 ± 2.46	10.00 ± 2.47
LSU		
Experimental Group	10.05 ± 3.49	11.50 ± 3.48
Control Group	1.00 ± 4.00	10.44 ± 4.75
Secondary Outcome Variables		
Passive ROM		
Knee extension-EG	44.25 ± 12.75	42.14 ± 11.91
Knee extension-CG	40.15 ± 11.69	40.62 ±10.04
Hip abduction-EG	25.56 ± 8.15	26.54 ± 7.88
Hip abduction-CG	29.06 ± 9.98	30.15 ± 8.58
Isometric strength		
Knee flexion-EG	15.13 ± 4.09	17.51 ± 4.18
Knee flexion-CG	13.21 ± 3.81	14.81 ± 4.47
Knee extension-EG	25.29 ± 9.70	32.26 ± 11.12
Knee extension-CG	21.48 ± 8.82	23.69 ± 9.56
Hip abduction-EG	8.98 ± 2.37	10.23 ± 2.53
Hip abduction-CG		
Spasticity		
Hip adduction-EG	1.92 ± 0.69	2.00 ± 0.54
Hip adduction-CG	2.09 ± 0.69	2.06 ± 0 .83
Knee flexion-EG	2.25 ± 0.67	1.86 ±0.61
Knee flexion-CG	2.15 ± 0.75	1.88 ± 0.52
Knee extension-EG	2.31 ± 0.75	2.17 ± 0.62
Knee extension-CG	2.35 ± 0.70	2.21 ± 0.71

The participants in the control group followed, throughout the 10 week intervention, with their conventional schedule. Their schedule incorporated services from PT, OT and speech therapy specialists, according to their individualized educational needs. They also received adapted physical education services three times per week.

The participants in the experimental group received their

Table 3: Reliability coefficients (ICC) for the primary outcome variables.

Variables	ICC
GMFM (D & E)	0.99
GMFM D	0.98
GMFM E	1
TUG	0.99
STS	0.88
LSU	0.97

Table 4: ANCOVA with the post test differences and the baseline (pre) scores as a covariate for the Primary Outcome Variables.

Control	62.95			
GMFM E		7.328	0.011	0.186
Experimental	58.84			
Control	56.4			
GMFM D		4.52	0.041	0.124
Experimental	72.36			
Control	69.54			
TUG		5.752	0.022	0.152
Experimental Group	17.62			
Control Group	18.56			
STS		6.25	0.018	0.163
Experimental Group	10.94			
Control Group	9.89			
LSU		6.761	0.014	0.174
Experimental Group	11.47			
Control Group	10.47			

conventional schedule with individualized PT, OT and speech therapy services. During the adapted physical education classes that lasted 40 to 45 min approximately, they performed the functional weight bearing program (20 min to 25 min). The weight bearing sessions consisted of a warm up, the main program and the cool down period. The main program incorporated functional weight bearing exercises for the lower limbs such us sit to stand, front and lateral step up in a circuit training format, in three stations. The first station consisted of one of the above mentioned exercises with the body weight for resistance and combined with ball skills such as passing, catching and shooting in various adapted games (e.g. basketball, volleyball, and handball). In the second station the participants had to rise from a chair and sit down (sit to stand) with a backpack with weights. The third station consisted of lateral or front step up or sits to stand according the participants capabilities with low charging. Each exercise was carried out with three sets of ten repetitions each, with a two minutes interval between sets. The amount of resistance was determined with the ten repetition maximum test. Redefinition of the resistance was estimated every week and the charge was increased by 5% to 10% when the participants were able to execute more than 12 repetitions during the third set. The progressive weight bearing resistance was initially estimated in the first week as 90% of the 10 RM in each station.

The participants, in both the experimental and control groups, were instructed not to follow an organized strength training program throughout the study.

Results

The total sample (N=35), classified at levels I (N=9), II (N=15) and III (N=11) of the GFMFC E&R, constituted from boys (N=17) and girls (N=18), with a mean age of 14.97 ± 2.03 years and BMI of 21.05 ± 1.98 (21.14 ± 1.94 for boys and 20.96 ± 2.07 for girls). The pre-post test data in the primary and secondary outcome variables are presented in (Table 2).

The Intraclass Correlation Coefficients (ICC) was used, accordingly, to estimate the reliability of the primary outcome variables. The analyses revealed coefficients ranging from 0.880 to 0.995. The overall findings are presented in (Table 3).

The ANCOVAs for the primary outcome variables revealed significant post test differences between the experimental and control groups with respect to sit to stand (F=6.250 p=0.018, n^2=0.163), lateral step up (F=6.761, p=0 .014, n^2=0.174), time up and go (F=5.752, p=0.022, n^2=0.152), GMFM (D&E) (F=9.877, p=0.004, n^2=0.236), GMFM D (F=4.520, p=0.041, n^2=0.124) and GMFME (F=7.328, p=0.011, n^2=0.186). Examination of the adjusted pot test mean scores revealed that the experimental group scored higher in the sit to stand, lateral step up, GMFM (D&E), GMFM-D and GMFM- E and lower in the time up and go, compared to the control group.

With respect to the secondary outcome variables, the ANCOVAs revealed significant differences in post test with respect to the isometric strength measures of knee extension (F=37.590, p=0.000, n^2=0.540) and hip abduction (F=6.430, p=0.016, n^2=0.167). The adjusted mean post test scores were higher for the experimental group compared to the control group. No significant differences were found with respect to: a) the passive ROM of knee extension (F=1.879, p=0.180, n^2=0.055) and hip abduction (F=0.609, p=0.441, n^2=0.019), b) spasticity of hip adduction (F=0.135, p=0.715, n^2=0.004), knee flexion (F=0.336, p=0.566, n^2=0.010) and knee extension (F=0.001, p=0.984, n^2=0.001) and c) isometric strength of knee flexion (F=1.932, p=0.174, n^2=0.057). The ANCOVA findings may be found in (Table 4,5).

Discussion

The aim of the present study was to examine the effect of a functional strength training program upon the mobility of adolescents and young adults with cerebral palsy. The results revealed a significant effect regarding the GMFM (D&E), GMFM D, GMFM E; Sit to Stand-STS, Lateral Step Up-LSU and Time Up and Go-TUG tests. Significant improvements were also found for the secondary outcome variables of isometric strength (knee extension and hip abduction) but not for knee flexion. Finally, no adverse effects were recorded for passive ROM (knee extension and hip abduction) and spasticity (hip adduction, knee flexion and knee extension).

With respect the GMFM findings, the results are in agreement with several researchers such as Liao et al. [15] and Fowler et al. [19] who found a significant effect on GMFM- 88 (D&E) and GMFM- 66 respectively after a strengthening intervention program. Similarly, Verschuren et al. [16] reported a significant effect on GMFM D, while Dood et al. [18] reported a trend of significance for GMFM E. On the other hand, Scholtes et al. [10], Taylor et al. [12] and Crompton et al. [23] did not report a significant improvement upon the GMFM- 66 total score, while Lee et al. [24] did not find a significant improvement on GMFM- 88 total score after a progressive resistance training of CP children and adolescents. The difference between the above

Table 5: ANCOVA with the post test differences and the baseline (pre) scores as a covariate for the Secondary Outcome Variables.

Variables	Adjusted post test	F	P	η2
Passive ROM		1.88		0.18
Knee extension	40.46			
Experimental Group	42.38			
Control Group				
Hip abduction		0.61	0.44	0.02
Experimental Group	28.05			
Control Group	28.55			
Isometric strength				
Knee flexion		1.93	0.17	0.06
Experimental Group	16.54			
Control Group	15.83			
Knee extension		37.6	0	0.54
Experimental Group	30.23			
Control Group	25.84			
Hip abduction		6.43	0.02	0.17
Experimental Group	11.64			
Control Group	10.67			
Spasticity				
Hip adduction		135	0.72	0
Experimental Group	2.05			
Control Group	1.99			
Knee flexion		0.34	0.57	0.01
Experimental Group	1.83			
Control Group	1.91			
Knee extension		0.001	0.98	0
Experimental Group	2.18			
Control Group	2.18			

studies and the present study may be due to the different intervention protocols (our study was a combined functional strengthening and adapted physical education program), the age (in the present study age ranged from 12 to 19 years) or the celling effect of scores reported by Crompton et al. [23].

With respect to the STS, the results are in agreement with Blundell et al. [25] who reported an improvement of the experimental group compared to a control group after a functional strength training program in a circuit format. Similar results were reported by Lee et al. [24] and Liao et al. [15] who reported a significant effect for squat to stand and 1 RP of the loaded STS tests respectively for the experimental group. Different results were reported by Scholtes et al. [10] who did not find a significant effect on the STS test in the experimental group. Scholtes et al. [10] however stated that the intervention group performed more repetitions at baseline in the STS, compared to the control group, and this may be the reason for not detecting significance.

In the present study, the experimental group exhibited a significant improvement on the LSU scores. Similar results were reported by Blundell et al. [25] who found a significant effect on the LSU test for the experimental group after functional circuit training. Lee et al. [24] reported that the experimental group showed a greater increase regarding the LSU scores compared to the control group, but 'not to significant degree' (p.). On the other hand, Scholtes et al. [10] reported no significant effect for the experimental group regarding the LSU test. The different search findings so far may be due to several reasons, such as the statistical analysis used (i.e. ANCOVA), training protocols (progressive, functional, circuit), populations examined (children, adolescents, adults), research settings (rehabilitation centers, schools, PT sessions), etc.

With respect to the TUG test, the results are in agreement with Salem et al. [26] who reported a significant effect after a task oriented strength training program in CP children, aged from 5 to 10 years old. In contrast, Crompton et al. [23] found no significant differences at post test between the experimental and control groups. However, a significant time effect was reported for the experimental group which scored higher during post test compared to pre test. According to Crompton et al. [23] these findings may be due to the ceiling effect of the measures employed (GMFM and TUG) since the task related group (experimental) was already highly functioning on the TUG test.

With respect to the secondary outcome variables, a significant effect was detected for the knee extension and hip abduction isometric strength for the experimental group. The results are in agreement with Blundell et al. [25], Scholtes et al. [10] and Dood et al. [18] who examined the isometric strength after a strengthening program. Similar results, regarding the strength of knee extensors, were reported by Chen et al. [13] and Fowler et al. [19] who examined strength with an isokinetic dynamometer. In contrast, Liao et al. [15] and Lee et al. [24] did not find a significant effect on isometric strength of the knee extensors and hip abductors respectively. The contradictive research evidence may be due to the different assessments and protocols conducted. Liao et al. [15] for example assessed the strength isometrically, while the respective program exercised the muscles isotonically. This contradiction may be the reason why Liao et al. [15] was not able to detect a significant improvement. In the present study, the strength training program was conducted with isotonic exercises to facilitate the functionality of the CP adolescents and young adults involved. The assessments however were conducted isometrically, and this may be the reason for the absence of significant effect of the knee flexors, similarly with the results reported by Liao et al. [15] and Scholtes et al. [10]. In line with this perspective are the results of Fowler et al. [19] and Chen et al. [13] who found a significant effect of the knee flexors, examined isokinetically, after a strengthening program.

In the present study the progressive resistance training principles were followed [27]. Specifically intensity, volume, frequency and duration were considered when the intervention program was planned and conducted [16]. Further, the isometric strength was trained functionally, in a closed kinetic chain pattern, and led to significant improvement as expected [18]. Specificity of training may have also contributed to the results, despite the fact that the assessments were conducted isometrically. The above elements have been recorded in the literature and are in line with previous studies supporting the effectiveness of resistance training on strength of CP individuals [10,12,18].

No effect was found for spasticity and ROM indicating that there was no adverse effect as a result of strength training. This finding is in agreement with Scholtes et al. [10], Morton et al. [28], Tweedy et al. [29] and Ensberg et al. [30] who reported no change in spasticity after a resistance training program. No adverse effects were also reported for ROM according to Tweedy et al. [29], Darah et al. [2] and Toner et al. [31]. On the other hand Scholtes et al. [10] found a significant effect in one out of five ROM assessments of the lower limbs. These researchers stated that muscle shortening should be considered after a strength training program [10].

Overall, an increased mobility was evident and the positive effects may be due to the repetitive task oriented characteristics and specificity of functional strength training that was employed in the present intervention program [15]. Further, the participants exhibited no adverse effects and increased their muscle strength of the lower limbs above the lower threshold that is necessary for daily activities. It appears therefore that the increased strength was not at the highest threshold or ceiling effect that could not be accompanied with mobility improvements [10].

The functional strengthening program employed in the present study incorporated certain elements that may have contributed to the positive results. These elements are mainly enjoyment and motivation which may have led to functional mobility improvement [18,24]. Specifically, resistance body weight exercises combined with basketball skills, such us catching and shooting, may have motivated the CP adolescents and young adults to participate. Different exercises such as handling objects resembled daily activities and may have had an effect upon balance, which in turn, had an effect upon mobility [15]. The functional strengthening of the participants involved was enriched compared to the repetitive and task specific program employed from a variety of researchers in the past. The outcome was evident from the improvement in several mobility measures (such as the TUG, STS and LSU) required for CP individuals to operate functionally in their daily lives [25].

Certain limitations do not allow for generalization of the present findings without caution. First, the convenience sample and the GMFCS classification levels (I, II and III) restrict generalizability. Secondly, the participants participated in a physiotherapy program throughout the intervention. The physiotherapy sessions, however, did not incorporate any organized strength training program. Third, the diversity of CP children and adolescents at level III was evident during the LSU and TUG assessments. Few participants were holding a rail, but we allowed that since they could not complete the assessments otherwise [21] finally, the active involvement of the physiotherapists and the adapted physical educators, who worked together and followed the study protocol, constitute another concern and possible limitation.

Future researchers may need to examine the effect of functional strength training, within the organized school program, at a lower classification level (IV). Further, resistance training with a longer duration and follow up should be conducted. Third, individualized programs, according to each participant or level of classification and taking into account specialized weakened muscle groups may be conducted. Fourth, the involvement of different specialists may be an issue to examine in order to clarify their respective effectiveness. Finally, the effectiveness of combined strengthening with balance, agility and Biofeedback may be considered from future researchers.

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