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RESEARCH PAPER

Group aquatic training improves gait efficiency in adolescents with cerebral palsy

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Abstract

Purpose. To evaluate the effect and feasibility of a 10-week group aquatic training programme on gait efficiency in adolescents with cerebral palsy (CP). The secondary purpose was to determine the exercise intensity during aquatic training in a heterogeneous group of adolescents with CP and to investigate the impact of the training programme on the musculoskeletal system.

Method. Twelve ambulatory adolescents with spastic CP were recruited. They participated in 20 aquatic training sessions (45 min twice a week). Three physical therapists and a sports teacher supervised the training sessions. Participants wore a heart rate monitor to assess sessions' intensity and a floatation device as appropriate. The primary outcome measure was gait efficiency as measured by the gait energy expenditure index (EEI). The secondary measures were (1) gait spatiotemporal parameters, (2) maximal isometric knee strength and (3) gross motor function.

Results. Ten adolescents completed the training programme. No adverse effect was reported. Average exercise intensity was mild to moderate for more than half of the training session. A significant reduction of the EEI and the heart rate during walking was observed following the training programme. No significant change was observed on secondary outcome measures.

Conclusions. Group aquatic training increases gait efficiency in adolescents with CP. This improvement is related to systemic cardiorespiratory adaptations. Group aquatic training programme is feasible in adolescents presenting CP at different levels of severity.

Keywords: *Aquatic training, gait efficiency, muscular strength, adolescent, cerebral palsy*

Introduction

Approximately three-quarters of children and adolescents with cerebral palsy (CP) are ambulatory with or without assistive device [1]. They typically walk more slowly and expend a greater amount of energy to walk than their healthy counterparts [2]. Such adaptations lead to poor gait efficiency, defined as energy cost per distance travelled during walking [3]. Poor gait efficiency has a significant impact on the autonomy and quality of life of patients with CP, reducing walking distance travelled and increasing the overall level of fatigue [4].

In CP, gait efficiency mainly depends on adaptations of the cardiorespiratory and musculoskeletal systems [2,5–7]. Adequate physical exercise training can attenuate the effects of these adaptations and eventually increases gait efficiency [7]. The cardiorespiratory system can be improved by aerobic training, therefore reducing the proportion of physical capacity required during gait. The musculoskeletal system can also be improved with an appropriate muscle strength training programme and positively impact gait pattern resulting in a more efficient gait [8,9]. Unfortunately, the intensity of spontaneous physical activity is usually too low to significantly improve the cardiorespiratory or musculoskeletal systems (i.e. aerobic capacity and muscular strength). People with CP need to be enrolled in a training programme to significantly impact these systems [10]. Adolescents with CP could particularly benefit from an adequate training

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programme considering the important functional decline reported during this life period [11] and the commonly observed degradation of ambulatory capacity during adolescence [12,13].

Previous works suggest that aquatic exercise could possibly improve both cardiorespiratory fitness and muscular strength in adolescents with CP and therefore be an interesting approach for improving gait efficiency. The resistive forces of buoyancy and viscous drag permit a variety of strengthening and aerobic exercises that can be adapted to a wide range of motor abilities [14]. Also, the negative influence of poor postural control and excessive joint loading is reduced in water. Moreover, swimming and aquatic exercise can be performed in a playful way, therefore maintaining a higher level of motivation and treatment adherence. Despite these multiple theoretical benefits, little work has been done on the effect of aquatic training in CP and its impact on gait efficiency is scarcely studied.

A systematic review of the effectiveness of aquatic training in children and adolescents with CP (excluding aquatic physical therapy programme such as hydrotherapy) included only three studies [14]. Among these three studies, two were single case reports [15,16]. Thorpe and Reilly [15] reported an improvement of gait efficiency, gait velocity and muscle strength after 10 weeks of water walking, and specific swimming exercises to increase muscular resistance. After 8 weeks of training based on swimming exercises, Peganoff [16] showed an improvement of the upper limb function in a child with CP but gait parameters were not measured during the study. Finally, Hutzler et al. [17] showed that an individualised mixed training programme, which included two swimming sessions and a gymnastic session per week for 6 months, improved the vital capacity of children with CP. The specific impact of aquatic activities remains unclear in said study because both land- and aquatic-based activities were included and the aquatic training was individualised. To our knowledge, no other significant work was conducted on aquatic training in CP.

The primary goal of this study was to examine the feasibility of a group aquatic training programme and its effectiveness to improve gait efficiency in adolescent with CP presenting motor deficits of various severities. Group aquatic training feasibility in CP has never been studied. Group training programmes can be more easily applied in a clinical setting because they allow training of multiple individuals at the same time. However, CP is characterised by inherent heterogeneity between patients and group training might be less adapted for this population. Also, the intensity induced by group aquatic training in CP has never been studied. The secondary purpose was to evaluate aquatic exercise intensity in a heterogeneous group of adolescents with CP. The impact of the training programme on the musculoskeletal system was also investigated.

Methods

Participants

Twelve adolescents (aged 14–21 years) with spastic CP were recruited from the same adaptive school. Inclusion criteria for this study were the ability to follow simple verbal instructions and to be independent in walking (with or without assistive devices) for at least 5 min. Exclusion criteria were any known cardiovascular disease and recent (within the last 8 months) surgical intervention or botulinum toxin A injection in the lower extremities. Selection criteria were set to include adolescents with different motor function levels in order to take into account the intrinsic variability in spastic CP. This study was approved by the Sainte-Justine University Hospital Research Center Ethics Committee and all participants or parents (as required) signed an informed consent. All participants received their usual medication and physical therapy care during the training programme, which did not change throughout the study period. Table I shows descriptive data for each participant.

Intervention

The adolescents participated in an aquatic training programme that focused mainly on swimming. All participants performed 20 group training sessions (45 min/twice a week) (water temperature range: 31°C–32°C). Each session was supervised by three

Table I. Participants' characteristics.

Participant	Age (years)	Type CP	GMFCS	Primary mobility device
1	18	Q	I	None
2	21	Q	I	None
3	17	H	II	None
4	18	D	II	None
5	18	D	II	None
6*	14	D	II	None
7	16	Q	III	Walker
8	18	D	III	Walker
9	20	D	III	Crutches
10	13	D	III	Walker
11	20	Q	IV	Walker
12*	14	D	IV	Walker

CP, cerebral palsy; D, diplegia; GMFCS, gross motor function classification scale; H, hemiplegia; Q, quadriplegia.
*Participant who did not complete the training.

physical therapists and one sports teacher. Depending on their ability to swim, participants wore a belt with the adequate number of floatation devices to ensure their safety. All participants entered the water self sufficiently and three used an adapted ramp. Each training session followed the same predetermined routine (see description in Appendix). After a warm-up, participants performed a 15-min race relay, which was followed by a 5-min cool down activity, and then participants took part in aquatic activities such as water polo or volley ball for 15 min.

During each training session, four participants at a time wore a heart rate monitor (Polar Electro Oy, Finland). These participants wore the device from the beginning of the warm up session to the end of the training session. This particular monitor records heart rate using a chest belt and transmits the data to a watch. It was chosen because its storage capacity was sufficient to record heart rate at a 1 Hz sampling rate during the entire duration of the training session. Moreover, this device does not restrict movement. The monitor was not used in two participants with important trunk deformity because it was difficult to keep the chest belt in place. Each session's intensity was expressed in percentage of the heart rate reserve (HRR; maximal heart rate − rest heart rate) with maximal heart rate defined as 220-age. According to the American College of Sports Medicine, percentage of HRR between 40–59% and 60–80% are defined as moderate and high exercise intensity, respectively. Time spent at these intensities was measured because they are known to influence cardiorespiratory adaptations [18].

Measurement

The present study used a single group pre-post design. All measurements were performed the week prior to and after the training programme. Measurements were performed between 9 AM and noon on two non-consecutive days. Participants were asked to refrain from caffeine, alcohol and tobacco consumption for at least 12 h before testing.

On the first day, a gait analysis was conducted. Sixteen 14-mm diameter reflective markers were placed by the same experienced examiner over the following anatomic locations of the pelvis and lower extremities: the anterior superior iliac spines, posterior iliac spines, lateral aspect of the knee joints, lateral malleoli, heels, second metatarsals and lateral aspects of the thigh and calf segments. A three-dimensional gait capture was performed using an eight-camera Vicon 512 motion analysis system (Oxford Metrics, Oxford, UK). Participants were asked to walk barefoot at a self-selected walking speed along a 12-m walkway, while data were collected over the middle section (6 m). Participants completed five trials with rest periods provided as needed. Depending on the strike position in the motion capture volume, one or two complete gait cycles were recorded for each trial. Among these complete gait cycles, the six cycles showing the closest velocity values were selected. Strike parameters (spatio-temporal parameters) were obtained using the VICON Clinical Manager software.

On the second day, the heart rate (HR) was measured, while subjects walked at a comfortable speed. HR was used to calculate the energy expenditure index (EEI) to assess walking efficiency. The EEI (beats/m) was used in various studies including individuals with CP [2,19] and is calculated as follows:

$$\mathrm{EEI} = (\mathrm{walking\,HR} - \mathrm{resting\,HR})/\mathrm{walking\,velocity};$$

where walking HR (beats/minute) is the average HR over the last 30 s of the 5-min walking test, resting HR is the average HR over the last 30 s of a 5-min quiet sitting period, and walking velocity (m/s) is the average walking speed during the test. To limit the influence of stress, this test was conducted at the participants' school. The HR was recorded using a Polar heart rate belt monitor (Polar Electro Oy, Finland).

Isometric strength testing was also conducted in a fixed order on the right and left quadriceps, and on the right and left hamstrings using a hand-held dynamometer (Lafayette Instruments, Lafayette, USA) [20]. During the test, participants were in a supported sitting position with the hip and knee at 90° of flexion. Each thigh (proximal to the femoral condyle) was strapped to the seat to fix the position. An experienced examiner held the device rigidly in place while the patient was encouraged with standardised verbal encouragement to push 'as hard as possible' for 4 s. Once familiar with the task, each participant performed three maximal exertions for each muscle with at least one 30-s rest period between each exertion. The peak force was recorded automatically by the dynamometer and the two higher values were retained and averaged. This force value was then normalised with respect to body weight and lower limb length (Newtons metre/kilogram [N m/kg]) [19]. Values obtained from the right and left sides were averaged for each participant. Finally, complaints of pain and injuries were systematically collected during and after the training period.

The functional level was also assessed using sections D (standing) and E (walking, running, jumping) of the Gross Motor Function Measurement (GMFM). The GMFM is a standard criterion-referenced test designed to assess gross motor function in children with CP [21].

Statistical analysis

The data were reported as mean and standard deviation (SD). The normalities of distribution were tested using the Kolgomorov–Smirnov test. The paired *t*-test for dependent group or Wilcoxon test was used to compare variables before and after training depending on the presence of normal distribution. Effect size was calculated by dividing the difference of the means for the outcome variable by the pooled SD, and was interpreted in accordance with Cohen's guidelines: 0.20 as small, 0.50 as moderate and 0.80 as large [22]. We also reported the 95% confidence interval (CI) when changes in the main outcome variables were significant. To assess the impact of the gross motor function level on variables, a subgroup analysis was performed. The higher gross motor function level group included participants with a GMFCS I–II and the lower motor function level group included participant with a GMFCS III–IV. For the subgroup analysis, the Wilcoxon test and Mann–Whitney *U* test were used to compare variables within and between groups, respectively. p values of less than 0.05 indicate statistical significance. Only significant results are reported. All statistical analyses were performed with SPSS (version 17.0).

Results

Training compliance

Participants 6 and 12 dropped out of the study after 5 weeks of training because of a lack of motivation. All other participants ($n = 10$) completed the whole training programme. No complaint of pain or injury related to the aquatic programme was reported by participants or their parents.

Training intensity

HR was successfully collected at least once for eight participants (range: 1–7 samples). The number of valid HR recordings (complete session recording) and a HR recording example are reported in Table II and in Appendix, respectively.

The exercise intensity of the sessions was over 40% of HRR for a total average duration of 24 min. Participants with a higher gross motor function level (GMFCS I–II) spent nearly twice as much time at an exercise intensity greater than 40% of HRR than participants with limited mobility (GMFCS III–IV) (29 min and 15 min, respectively) (see Table II for more details).

Gait efficiency

The EEI significantly decreased (i.e. improved) after training (paired *t*-test, $p = 0.007$, effect size 0.2, 95% CI 0.08–0.39). The EEI decreased in all participants except one (see Table III). Walking HR also decreased significantly after training (paired *t*-test, $p = 0.014$, effect size 0.6, 95% CI 3.29–22.3) whereas resting HR and the distance covered during the walking test remained unchanged (paired *t*-test, $p = 0.3$ and $p = 0.15$, respectively, see Table III).

A subgroup analysis was performed (see Table III) to compare participants with higher (GMFCS I–II) and lower (GMFCS III–IV) motor function levels and to determine whether the impact of training is the same for all levels of severity. As expected, the EEI was significantly lower and walking velocity was significantly higher in participants with GMFCS I–II compared to participants with GMFCS III–IV (Mann–Whitney *U* test, $p = 0.008$). Training led to a significant decrease of the EEI in the lower motor function level group (Wilcoxon test, $p = 0.042$) whereas a trend ($p = 0.09$) was observed in the other group (GMFCS I–II).

Secondary measures

Regarding the effects of training on the secondary outcome measures, opposite foot off and foot off variables increased significantly (paired *t*-test, $p = 0.005$ and $p = 0.029$, respectively). The subgroup

Table II. Training intensity.

	Participants' GMFCS Level	Exercise intensity period (min)		Number of recordings per participant
		40–59% HRR	>60% HRR	
Mean (SD) ($n = 5$)	I–II	19 (3)	10 (11)	4 (2)
Mean (SD) ($n = 3$)	III–IV	12 (5)	3 (5)	3 (2)
Mean (SD) ($n = 8$)	I–IV	16 (5)	7 (10)	4 (2)

GMFCS, gross motor function classification scale; HRR, heart rate reserve; SD, standard deviation.
Number of recordings per participant represents the number of valid recordings included to compute exercise intensity for each participant of the subgroups.

Table III. Participants' gross motor function and EEI variation.

Participant	GMFCS level	EEI (beats/m) Pre-training	EEI (beats/m) Post-training	Walking HR (beats/min) Pre-training	Walking HR (beats/min) Post-training	Resting HR (beats/min) Pre-training	Resting HR (beats/min) Post-training	Walking velocity (m/s) Pre-training	Walking velocity (m/s) Post-training
1	I	0.96	0.82	165	139	89	74	1.3	1.3
2	I	0.54	0.34	133	119	98	96	1.1	1.1
3	II	0.81	0.70	108	110	59	64	1.0	1.1
4	II	1.12	1.22	181	172	105	77	1.1	1.3
5	II	1.25	0.99	143	148	70	82	1.0	1.1
7	III	1.73	1.51	164	152	85	76	0.8	0.8
8	III	2.45	2.10	195	156	94	86	0.7	0.6
9	III	1.65	1.51	173	169	87	87	0.9	0.9
10	III	2.11	1.38	171	149	95	100	0.6	0.6
11	IV	5.06	4.70	163	154	75	75	0.3	0.3
Subgroup mean (SD)	I–II	0.93 (0.28)	0.81 (0.33)	146 (28)	138 (25)	84 (19)	79 (12)	1.1 (0.1)	1.2 (0.1)
Subgroup mean (SD)	III–IV	2.6 (1.41)*	2.24 (1.4)*,†	173 (13)	156 (8)†	87 (8)	85 (10)	0.6 (0.2)*	0.6 (0.2)*
Total mean (SD)	I–IV	1.77 (1.3)	1.53 (1.22)‡	160 (25)	147 (20)‡	86 (14)	82 (11)	0.9 (0.3)	0.9 (0.3)

EEI, energy expenditure index; GMFCS, gross motor function classification scale; HR, heart rate reserve; SD, standard deviation.
*Significant difference between subgroups ($p < 0.01$, Mann–Whitney *U* test).
†Significant difference before and after training ($p < 0.05$, Wilcoxon test).
‡Significant difference before and after training ($p < 0.01$, paired *t*-test).

analysis also showed a significant increase for children with GMFCS III–IV in section E of the GMFM (Wilcoxon test, $p = 0.041$) but not in section D (Wilcoxon test, $p = 0.14$). A detailed description of the results obtained for the secondary measures is presented in Table IV.

Discussion

The goal of the present study was to evaluate the feasibility of a group aquatic training programme in adolescents with CP and its impact on gait efficiency. The programme significantly improved gait efficiency, as measured by the EEI. The EEI reduction was observed in all but one participant. This reduction is mainly due to a significant reduction of the walking HR possibly resulting from cardiorespiratory adaptations. This result is in accordance with other land-based aerobic exercise training results showing a rise of aerobic capacity in children and adolescents with CP [23,24]. Improving gait efficiency could have a significant impact on the quality of life of children with CP because a more efficient gait can increase the distance travelled without fatigue [4]. Also the adaptation of the cardiorespiratory system should be beneficial for all aerobic activities.

Training time spent at an appropriate intensity (>40% HRR) is crucial to provide significant benefits to the cardiorespiratory system in healthy young people [25]. However, to date it was not known whether this observation also applies to patients with CP as there are no specific guidelines available for this population [7]. In the present study, reduction of the EEI and HR during walking did not seem directly related to the total duration spent at over 40% HRR. In fact, participants with lower motor function levels (GMFCS III–IV) obtained the greatest benefit on the EEI even though they spent much less time at exercise intensity greater than 40% HRR than the less affected participants (GMFCS I–II). In patients with lower motor function levels, aerobic fitness is possibly poorer and minimal exercise is then necessary for improving fitness and gait efficiency. Overall, this study shows that 45 min of aquatic activities performed two times per week during 10 weeks is sufficient to improve gait efficiency in adolescents with CP, a population prone to physical deconditioning [7].

Regarding the effects of training on the secondary outcome measures, only two parameters reached statistical threshold (opposite foot off and foot off) but these variations lie within the expected range of spatiotemporal variation, and hence are not clinically relevant [26]. This result can be explained by the fact that the major part of the training sessions included swimming exercises that did not specifically target muscular strength improvement. Whereas this training incorporated specific tasks to increase lower limb muscular strength (i.e. jumping), the time spent practicing such skills was insufficient to induce significant adaptations. Similar results have also been reported by Fragala-Pinkham et al. [27], who showed no effect on muscle strength after a 14-week aquatic training (24 sessions) in children with disabilities. It

Table IV. Participants' secondary outcomes' measure variation.

	Subgroup mean (SD) GMFCS level I–II			Subgroup mean (SD) GMFCS level III–IV			Total mean (SD) GMFCS level I–IV		
	Pre-training	Post-training	*p* value*	Pre-training	Post-training	*p* value*	Pre-training	Post-training	*p* value†
Opposite Foot Off (%)	9 (4)	12 (4)	0.08	11 (3)	14 (3)	0.068	10 (3)	13 (3)	0.005
Opposite Foot Contact (%)	51 (1)	50 (1)	0.225	49 (1)	50 (1)	0.144	50 (1)	50 (1)	0.813
Foot Off (%)	59 (5)	61 (3)	0.893	61 (4)	64 (4)	0.144	60 (4)	63 (4)	0.029
Step Length (m)	0.53 (0.19)	0.57 (0.09)	0.465	0.41 (0.10)	0.41 (0.10)	0.854	0.48 (0.16)	0.50 (0.12)	0.435
Cadence (step/min)	120 (19)	114 (21)	0.50	100 (13)	92 (12)	0.068	111 (19)	104 (20)	0.094
Walking Speed (m/s)	1.03 (0.36)	1.05 (0.10)	0.686	0.68 (0.19)	0.64 (0.19)	0.285	0.88 (0.34)	0.87 (0.26)	0.931
Flexion knee strength (Nm/KG)	0.114 (0.027)	0.122 (0.026)	0.50	0.034 (0.015)	0.042 (0.004)	0.273	0.079 (0.047	0.086 (0.046)	0.197
Extension knee strength (Nm/KG)	0.180 (0.032)	0.212 (0.027)	0.225	0.168 (0.070)	0.150 (0.055)	0.50	0.174 (0.052)	0.181 (0.052)	0.663
GMFM D	90 (12)	88 (12)	0.317	30 (24)	35 (24)	0.141	56(37)	61 (33)	0.149
GMFM E	87 (12)	87 (12)	0.713	24 (28)	27 (29)	0.041	52(40)	57 (38)	0.581

GMFM, gross motor function measure; HR, heart rate reserve; SD, standard deviation.
*Wilcoxon test.
†Paired *t*-test.

appears that non-specific aquatic training has no impact on the musculoskeletal system and gait kinematics.

This study also shows that group aquatic training is achievable in adolescents with heterogeneous functional ability. The use of appropriate floating equipment and a clinician/child ratio of 1/3 were sufficient to ensure the safety of the participants and adequate session animation. In heterogeneous groups, there is a risk that more severely affected participants do not adhere to the training programme because of their functional limitations. Despite the significant commitment required by the participants to complete the training programme, only two participants did not finish the programme, and in these cases, the cessation was related to a lack of motivation. Anecdotally, the participant with the most severe limitations (GMFCS IV) verbally reported the greatest satisfaction. Group aerobic aquatic training programme with children presenting heterogeneous disabilities is therefore feasible and is a pleasurable alternative to land-based exercise programmes to improve aerobic fitness. This is especially important for patients with severe CP suffering from joint deformity and poor balance control because aquatic activities provide an opportunity to generate energy expenditure with minimum joint impact and balance control.

Finally, this study highlights the difficulty related to HR recording with a chest belt during swimming activities in adolescents with CP. Many recordings were uncompleted because of chest belt displacements or because of floatation belt interferences. This problem frequently occurred during swimming movements or when the adolescents clung to the edge of the pool, and was observed more predominantly in children with poorer motor function (GMFCS III–IV), which could explain, at least partially, the slightly smaller number of valid recordings observed in this group (Table II). Some adolescents also presented some trunk deformities that affected the adequate placement of the belt. The experimenters made the choice not to focus on HR recordings during the training session to avoid disturbing the participants during the session. As the training session exercises remained roughly the same during the training programme, it is assumed that the intensity reported provides an adequate representation of the training intensity. To our knowledge, it is the first time that intensity in a group aquatic training is reported in adolescents with CP.

There were inherent limitations in this study. First, the design of this study did not include a control group. However, it should be noted that the training period was short. Also, the main outcome (EEI) is based on a measurement which, in our opinion, is not likely to be influenced by a learning effect. Second, the sample size was rather small. However, as this study aimed to determine the feasibility of group aquatic training, this sample size appears appropriate. Third, the reliability of the EEI and muscular strength measurements has not been tested in the present study. However, the reliability of these measurements has been repeatedly demonstrated in the literature [2,3,28,29]. These measurements were also collected by well trained and experienced evaluators in the present study. Fourth, the measure of training intensity was based on measurements collected during a limited number of training sessions. However, because the training exercises and verbal encouragements remained the same throughout the training sessions, it can be assumed that our data sample was a valid representation of the training intensity across all sessions. In addition, low variability between measurements was observed when multiple recordings were obtained within a given child.

In conclusion, this study demonstrates the feasibility of group aquatic training programmes in adolescents with different severity of CP. This type of training increases gait efficiency through systemic cardiorespiratory adaptations. Aquatic training programmes could therefore have a significant impact on the autonomy and quality of life of patients with CP allowing them to increase their walking distance with less fatigue.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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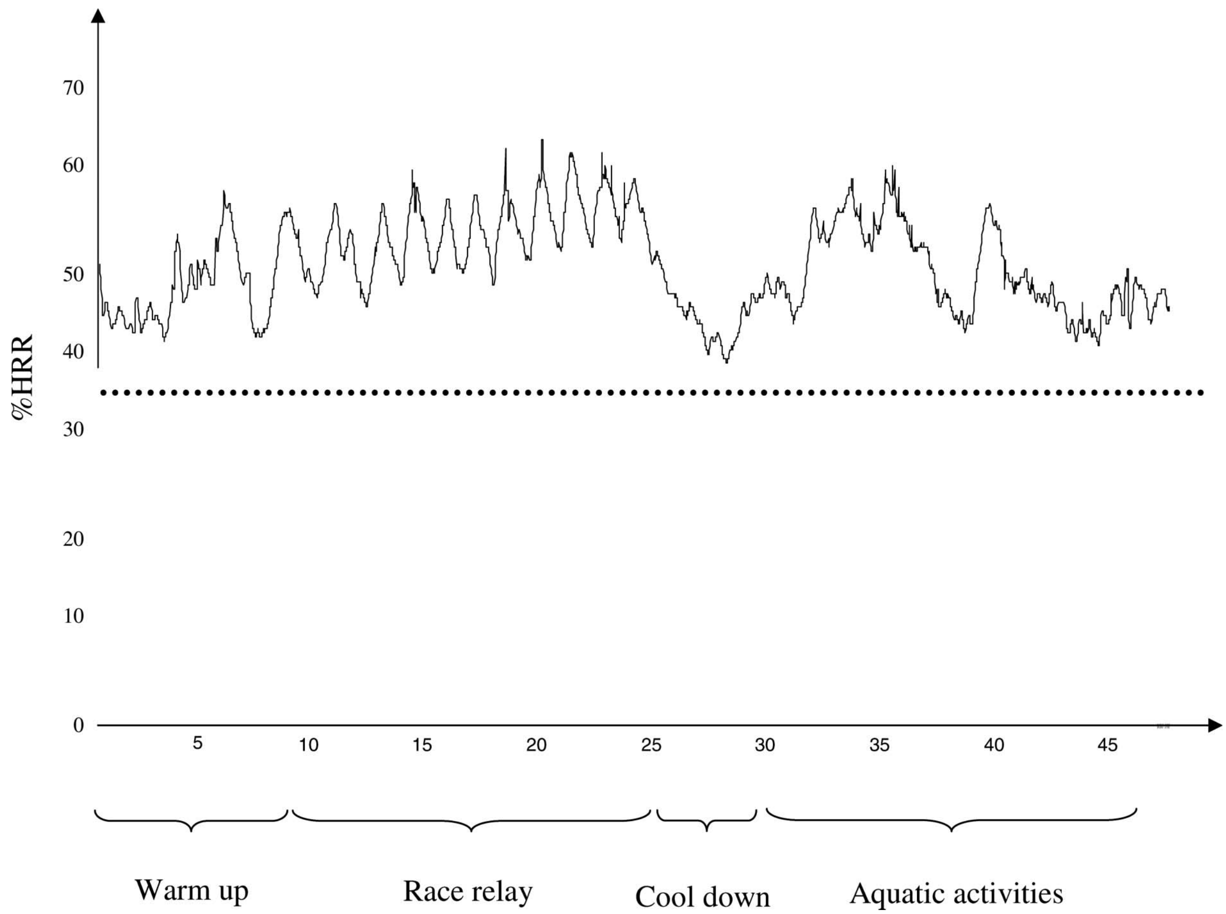
Appendix. Training description

Example of a heart rate recording during a training session



Abbreviation: HR, heart rate.

Training description

All training sessions contained a warm up, relay race, and relaxation period as described above. Aquatic play activities were changed every second week.

Warm up (10 min)

Participants stood in the shallow end of the pool.

Cervical exercises. Participants successively performed five left and right full head rotations, five full head flexions and extensions, five clockwise and counter-clockwise head circumduction motions.

Upper limb exercises. Participants (1) extended their arms upward with fingers interlocked and the palms turned upward (holding the position for 5 s); (2) extended their arms and shoulders forward with fingers interlocked and palms turned forward (holding the position for 5 s); (3) performed 10 push ups on the edge of the pool and finished seated on the edge of the pool.

Lower limb exercises. Participants performed (1) ten jumping jacks; (2) flutter kicks in prone position with hands holding the edge of the pool (slow 5 s, fast 10 s); (3) five water starts by pushing off from the wall of the pool with their legs; (4) five water starts by pushing off from the wall of the pool with their legs, followed by ten flutter kicks.

Relay race (15 min)

Participants were in the deep end of the pool.

Participants were paired according to the same swimming skill levels. They were asked to swim across the width of the pool. Team members were positioned face to face on the opposite edge of the pool and asked to swim successively. Each team member was allowed to swim when his partner touched the edge of the pool.

Therapists followed the children's activities closely.

Relaxation period (5 min)

Participants were asked to float in supine position while relaxing as much as possible.

Therapists made sure that the children made no active movements.

Aquatic play activity (15 min)

Participants stood in the shallow end of the pool.

Participants were asked to pass under the water line five times while swimming down the length of the pool.

By groups of two, participants were asked to pass a balloon to his partner while they swam down the length of the pool.

By groups of three or four, participants were asked to make a pass with a balloon.

Other aquatic play activity implemented. Participants stood in the shallow end of the pool.

- Modified Synchronised swimming: (1) In standing position, participants formed a circle, joined hands, and moved together to the centre of the circle. (2) Participants floated in supine position and formed a circle by touching their feet. Then, the children performed simple synchronised movements (lower or upper limbs).
- Balloon game: (1) Participants formed a circle. They punch the ball which was required to stay in the circle. (2) Same game was repeated with participants kicking the ball in supine position.
- Participants tried to stand on a floating board, floating noodle and balloon in upright and kneel down positions.
- Volley ball.